NOAA Technical Memorandum NMFS-SEFSC-503

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

4 to 7 April 2002
Miami, Florida, USA

Compiled by:
Jeffrey A. Seminoff

U.S. Department of Commerce
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Southeast Fisheries Science Center
75 Virginia Beach Drive
Miami, FL 33149 USA

August 2003

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U.S. DEPARTMENT OF COMMERCE
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PREFACE

The 22nd Annual Symposium on Sea Turtle Biology and Conservation was held April 4-7, 2002 in Miami, Florida and hosted by the U.S. Fish and Wildlife Service. The 22nd symposium was the most globally diverse ever with 839 individuals from 73 countries attending the symposium and associated regional meetings. One third of the attendees were from outside the United States.

This diverse attendance was made possible in large part because of substantial donations from The Packard Foundation, National Fish and Wildlife Foundation, National Marine Fisheries Service, U.S. Fish and Wildlife Service, Convention on Migratory Species, Oceanic Research Foundation, and the International Sea Turtle Society which supported travel grants for 170 international travelers.

A special one day mini-symposium was held concurrently on the second day of the symposium to focus specifically on black sea turtle biology and conservation, with 16 invited papers presented. One hundred and eight oral papers and 321 posters were accepted for the main three-day symposium. Spanish bi-directional interpretation was available for the entire symposium including the black turtle mini-symposium. For the first time French bi-directional interpretation was available for most of the three day symposium. Two workshops, one on beachfront lighting and the other on sea turtle anatomy were well attended.

For two days preceding the symposium, The Wider Caribbean Sea Turtle Conservation Network (WIDECAST) held its annual meeting with country coordinators from 26 Caribbean countries and territories in attendance. Similarly, The Ninth Reunion of Latin American Sea Turtle Specialists convened for two days prior to the symposium with 75 attendees from 15 countries. One day prior to the symposium, two other regional meetings convened at the symposium for the first time. These were the West African Sea Turtle Specialists Group, attended by 38 individuals from 12 West African and one East African country, and the Mediterranean Sea Turtle Specialists which had 23 participants and observers from 13 countries. The IUCN Marine Turtle Specialists Group also met following the symposium and was well attended as always.

This symposium would not have been possible without the service of countless dedicated volunteers who contributed thousands of hours during the year preceding the symposium, throughout the symposium, and until completion of the proceedings. To them on behalf of the entire symposium community I express our gratitude and deep appreciation.

As you reacquaint yourselves with the broad range of topical and informative papers in the proceedings it will become self evident just how successful the 22nd Sea Turtle Symposium was in advancing the cause of sea turtle conservation. It has truly been a great honor and my pleasure to serve as President of the 22nd Annual Symposium on Sea Turtle Biology and Conservation.

Earl Possardt

COMMITTEES, CHAIRS, AND KEY ORGANIZERS

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Latin Reunion	Ana Barragan, Anabella Barrios, Joanna Alfaro
WIDECAST Meeting	Karen Eckert
Mediterranean Meeting	Dimitris Margaritoulis
West African Meeting	Jacques Fretey
Marine Turtle Specialist Meeting	F. Alberto Abreu-Grobois
Fund Raising	Jack Frazier, Wallace J. Nichols, Barbara Schroeder, Earl Possardt, Jeffrey Seminoff, Donna Broadbent

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STUDENT AWARDS

There were 122 student presentations - 28 papers and 94 posters with $US 3,250 awarded to eight recipients. The awards committee was composed of Jeanette Wyneken (Chair), Ana R. Barragan, Stephen J. Morreale, Frank V. Paladino, Michael Salmon, Jeffrey A. Seminoff, Lisa Campbell, Molly Lutcavage, Wallace J. Nichols. The awards were financed by the Chelonian Research Foundation and the Sea Turtle Symposium.

Oral Presentations

Best Biology Oral Presentation

Jennifer M. Keller, Margie Peden-Adams, M. Andrew Stamper, John R. Kucklick, and Patricia McClellan-Green. "Are contaminants affecting loggerhead health?" (Duke University, Coastal Systems Science and Policy, and Integrated Toxicology Program, Beaufort, North Carolina, USA). $500

Runner Up Biology Oral Presentation

Larisa Avens and Kenneth J. Lohmann. "Orientation cues used by juvenile loggerhead sea turtles, *Caretta caretta*, from Core Sound, North Carolina, USA" (University of North Carolina - Chapel Hill, Chapel Hill, North Carolina 27599, USA). $250

Best Conservation Oral Presentation

Kiki Dethmers and Damien Broderick. "Commercial turtle harvests in Australasia: assessing the extent of their impact using mtDNA markers" (Nijmegen University, P.O. Box 9010, 6500 GL, Nijmegen, GLD NL). $500

Poster Presentations

Best Biology Poster

T. Todd Jones, Richard Reina, and Peter L. Lutz. "A comparison of the ontogeny of oxygen consumption in leatherback, *Dermochelys coriacea,* and olive ridley, *Lepidochelys olivacea,* sea turtle hatchlings - Different strokes for different life styles" (Department of Biological Sciences, Florida Atlantic University, 777 Glades Rd., Boca Raton, Florida 33431, USA). $500

Runner Up Biology Poster

Milagros Lopez Mendilaharsu, Susan C. Gardner, Jeffrey A. Seminoff, and Rafael Riosmena. "Feeding ecology of the East Pacific green turtle (*Chelonia mydas agassizii*), in Bahía Magdalena, B.C.S, Mexico" (Centro de Investigaciones Biologicas del Noroeste, S.C. La Paz, BCS 23090, Mexico). $250

Best Field-Based & Experimental Conservation Poster

Christopher Makowski, **Ryan Slattery**, and Michael Salmon. "Shark fishing": A technique for estimating the distribution of juvenile green turtles (*Chelonia mydas*) in shallow water developmental habitats, Palm Beach County, Florida, U.S.A." (Department of Biological Sciences, Florida Atlantic University, 777 Glades Rd., Boca Raton, Florida 33431, USA). $500

Runner Up Field-Based & Experimental Conservation Poster

Lesley Hughes, Anthony Cornett, Kendra Garrett, Michael Salmon, and Ann Broadwell. "The influence of embedded roadway lighting on the orientation of hatchling sea turtles (*Caretta caretta*)" (Department of Biological Sciences, Florida Atlantic University, 777 Glades Rd., Boca Raton, Florida 33431, USA). $250

Best Socio-economic Conservation Poster

Antonia C. Marte. "Preliminary study of the trade of hawksbill turtle shell in the Dominican Republic" (Secretaría de Medio Ambiente y Recursos Naturales, Sub-secretaría de Recursos Costeros y Marinos, Av. J.F. Kennedy, Los Jardines, Santo Domingo, Dominican Republic). $500

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CONSERVATION GENETICS

MOVEMENTS AND ACTIVITIES

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NESTING BEACHES AND THREATS

PUBLIC RELATIONS AND EDUCATION

ANATOMY, PHYSIOLOGY AND DEVELOPMENT

BEHAVIOR AND ECOLOGY

Thirty years of spatial and temporal patterns in distribution of emergences by nesting green turtles in Tortuguero, Costa Rica

Manjula Tiwari[1], Karen A. Bjorndal[1], Alan B. Bolten[1], Rankin Family[2], and Caribbean Conservation Corporation[3]

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[2] Tortuguero, Costa Rica
[3] 4424 NW 13th Street, Suite #A1, Gainesville, Florida 32609, USA

Tortuguero, Costa Rica supports the largest green turtle, *Chelonia mydas*, rookery in the Atlantic. A recent study has shown an encouraging, upward trend for the green turtle nesting population on this 36-km beach. Thirty years (1971-2000) of nesting data are analyzed to determine trends in spatial and temporal patterns of distribution for nesting emergences within a season and among seasons in an increasing, but also naturally fluctuating, sea turtle population. Addressing issues of spatial and temporal nesting patterns are essential for determining the role of density-dependent effects on the reproductive success of this population and, consequently, the carrying capacity of the beach. These results have important implications for recovery and management plans.

A power analysis of selected Caribbean sea turtle population trends

Rhema Kerr Bjorkland and James I. Richardson

Institute of Ecology, University of Georgia, Athens, Georgia 30602, USA

An important objective of survey and monitoring programs is the assessment of population trends. Increasingly such assessments are being used to adaptively manage natural resources. Our objective is to see with what confidence (as measured by statistical power) are some of the current survey designs for nesting beach studies able to detect population trends. Using data from several long-term sea turtle research programs in the Caribbean, we examine the implication of study duration and monitoring frequency on estimates of power. Our results inform our discussions on the implications for the design and conduct of nesting beach studies.

New insights into population biology of leatherbacks from 20 years of research: profile of a Caribbean nesting population in recovery

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[2] National Marine Fisheries Service, Southwest Fisheries Science Center, 8604 La Jolla Shores Drive, La Jolla, California 92037, USA
[3] National Park Service, St. John, 00831 U.S. Virgin Islands
[4] DPNR, Division of Fish and Wildlife, St. Croix 00840, US Virgin Islands
[5] Indooroopilly Sciences Centre, 80 Meiers Road, Indooroopilly, Queensland 4068, Australia

The Sandy Point Leatherback Project takes place on the Sandy Point National Wildlife Refuge in St. Croix, U.S. Virgin Islands. The Virgin Islands Department of Planning and Natural Resources, the project's managing agency, began flipper tagging in 1977, and since 1981 saturation tagging and consistent night patrols each night during the main part of the nesting season have yielded a complete database of information on each female nesting at Sandy Point. Because Sandy Point is subject to predictable seasonal patterns of erosion and accretion, nest relocation of "doomed" clutches (those laid in the erosion zone or below the high water mark and thus have little or no chance of survival) has also been done since 1982. Prior to the start of this project, about 30-40% of nests were washed away, and humans took most of the rest. Nightly patrols and this intensive relocation effort have reduced these threats. Numbers of females nesting annually have increased from around 25 - 30 in the early years to a record 186 in 2001 (Fig. 1). Hatchling numbers have increased from about 2,000 in 1982 to over 41,000 in 2001 (Fig. 2). There was minimal hatchling production prior to 1982, when we began relocating around 30% of the nests laid each season. We propose that the exponential growth in adult numbers beginning in 1991-1992 is the result of the orders of magnitude increase in hatchling production that began in 1982. These trends are consistent with the average age of maturity of 9-14 years that has been proposed for leatherbacks (Zug 1996). The data for the St. Croix nesting population is of sufficient quality to allow application of new modeling techniques that incorporate more realistic assumptions than in the past. Dutton et al. (2000) have previously expressed concern over low nester survival estimated from tag-recapture data, however acknowledged that their measure of "apparent survival", which did not take into account emigration, may have underestimated actual survival. Here we present preliminary results of a more sophisticated model and provide new estimates of nester survival.

Genetic Fingerprinting. We used multiple genetic markers (mtDNA and microsatellites) to construct genetic fingerprints, and have been able to identify individuals and determine family relationships (Dutton et al. 2002). These relationships suggest that this population increase is the result of conservation measures applied years ago. We have also determined that St. Croix is a distinct population with a unique haplotype, and this supports the natal homing theory (Dutton et al. 1999).

Identification. We use a combination of metal flipper tags, photoidentification of the pineal spot, or "pink spot", and PIT tags to identify individuals. High flipper tag loss between nesting seasons (nearly 50% some seasons) prompted the use of photo id as a secondary identification technique. Beginning in 1992, we have also injected each individual with a PIT tag. Using these three methods combined, we are confident that we can accurately identify remigrants.

It was previously thought most turtles are only seen on a nesting beach during one season. These improved identification techniques have shown that on Sandy Point, the majority (69%) are seen again in subsequent seasons. In some seasons, we have used photo ID and PIT tags to identify nearly 33% of untagged (no flipper tags) turtles as remigrants. We estimate that 588 leatherbacks have been tagged since 1977. While the longest remigration interval was 11yrs, most remigrants (97%) returned to nest within 5 years.

Population Model. The consistent, long-term data set has allowed us to apply new modeling techniques based on methods outlined in Kendall (2001). This model estimates survivorship and abundance by taking into account emigration based on re-nesting probabilities that are derived from the turtles' past nesting history. This is one of the first models to account for the variable remigration intervals characteristic of sea turtles. Our resulting model is a good fit to the actual data (X^2=573.2, df=573, P=0.49), and shows that the population is increasing at about 13%. This is high, and similar to those estimated for other recovering populations like the Kemp's ridley. Annual adult nester survival rate is estimated at 0.8932 (95% CI, within 86% - 91%), which is consistent with a healthy stock. This estimate of nester survival is higher than previously estimated (Dutton et al. 2001), since emigration had not been taken into account before.

Recent population models suggest that female biases in sex ratios can have a greater effect on leatherback population trends than previously thought (Chaloupka, this symposium). It is not always possible to predict whether a "doomed" nest will indeed be washed away on some areas of the beach, however, in the past a conservative approach has been taken, where all nests that might be washed away are relocated. We are concerned that this may be depriving this population of the ability to produce males, since these "marginal" nests (e.g. ones that are washed over periodically by high tides, but not necessarily destroyed) may be the only ones exposed to cooler male-producing temperatures (<29.5ºC) (Dutton et al. 1984). At Sandy Point, only prior to April are sand temperatures cool enough to produce males, except for in washover zones. Therefore we believe it is necessary to shift emphasis away from relocating these "marginal" nests.

CONCLUSIONS

(1) The St. Croix population of leatherbacks is truly a population in recovery; (2) Accurate identification techniques show that most turtles are seen in more than one nesting season on Sandy Point; (3) Annual female nester survival is approximately 89%, which is consistent with a healthy population; (4) Beach protection and egg relocation can be effective management tools for a population in peril; and (5) Consistent long-term monitoring and saturation tagging are crucial to realistic population modelling.

Acknowledgements. Funding was provided by US Fish and Wildlife Service, Section 6 appropriations to Virgin Islands Department of Planning and Natural Resources, by Earthwatch Institute, which also provided volunteer support and the National Marine Fisheries Service. Researchers and volunteers: Otto Tranberg, Scott Eckert, Karen Eckert, Susan Basford, Robert Brandner, Barry Kreuger, Janine Ferguson, James Rebholz, Janet Cowden, Scott Forbes, Ana Barragan, Elizabeth Taylor, John Shih, Philippe Mayor, Violeta Villanueva-Mayor, Jeanne Alexandar, and Sean Deishley; Amy Mackay, Zandy Hillis, Brendalee Phillips, Cecil Henry, Thom Grace, Marty Campbell, Andi Dill, Isabella Furer, and 1177 Earthwatch volunteers. Sandy Point National Wildlife Refuge Managers: Greg Hughes and Michael Evans.

LITERATURE CITED

Chaloupka, M. This symposium. Is the decline in some western Pacific leatherback populations attributable to temperature-dependent sex determination? In: Proceedings of the 22nd Annual Symposium on Sea Turtle Biology and Conservation. NOAA Tech. Memo.

Dutton, D.L., P.H. Dutton, and R. Boulon. 2000. Recruitment and mortality estimates for female leatherbacks nesting in St. Croix, U.S. Virgin Islands. In: H.J. Kalb and T. Wibbels, comps. Proceedings of the Nineteenth Annual Symposium on Biology and Conservation. NOAA Tech. Memo. NMFS-SEFSC-443. p. 268-269.

Dutton, P.H., C.P. Whitmore, and N. Mrosovsky. 1984. Masculinisation of leatherback turtle, *Dermochelys coriacea*, hatchlings from eggs incubated in Styrofoam boxes. Biological Conservation 32:249-264.

Dutton, P.H., D.L. Dutton, and A. Frey. 2002. Familial relation ships among nesting female leatherbacks examined with genetic markers. In: A. Mosier, A. Foley, and B. Brost, comps. Proceedings of the Twentieth Annual Symposium on Biology and Conservation. NOAA Tech. Memo. NMFS-SEFSC-477. p. 20.

Dutton, P.H., B.W. Bowen, D.W. Owens, A. Barragan, and S.K. Davis. 1999. Global phylogeography of the leatherback turtle (*Dermochelys coriacea*). Journal of Zoology, London 248:397-409.

Kendall, W.L. and R. Bjorkland. 2001. Using open robust design models to estimate temporary emigration from capture-recapture data. Biometrics 57:1113-1122.

Zug, G.R. and J.F. Parham. 1996. Age and growth in leatherback turtles, *Dermochelys coriacea* (Testudines: Dermochelyidae): a skeletochronlogical analysis. Chelonian Conserv. Biol. 2:244-249.

Table 1. Number of female leatherbacks observed nesting on Sandy Point, St. Croix, U.S. Virgin Islands from 1983-2001. Number of remigrants and first time nesters (recruits) are shown.

YEAR	RECRUITS	REMIGRANTS
1983	11	9
1984	24	4
1985	30	16
1986	15	3
1987	13	16
1988	30	17
1989	17	7
1990	16	6
1991	13	16
1992	30	25
1993	26	17
1994	31	24
1995	25	28
1996	14	24
1997	61	57
1998	17	25
1999	49	50
2000	62	45
2001	90	96

RECRUITS=no of untagged females (e.g. apparently nesting for first time on St.Croix)
REMIGRANTS=no. of turtles having nested before (total ID's from flipper tags/PITs and/or Pink Spot photos

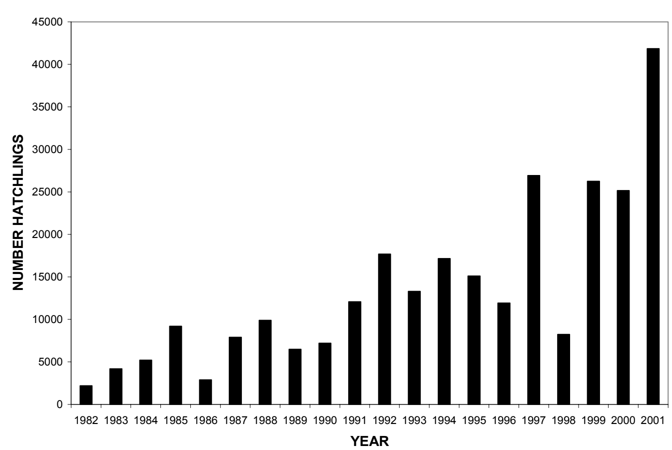

Fig. 1. Estimated number of leatherback hatchlings produced on Sandy Point, St. Croix, U.S. Virgin Islands from 1982-2001.

Twenty years of marine turtle nesting at the Archie Carr National Wildlife Refuge, Florida, USA

Llewellyn M. Ehrhart, Dean A. Bagley, William E. Redfoot, and Stacy A. Kubis

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The 21 km coastline in south Brevard County, Florida supports more loggerhead and green turtle nesting than any comparable beach in the United States, and leatherback nesting has risen markedly since 1996. Nesting surveys, tagging and morphometric data collection have been constant since 1982. During this time, there have been more than 4,700 loggerhead encounters, about 1,600 Florida green turtle encounters and 23 leatherback encounters. The Refuge concept was based on loggerhead and Florida green turtle nest production during the 1980s. Since that time, loggerhead nesting has increased by 33%, Florida green turtle nesting has increased by 294%, and leatherback nesting has increased by about 170%. Tag returns and satellite tracking data indicate that turtles utilizing the Carr Refuge are migrating from the nearby Atlantic, the Gulf of Mexico, Cuba, and the Bahamas. Research in the Carr Refuge has ranged from simple nesting surveys to satellite telemetry.

Estimates of survival probabilities for immature green turtles in the southern Bahamas

Karen A. Bjorndal[1], Alan B. Bolten[1], and Milani Y. Chaloupka[2]

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Capture-recapture data for a population of immature green turtles at Inagua, Bahamas, collected over 22 years (1978 - 1999) were evaluated. The Cormack-Jolly-Seber approach (using the program MARK) was used to model recapture probabilities and annual survival probabilities. We evaluated temporal and size-class-specific demographic effects on both survival and recapture estimation as well as the possible transient behavior of the immature green turtles. Transience was evaluated using program TMSURVIV. The model with the best fit had size-class-specific and time-dependent survival probabilities but size-class-independent and time-dependent recapture probabilities. Estimates of annual survival probabilities are presented. We discuss the caution required in interpreting these data, because our estimates of apparent survival confound mortality with emigration. Meta-population studies are needed to distinguish between mortality and emigration.

Survival rate estimates in sea turtles with variable inter-nesting intervals: new statistical modeling of capture-recapture data

Philippe Rivalan[1], Rémy Choquet[2], Jean-Paul Briane[2], Matthew Godfrey[2], Marc Girondot[2], and Anne-Caroline Prévot-Julliard[2]

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[2] Centre dEcologie Fonctionnelle et Evolutive - CNRS - 1919 route de Mende - 34293 Montpellier, France

One of the main objectives of tagging programs should be to provide estimates of demographic parameters, such as survival rates. To date, this has not been adequately achieved for marine turtles due to the lack of available models that take into account variable inter-nesting intervals. Indeed, in the case of marine turtles, the capture probability of an individual is dependent on its past history. To correct for this problem, we have developed a new demographic model in which the inter-nesting intervals are now an output, in addition to survival rates and capture probabilities. The benefits of this new method relative to increased knowledge of sea turtle biology will be presented.

Changes in relative abundance and population structure of immature marine turtles in the Indian River Lagoon, Florida over the past 20 years

Stacy A. Kubis, William E. Redfoot, Dean A. Bagley, and Llewellyn M. Ehrhart

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The Indian River Lagoon system serves as a developmental habitat for juvenile green turtles and sub-adult loggerheads. The capture of 574 loggerheads and 1508 green turtles over the last 20 years of an ongoing study has provided an index of relative abundance and an understanding of population structure for these aggregations. During the first two years of this study, the ratio of loggerhead captures to green turtle captures was 3:1. During the intervening years this has reversed, so that the ratio is now 1:4. While the relative abundance and mean standard carapace length of green turtles has increased significantly, this has not been the case for loggerheads. The results of this study to date suggest that conservation efforts over the past two decades may be paying off, but this optimism is tempered by the high prevalence of fibropapillomatosis in this green turtle population.

Survival estimates of large juvenile and adult green turtles in the western Caribbean

Cathi L. Campbell

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Most green turtle rookeries in the Caribbean have been severely depleted or extirpated, primarily from overexploitation. Although some depleted populations have shown signs of recovering, the resurgence of a turtle fishery in Nicaragua during the past decade may threaten the rookery at Tortuguero, Costa Rica, the largest remaining population in the Atlantic. Based on band recovery analysis, survival rates of large juvenile and adult green turtles on the Nicaragua foraging ground and adult females from the Tortuguero rookery were estimated to better understand the impact of the Nicaragua green turtle fishery on the Tortuguero population. The survival estimates from this study were much lower than survival estimates of other sea turtle populations using similar estimation methods. Based on the estimates presented, it is likely that the Tortuguero population as a whole is declining, even if a decline is not yet evident in the nesting population.

Acknowledgements. I would like to thank the turtle fishers along the Caribbean coast of Nicaragua for their collaboration with tag returns (especially the fishers in the Pearl Lagoon area); William McCoy (Wildlife Conservation Society) for his dedication to catching turtles for the study; Cynthia Lagueux (Wildlife Conservation Society) for her guidance and unwavering support; MARENA (Ministerio del Ambiente y los Recursos Naturales, Nicaragua) for permission to conduct this study; the Caribbean Conservation Corporation for allowing me access to their data on the Tortuguero nesting population; and Jim Nichols, Jim Hines, and Bill Kendall of the Patuxent Wildlife Research Center, USGS, for their assistance with data analysis. The project was financially supported by: the Wildlife Conservation Society, *Chelonia* Institute, The Linnaeus Fund (Chelonia Research Foundation), DIPAL II (Proyecto para el Desarrollo Integral de la Pesca Artesanal), and Lerner-Gray Fund for Marine Research (American Museum of Natural History)

Population model analysis for the northern nesting subpopulation of loggerhead sea turtles (*Caretta caretta*) in the western North Atlantic

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[2] NOAA – National Marine Fisheries Service, Southeast Fisheries Science Center, Miami, Florida, USA

Based on mtDNA data, there are at least 5 genetically distinct loggerhead nesting subpopulations in the western North Atlantic. In the United States, the northern subpopulation, which extends from North Carolina to northeast Florida is of greatest concern due to its small size. To assess the status of this subpopulation, we analyzed databases to develop new parameters for an existing matrix population model. We developed a new von Bertalanffy growth curve from mark-recapture data, estimating age to reproductive maturity at 36 to 41 years. From strandings and genetics data, we estimated 35% female offspring for the northern subpopulation. Catch curve analyses of strandings data from 1986-1989 were used to estimate benthic juvenile annual survival rates prior to TED regulations. Tag-return data from nesting beaches were analyzed to estimate adult female annual survival rates. To incorporate uncertainty in population trends prior to the implementation of TEDs, we ran models using pre-1990 asymptotic population growth rates (l) of 0.95, 0.97 and 1.00. Recent data indicate that current US regulations for the size of TED openings release only smaller benthic juveniles. We ran the models under 2 TED scenarios; 1) protects only small benthic juveniles (current TED regulations), 2) protects all benthic juveniles and adults (expanded TED regulations). Model results indicate that if the northern subpopulation was in decline prior to 1990, current TED regulations are not enough to stabilize population growth rates. Expanded TED regulations at best achieve stable populations and are not enough to result in increasing population growth rates.

Is the decline in some western Pacific leatherback populations attributable to temperature-dependent sex-determination?

Milani Y. Chaloupka

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Many populations of the Western Pacific leatherback genetic stock have declined dramatically over the last 25 years. This decline has been widely attributed to a combination of egg harvesting and incidental capture and drowning in coastal and distance water fisheries. However, it is evident that human interventions such as beach vegetation clearance caused increased nesting beach temperatures and highly skewed female hatchling sex ratios that could have resulted in a severe shortage of adult males and a low probability of an adult female finding and mating with at least 1 male – a strong depensatory or Allele effect caused by the highly sensitive temperature-dependent sex-determination behaviour of leatherbacks compared to most other sea turtle species. This plausible scenario is compared in a competing risks framework with egg harvesting and fishery related mortality risks to help diagnose the probable causes of the decline in Western Pacific leatherback nesting populations. This competing risks model is implemented in this presentation using a very fast and interactive stochastic simulation model to evaluate with the audience the probability that nesting beach intervention and the temperature-dependent sex-determination behaviour of leatherbacks are strongly implicated in the demise of some leatherback populations.

The discovery of a green turtle developmental habitat in Greece advocates a stronger regional cooperation

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The green turtle, *Chelonia mydas*, has evolved a fairly isolated local population in the Mediterranean Sea. The nesting areas of this population are confined in the easternmost part of Mediterranean, because of favorable climatic conditions. The occurrence of green turtles away from this part of Mediterranean is considered rather rare. However, in the course of a fisheries interaction study in Lakonikos Bay, southern Greece, it was found that this bay represents an important developmental habitat of the Mediterranean green turtle population. A three-year (1997-2000) systematic study, in cooperation with local fishermen, was conducted during the fishing period (October-May) to assess the magnitude of incidental catch. About 26% of the total fishing effort (by 25 trawlers, beach seines and gill-netters) was monitored by an observer recording catches as soon as the fishing vessels returned to port. Fishermen were trained to identify marine turtle species, classify turtles' CCL in four size classes and record their physical condition as well as the approximate location and depth of captures. During the study period, 188 turtles were caught by the monitored fishing vessels. Of these, 112 (59.6%) were loggerheads and 76 (40.4%) were green turtles. All green turtles were classified as juveniles, providing evidence that Lakonikos Bay is a developmental habitat of the Mediterranean green turtle population. This finding will certainly change existing conservational aspects and provide stimulus for better regional cooperation by supranational conventions as well as among states.

Marine turtles and fisheries in the Mediterranean: are we missing something?

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INTRODUCTION

The first studies on marine turtles in the Mediterranean basin were started in the early 1980s, on the nesting beaches in Greece and in Cyprus. Today, the main nesting areas of the two species that reproduce in the region, the loggerhead turtle and the green turtle, are well known, concentrated almost exclusively in the eastern basin (Margaritoulis et al., in press).

The first at-sea studies started with a decade's delay, in the late 1980s' and early 1990s', and were carried out through the assessment of interactions between marine turtles and fisheries (Delaugerre 1987, De Metrio and Megalofonou 1988, Laurent 1990, 1991, Argano et al. 1992). Almost all these studies were and still are focused on large-scale commercial fisheries, longlines and trawls. Indeed, the first results revealed a high level of bycatch by both fisheries, and identified the fishery interactions as the main threat to sea turtles in marine habitats in the Mediterranean (see review by Gerosa and Casale 1999). More than 22,000 juveniles a year are caught just by the Spanish longline fleet operating in the Balearic Sea (Aguilar et al. 1995), while estimates of the annual bycatch in bottom trawls also range in thousands of turtles caught. Nevertheless, direct mortality rates in both fisheries seems to be rather low: 0.4% in longlines, and 0-10% in trawls.

However, there is another fishery widely distributed in the Mediterranean, one that is almost ignored in all such studies: the gill net fishery. The gill net fishery exists in almost all coastal zones around the globe on a large and a small scale, and it is one of the oldest fishing techniques. It uses a variety types of nets and methods, and therefore it is not easy to classify it. In this paper we analyze data on the bycatch of loggerhead sea turtles in coastal gill nets in the eastern Adriatic Sea, and discuss the interactions of turtles and the gill net fisheries in the Mediterranean basin.

MATERIAL AND METHODS

We present the data on the bycatch of 59 loggerhead sea turtles by eastern Adriatic gill-netters in the coastal waters of Slovenia and Croatia in the period 2000-2002. We analyzed bycatch incidents with regard to temperature regimes. For this purpose we divided the year into two periods: the "warm period" (from the beginning of May to the end of October) and the "cold period" (from the beginning of November to the end of April), and tested the temporal distribution of bycatch by means of a chi sq. test.

Data on the gill net fishing fleet were obtained from the Directorate of Fisheries, the Ministry of Agriculture and Forestry of Croatia, and through personal interviews with fishermen in Slovenia.

RESULTS AND DISCUSSION

Forty-four turtles were captured in gill nets during the warm period, with the highest number of incidents coming from the northernmost part of the eastern Adriatic Sea (Slovenian waters and northern Croatian waters). In contrast, we recovered just 15 loggerheads in the cold period, all along the southern Croatian coast, in sea temperatures >14 °C. There is a significant association between bycatch in gill nets and the warm period (χ^2=4.33, p=0.03, d.f.=1). This means that loggerheads in the eastern Adriatic are mostly involved with gill nets during the period of increased activity, between the end of April and November. Furthermore, our study showed that gill nets affect both small juveniles (<50 cm CCL) and large, benthic size-classes (>50 cm CCL), in the ratio 1.2:1, respectively. The mean mortality was 54.9% (n=51).

The gill net fishery in the eastern Adriatic Sea, as well as throughout the whole of the Mediterranean, is mostly a small-boat-based, traditional fishery, which uses low-cost boats. Out of 2,400 fishing vessels that operate with gill nets along about 3,000 km of the total coastline of Croatia, 89.4% are less than 12 m in length. A total of 12,142 km of gill nets are registered, which gives about 5 km of gill nets per boat, or 3.3 to 6.2 times more than is allowed by the law, depending of the type of net. About 60 gill netters are registered along 44 km of Slovenian coast, fishing with 2-4 km of gill nets per boat. In total, between 120 and 240 km of gill nets are set along 44 km of Slovenian coastline, causing a direct mortality of loggerheads of 65.4%.

Gerosa and Casale (1999) gave a general overview of interactions of marine turtles and fisheries in the Mediterranean. There is an obvious lack of data and systematic studies on turtles and gill nets in the region. There are several main reasons for this: First, the gill net fishery is a "dispersed" fishery, based on thousands of small vessels situated in numerous ports, which makes it very difficult to asses. Second, besides professional fishermen, there are numerous non-occupational (recreational) fishermen who use gill nets on an irregular basis, so it is difficult to estimate the fishing efforts or bycatch rates. Furthermore, data on gill net fishing fleet are lacking for most of the Mediterranean countries (Gerosa and Casale 1999). Nonetheless, the few data available on bycatch of turtles in gill nets in the Mediterranean are alarming. Delaugerre (1987) reported a mortality rate of 94.4% in trammel nets in Corsica (n=18), while a mortality of 73.7% (n=19) in gill nets has been reported by Argano et al. (1992). Laurent (1991) encountered a mortality of 53.7% (n=149) in France which is consistent with our data. Godley et al. (1998) estimated a mortality of 10% in artisanal fisheries in Cyprus and Turkey, but they addressed all types of small-boat based fisheries, including longlines and trawls - fisheries with a rather low direct mortality.

It is obvious that gill nets are the most lethal fishing tool for sea turtles in the Mediterranean. However, there is a dearth of studies to assess the levels of interactions between turtles and gill net fisheries in the region. Considering the high mortality rates, it is quite possible that the cumulative lethal effect of numerous small coastal gill net fisheries could have a direct mortality level equivalent to that of larger, commercial fisheries. De Metrio and Megalofonou (1988) estimated a bycatch rate of 16,000 turtles per season entangled in drift nets in the Ionian Sea, Italy, with a mortality between 20% and 30%. Hence, the assessment of interactions of marine turtles and coastal gill-net fisheries should be a priority at the Mediterranean level.

Gill-net fisheries affect not only small, but also the larger sized individuals. A loggerhead population model showed that a reduction of mortality in the large juvenile and subadult stages would contribute most to population recovery (Crouse et al. 1987). Therefore, assessment and management of gill net fisheries in the Mediterranean and a reduction of mortality through time and/or area closures should be emphasized as a conservation priority, particularly in foraging and inter-nesting habitats, and along the migration pathways of marine turtles.

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LITERATURE CITED

Argano R., R. Basso, M. Cocco, and G. Gerosa. 1992. New data on loggerhead (*Caretta caretta*) movements within Mediterranean. Bollettino del Museo dell' Instituto di Biologia dell' Universita di Genova 56/57:137-164.

Aguilar R., J. Mas, and X. Pastor. 1995. Impact of Spanish sword fish longline fisheries on the loggerhead sea turtle *Caretta caretta* population in the western Mediterranean. In: J.I. Richardson and T.H. Richardson, comps. Proceedings of the Twelfth Annual Workshop on Sea Turtle Biology and Conservation. NOAA Tech. Memo. NMFS-SEFSC-361. p. 1-6.

Crouse D.T., L.B. Crowder, and H. Caswell. 1987. A stage-based population model for loggerhead sea turtle and implications for conservation. Ecology 68:1412-1423.

Delaugerre M. 1987. Status des tortues marines de la Corse (et de la Mediterranee). Vie Milleu 37:243-264.

De Metrio G. and P. Megalofonou. 1988. Mortality of marine turtles (*Caretta caretta* L. and *Dermochelys coriacea* L.) consequent to accidental capture in the Gulf of Taranto. Rapports et Proces-verbaux des reunions de la Commission Internationale pour l'Exploration Scientifique de la Mer Mediterranee 31:285.

Gerosa G. and P. Casale. 1999. Interaction of marine turtles with fisheries in the Mediterranean. UNEP/MAP RAC/SPA, Tunis.

Godley B.J., A.C. Gucu, A.C. Broderick, R.W. Furness, and S.E. Solomon. 1998. Interactions between marine turtles and artisanal fisheries in the eastern Mediterranean: a probable cause for concern? Zoology in the Middle East 16:49-64.

Laurent, L. 1990. Les tortues marines en Algerie et au Maroc (Mediterranee). Bulletin de la Societe Herpetologique de France 55:1-23.

Laurent, L. 1991. Les tortues marines des cotes Francaises Mediterraneennes continentales. Faune de Provence (C.E.E.P.) 12:76-90.

Margaritoulis D., R. Argano, I. Baran, F. Bentivegna, M.N. Bradai, J.A. Caminas, P. Casale, G. De Metrio, A. Demetropoulos, G. Gerosa, B.J. Godley, D.A. Haddoud, J. Houghton, L. Laurent, and B. Lazar. In press. Loggerhead turtles in the Mediterranean: present knowledge and conservation perspectives. In: A. Bolten and B. Witherington, eds. Ecology and Conservation of Loggerhead Sea Turtles. Smithsonian Institution Press, Washington, D.C.

Evaluating the impact of turtle excluder devices on strandings in the western Gulf of Mexico

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The Sea Turtle Stranding and Salvage Network has been monitoring turtle strandings for more than 14 years. High numbers of strandings in the mid to late 1980s, thought to be an indicator of negative impacts of commercial fisheries on imperiled turtle populations, prompted regulations to require Turtle Excluder Devices (TEDs) on shrimping vessels (trawlers). However, following TED implementation in 1991, stranding levels have increased. Here, we evaluate the efficacy of TEDs and other management actions (e.g. fisheries closures) on loggerhead and Kemps ridley turtles using a long-term dataset from the western Gulf of Mexico. Our analyses suggest that both sea turtle population growth and shrimping activity have contributed to the observed increase in strandings. TEDs have, however, been effective in reducing strandings, as analyses of strandings during and before or after the seasonal Texas Closure indicate larger proportional declines in strandings once TED compliance increased. Model projections suggest that improved compliance with TED regulations will reduce strandings to levels that should promote population recoveries for loggerheads and Kemp's ridley turtles. Local, seasonal fisheries closures, concurrent with TED enforcement, could reduce strandings to even lower levels. A seasonal closure adjacent to a secondary Kemp's ridley nesting beach may also reduce adult mortality of nesting adults and thus promote long-term population persistence by fostering the establishment of a robust, secondary nesting site.

Integrating turtle conservation into shrimp management strategies: a Texas case history

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Texas marine waters and adjacent barrier islands are important migration, feeding, mating, and nesting areas for sea turtles in the Gulf of Mexico. Five species occur regularly off Texas: the green, the hawksbill, the leatherback, the loggerhead, and the Kemp's ridley. The hawksbill, the leatherback and the Kemp's ridley are listed as endangered while the green and the loggerhead are threatened.

Commercial shrimping is a major industry in Texas marine waters with 73 million pounds landed annually. This fleet activity has been identified as a major contributor to strandings of sea turtles in Texas that have averaged 392 per year over the last decade. Turtle strandings peak in April and May before the Texas shrimping closure and in July and August after the closure.

Authority for Texas shrimping rules rested with the State Legislature until 1989. Texas Parks and Wildlife (TPW) assumed regulatory authority over shrimping at that time, following adoption of the Texas Shrimp Fishery Management Plan. TPW immediately began a management strategy to reduce the overall impact of the shrimp fleet on Texas marine resources and habitats, primarily through a shrimp license limited entry and buyback program.

In October 1998, TPW initiated a process to revise the existing shrimping regulations. TPW sponsored a workshop with shrimp industry leaders and turtle conservation scientists and advocates. A specific goal of the workshop was to identify new shrimping rules that would improve economic benefits to the shrimp community and, at the same time, reduce interactions between shrimpers and sea turtles. While no consensus was reached, the workshop did produce a number of options for achieving compatible shrimp and turtle rules.

A comprehensive review of all shrimping rules was needed to find balance among various stakeholder needs. A TPW shrimp management team of staff managers, biologists, statisticians, and outreach personnel was created to examine relevant data and other information in their respective bay systems with the goal of designing rules to assure sustainable resources and achieve an ideal balance among user groups. TPW held 24 public workshops coast wide over an 18-month period to solicit ideas for rule changes. A leader in the Asian-American fishing community was hired to conduct four workshops in the Vietnamese language in communities with large numbers of Vietnamese-speaking shrimpers.

Throughout the 18-month process, the TPW shrimp management team met regularly to review available public input and data analyses and to redirect outreach and assessment efforts. Following the full review of relevant data on a bay system basis, the shrimp management team turned its attention to integrating bay system and nearshore Gulf differences into a coastwide shrimp fishery management strategy. Pros and cons associated with each possible regulatory change and the specific effects on different stakeholders were extensively discussed. A preliminary list of rule changes was drafted and subsequently reviewed separately with some identified leaders in the bay shrimping industry, the Gulf shrimping industry, and the Asian-American community. Modifications to the draft rules were made based on their input.

In early April 2000, the TPW Commission was briefed on the conclusions of the 18-month study and staff requested guidance on proceeding with rule changes. The Commission directed staff to develop a "moderate" package of new rules. A briefing book summarizing the study's conclusions and detailing the pros and cons of each draft rule was mailed to the agency's Shrimp Advisory Committee, other interested parties, and all coastal legislators.

The proposals in the briefing book generated intense stakeholder and legislative interest. Serious differences of opinions on the timing and need for rule changes were voiced by industry members. The inclusion of sea turtle conservation goals as part of the shrimp fishery management strategy was also attacked as inappropriate. The draft rules elicited vigorous and emotional debate among stakeholders and TPW both through media outlets and other forums.

Proponents and opponents organized letter-writing campaigns to TPW and legislators. TPW was requested to provide detailed briefings to legislative offices and other authorities to clarify the intent of the rules.

The conservation of sea turtles as a component of the rule changes garnered a great deal of public attention. It became apparent that much of the announced support for the rule changes had sea turtle conservation at its base even though TPW continued to emphasis benefits to the overall shrimp industry as the primary justification.

The TPW Commission agreed to formally propose the rules through publication in the Texas Register in May 2000. This action came despite a protest demonstration outside the Commission meeting of about 500 Asian-American men, women, and children.

Eight public hearings were held coastwide with five meetings scheduled during the closed Gulf shrimp season and three during the closed bay shrimp season to facilitate better attendance. The hearings were well attended with 760 people present and 182 people providing comments. Both opponents and proponents made impassioned statements. Rejection of the scientific data and fears of the impacts of regulations were common themes throughout the hearings. Two conferences with shrimp industry leaders, sea turtle advocates, and other stakeholders were also conducted. TPW noted all comments and later crafted the final recommendations for presentation at the August Commission meeting.

Several hundred protesting Asian Americans along with a host of other stakeholders came to the August Commission meeting. Sixty-eight people spoke to the Commission, although comments generally mirrored those heard previously and were predominately in favor of no changes to the shrimp rules. This contrasted sharply with the final tally of 6139 comments received, both verbal and in writing, throughout the three-month comment period. About 97% of all comments favored adoption of some or all of the proposed rules. The Commission ultimately approved the revised rule changes proposed by staff. In doing so, they indicated concern about the potential economic impacts on shrimpers and asked staff to monitor the fishery over the next five years and report back on how successful the rules were in achieving the stated objectives.

Certain rules adopted by the Commission were designed to reduce fishing effort on shrimp stocks and provide additional protection to sea turtles, particularly in the near shore Gulf. The most significant rule with respect to sea turtle conservation was establishing a seasonal shrimping closure from Corpus Christi Fish Pass to the Texas-Mexico border (110 linear miles including all of Padre Island National Seashore) from the beach out to 5 nautical miles from December 1 to the Summer Gulf opening or July 15. Historically 68% of the turtle strandings, yet less than 3% of the total Texas shrimp landings, occur in this area during this timeframe. The seasonal closure affords additional protection of adult Kemp's ridleys off Padre Island that could lead to increased nesting and establishment of a secondary nesting beach for this endangered species. In addition, by protecting immature shrimp, the closure was also compatible with shrimp fishery management goals.

Another important sea turtle conservation measure was limiting the total width and number of trawls per vessel in the near shore Gulf. Vessels shrimping from Corpus Christi Fish Pass to the Texas-Louisiana border from the beach out to 3 nautical miles are restricted year around to no more than two trawls with a total width of 130 feet of headrope. Vessels shrimping from

Corpus Christi Fish Pass to the Texas-Mexico border are also restricted to two trawls with a total width of 130 feet of headrope from the beach out to 3 nautical miles from July 16 (or the Summer Gulf opening date) to November 30. Prior to the new shrimping regulations, there was no limit to total width and number of trawls each vessel could deploy. The rule is expected to reduce fishing effort, especially from large vessels, in the near shore Gulf, thereby decreasing the occurrence of sea turtles in shrimp trawls. And, again compatible with shrimp management, the rules allow for additional shrimp spawning and growth to a larger, more valuable size.

A state rule requiring the use of a turtle excluder device in all trawls in the Gulf was adopted which matches the federal requirements. Enhanced law enforcement from state game wardens is one of the expected benefits.

Industry members continued to pursue options to remove some or all of the new regulations following the final Commission action. A temporary restraining order and two lawsuits to overturn the new rules were filed. The temporary restraining order was denied but the lawsuits continue to be pursued.

The Commission action was also subject to debate in the 2001 Texas legislative session. Two bills were filed to overturn the new shrimp rules and to put constraints on the rule-making authority of the Commission. Much of the impetus for legislative intervention was generated by industry members complaining about the gulf seasonal closure off Padre Island, which also provided the greatest protection for sea turtles. The bills to overturn the rules were not enacted; however, a statutory mandate was given to TPW to conduct a comprehensive study of the shrimp resources and associated fisheries prior to making additional substantive shrimp rules. A report to the legislature on the study results is due in September 2002.

Integrating sea turtle conservation measures into Texas' shrimp management strategy was successful, at least pending the final resolution of current litigation. Fishery managers who are stewards over similar resources should note several important lessons from this case study. By taking a comprehensive approach with rule proposals, which affected all segments of the shrimp fishery, and by providing justification that included a wide range of benefits to industry profits, bottom habitat, water quality, bycatch, and specifically sea turtles, TPW was able to build an accumulation of smaller positive attributes of each rule into a larger set of cumulative benefits.

The comprehensive rule-making approach also dramatically increased the number and variety of stakeholders participating in the process. Attempting to manage these public marine resources for optimum benefits to the whole state of Texas helped gain credibility for the stated goals in the TPW Shrimp Fishery Management Plan. In addition, a comprehensive approach made it more obvious that balancing the interests of all stakeholders in the final resolution was paramount in importance.

Managers seeking to follow a multi-species holistic approach in formulating fishery rules should be prepared for a long-term commitment to carrying out the process. It is essential that managers be prepared for questions and varying opinions on the biology, statistics, economics, and law enforcement considerations surrounding the rules. This requires a comprehensive look at existing data sources on a wide array of topics. The consistent application of the data collected during TPW's 25-year-long standardized fishery dependent and independent monitoring programs was critical in demonstrating valid scientific rationale.

The management process, including this on-going Texas case study, would benefit from the development of more leaders in the fishing communities that recognize the long-term financial gains possible from matching harvesting capacity to the ability of the resource to withstand harvest. Additionally, industry advocates are needed to recognize and promote the responsibilities of the fleet to reduce bycatch and habitat damage of public resources. Unless industry recognizes these responsibilities, fishery managers can continue to expect an adversarial process to dominate future conservation initiatives.

Preliminary results of the new shrimping regulations are encouraging. Total sea turtle strandings in Texas during 2001 were 13% below the 5-year average and 27% below the 5-year average from February 15 – May 15 in the seasonally closed area off Padre Island.

Bycatch of marine turtles in Cuban shelf-waters

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INTRODUCTION

Incidental catch of marine turtles occurs in many fishing operations throughout the world. From 1968 to 1992, Cuba had a nationally managed harvest of marine turtles. Turtles taken as bycatch were considered part of the harvest and landings were recorded. From 1992 onwards, Cuba voluntarily phased down its harvest, so that by 1996 harvesting was restricted to two small and remote areas (Nuevitas and Isle of Youth). Turtles taken as bycatch in other fisheries today can only be used in those two communities. Elsewhere, they cannot be utilized, and must be discarded (see ROC 1998, 2000, 2002). As a result formal records on incidental catch of marine turtles in Cuba are no longer kept by fishing operations. This report summarizes the results of a recent study undertaken to quantify incidental catch of marine turtles in Cuban fisheries.

MATERIALS AND METHODS

Data were collected in 2000 and 2001, mainly through interviews with fishermen working in fisheries known to interact with marine turtles, fisheries biologists and technicians from the Fisheries Research Center, and with staff from fisheries enterprises. Surveys were undertaken in nine fisheries areas: Puerto Esperanza, Caibarien, and Nuevitas on the northern coast; and, La Coloma, Casilda, Cienaga de Zapata, Cienfuegos, Isla de la Juventud, and Santa Cruz in the southern coast. Fisheries enterprises here are responsible for 70% of all Cuban shelf fisheries. Additional information was collected by technicians working on fishing boats in the southern coast areas of La Coloma, Isla de la Juventud, Cienfuegos and Casilda.

Information was obtained on the type of fishery (species targeted, extent and characteristics of area fished, extent of fishing season, type of fishing gear, type of ship and size of fleet, fishing effort of ship or fleet (numbers of nets, fishing hours), mortality rate of captured turtles, species, size and numbers of turtles captured.

Estimates of total bycatch of turtles were calculated by extrapolating reported capture rates to the total number of ships and boats in each area, and were then extrapolating for Cuba as a whole based on these areas representing 70% of fishing operations. (Surveys in the remaining 30% are being conducted in 2002).

RESULTS AND DISCUSSION

Turtles. The results indicated that about 855 marine turtles are captured as bycatch each year (2000 and 2001), in the areas examined. This was made up of greens (46%), hawksbills (40%), loggerheads (13%) and leatherbacks (1%) turtles. Of the turtles caught, 39% were alive and were released by fishermen. When extrapolated to the whole of Cuba, this suggests an annual bycatch of 1221 turtles, with about 745 turtles being killed: 342 greens; 298hawksbills; 97loggerheads; and 8 leatherbacks.

The percent composition of species caught varied between the north and south coasts. On the north coast, the bycatch was greens (47%), hawksbills (34%) and loggerheads (19%), whereas on the south coast it was hawksbills (45%), greens (39%), loggerheads (15%) and leatherbacks (1%).

Fisheries. Finfish fisheries accounted for the greatest proportion of turtle bycatch (53%). The highest incidence of capture was in trawl nets (73%), which are used in various habitat types, in relatively shallow waters. Fixed nets and cages accounted for lower proportions (16% and 11%, respectively), and none were reported as being caught in traps. Mortality rate in fixed nets was 88%, in trawl nets 60% and in cages 0%. Ray (spotted ray and stingray) fisheries accounted for 35% of the turtle bycatch. This fishery utilizes bottom nets (20 cm mesh) of different lengths, and with different weights in the lower part of the net. Most ray fishing occurs in the southeastern part of Cuba. Mortality rate of turtles is 90-100%, depending on the frequency of checking of nets; large turtles are more often found alive than smaller ones.

Shrimp fisheries accounted for 12% of the turtle bycatch, and are carried out in the southeastern part of Cuba, mainly in habitats with sandy and/or muddy bottoms. Mortality rate depends on trawl time, but is about 40%. Internationally, the incidental catch in shrimp fisheries includes a higher incidence of marine turtle species which feed mainly on crustaceans (eg., loggerheads and ridleys). In Cuba, the main turtle caught are greens. In the Cuban platform, habitats in which the shrimp fishery operates tend to have few turtles associated with them, and turtle-excluder devices (TEDs) are not considered necessary.

Size of Turtles. The mean size of turtle recorded by observers on boats was 50.5 cm CCL. Interviewees were asked to classify turtles caught within one of three broad size categories: small (up to 45 cm CCL), medium (up to 65 cm CCL); and large (greater than 65 cm CCL). Most turtles were reported as being small (42%) or medium (42% each), with 15.8% being large. This suggests juveniles rather than adults are most commonly caught.

CONCLUSIONS

This study represents the first detailed assessment of incidental catch of marine turtles in Cuban waters. The study is continuing in 2002, and revised figures should be available by the end of the year. In 1996, incidental catch of hawksbill turtles was estimated as 100-200 individuals killed per year (ROC 1998). The results of this study suggest that numbers killed have increased to about 300. Since 1996 the wild population has been steadily increasing (ROC 2000, 2002), and so the two estimates are broadly consistent. Most hawksbills are taken are juveniles caught in ray fisheries, which operate mainly in shallow water areas in the south of Cuba (see Carrillo and Contreras 1998), where densities of hawksbills can be high (ROC 2000). In absolute terms, incidental catch in Cuban waters involves fewer turtles than in other regions of the world (eg., Gulf of Mexico, Pacific and Atlantic coasts of USA, Central America, Mediterranean Sea), where incidental catch can be as high as 50,000-100,000 turtles per year. However, as the wild turtle populations continue to expand in Cuba, where they are protected in over 99% of all marine habitats, incidental catch is likely to increase rather than decrease.

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LITERATURE CITED

Carrillo E.C. and J. Contreras. 1998. Cuba and its marine environments. Rev. Cubana Invest. Pesqueras 22:61-68.

Republic of Cuba. 1998. An annotated transfer of the Cuban population of hawksbill turtles (*Eretmochelys imbricata*) from Appendix I to Appendix II of CITES. Revista Cubana Invest. Pesqueras 22:1-205.

Republic of Cuba. 2000. An annotated transfer of that part of the Caribbean population of Hawksbill Turtles (*Eretmochelys imbricata*) inhabiting Cuban waters, from Appendix I to Appendix II. Proposal 11.40, COP11, Nairobi, Kenya, April 2000.

Republic of Cuba. 2002. Presentation on the Cuban proposal. CITES Doc. 10, Second CITES Wider Caribbean Hawksbill Turtle Dialogue Meeting, Grand Cayman, Cayman Islands, 21-23 May 2002.

Incidental capture of loggerhead (*Caretta caretta*) and leatherback (*Dermochelys coriacea*) sea turtles in the Uruguayan long-line fishery in the southwest Atlantic Ocean

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This paper reports the incidental catch of loggerhead and leatherback sea turtles by the Uruguayan long-line tuna fleet determined by observations made in the National Observers Program, and analyzes the space-time distribution of these species. Sampled ships operated in the South West Atlantic Ocean between 26º and 37º South. The information was collected by scientific observers in ten trips made from April 1998 to November 2000. During this period, 170 loggerheads and 27 leatherbacks were caught. From 0 to 50% of the loggerheads were discarded dead, while leatherbacks were all released with hook and fishing line. The distribution of *Caretta caretta* was found to be associated with water temperature. The catch of juvenile and subadult loggerheads and adult leatherbacks make it advisable to foster research and quantify bycatch by the long-line South Atlantic fleet.

Impacts of pelagic longline fishery on Atlantic loggerhead sea turtles

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Nearly 30 nations participate in longline fishing throughout the North and Tropical Atlantic Ocean and the Mediterranean Sea. Although the U.S. longline fleet accounts for a relatively small proportion of total hooks fished in the North Atlantic (<10%) it is highly efficient: 4-8 times more efficient at catching swordfish and 2-3 times more efficient at catching tunas than the other fleets working in the region. Sea turtles are a bycatch of the fishery. Based on U.S. observer data, loggerheads and leatherbacks are the two species of sea turtle most often captured with annual estimates of domestic takes for loggerheads ranging from 293-2439 and takes of leatherbacks ranging from 308-1054. Sea turtle bycatch rates by the U.S. fleet are highest on the Grand Banks. We examined how a potential regulation of the pelagic longline fishery to effect an increase in survival of pelagic animals would impact population growth rates of the northern subpopulation of loggerheads. We considered 3 growth models, new stage-specific survival rates, 2 initial population growth rates, and an effective sex ratio of 35% female in our population models. Results from the models indicate that if the northern subpopulation was in decline prior to 1990 and individual growth rates are as slow as we now believe, regulation of the longline fishery to achieve a 10% decrease in mortality is not enough to realize positive population growth rates. Increasing population growth rates may be achieved, however, by a combination of regulations to reduce both pelagic stage mortality and mortality on the large immature and reproductive animals. The latter can be accomplished by expanded TED regulations requiring larger escape openings.

Experiments in the western Atlantic to evaluate sea turtle mitigation measures in the pelagic longline fishery

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The National Marine Fisheries Service, Southeast Fisheries Science Center has initiated a multiyear cooperative research initiative with the commercial pelagic longline industry to develop and evaluate mitigation measures capable of reducing interactions and injury of endangered and threatened sea turtle species by pelagic longline fisheries. In 2001, eight commercial longline vessels with NMFS observers aboard were employed to evaluate potential mitigation techniques, collect data on turtle/longline interactions, evaluate dehooker and line cutter devices, and conduct a pilot tagging project employing pop-up archival satellite tags (PATs) in the Western Atlantic Ocean. Research included evaluation of the effectiveness of blue dyed squid bait and position of hooks relative to float lines in reducing turtle interaction rates. Observers collected a suite of data including longline gear configuration data, catch data, meristics data, and sea turtle life history data. One hundred and eighty five experimental sets have been conducted and turtle interactions with 111 loggerhead turtles (*Caretta caretta*) and 76 leatherback turtles (*Dermochelys coriacea*) have been recorded. The results of this research will be presented.

Results of an experiment to evaluate gear modifications on sea turtle Bycatch in the swordfish longline fishery in the Azores: effects of hook type and size

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The problem of sea turtle bycatch in longline fisheries has been recognized worldwide. To reduce this bycatch, we have designed a multiyear program to evaluate gear modification on sea turtle bycatch in the swordfish longline fishery in the Azores. We present results from over 150 sets conducted during the first two years of the program. During the second year, a commercial longline fishing vessel from the Azores was chartered to conduct the experiment from September to December 2001. The experiment consisted of 60 sets, and each set consisted of about 1500 hooks. The experiment evaluated 3 different hook types: a J hook and two sizes of circle hooks. The primary objectives were to evaluate the effect of both hook type and size on rates of sea turtle bycatch and location of hooking (e.g., mouth vs. esophagus). Effects of hook type and size on target species were also evaluated. Results from this experiment are evaluated in conjunction with the results from the previous years experiment that evaluated hook shape. Results from these experiments have broad application and can be applied to swordfish longline fisheries around the world. We make recommendations for future experiments.

Behavioral and genetic components of marine turtle olfaction: an investigation aimed at reducing the incidental bycatch of marine turtles in longline fishing gear

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We report our findings on behavioral experiments with captive marine turtles and a molecular biological analysis of turtle odor receptor (OR) genes with the aim of identifying a bait modification that could reduce the capture of marine turtles in longline fishing gear. Behavior experiments with captive green (*Chelonia mydas*) and loggerhead (*Caretta caretta*) sea turtles are currently underway to determine the importance of vision and olfaction in biting food items. Preliminary data with modified and artificial baits suggest that turtles use a combination of vision and olfaction in making the decision to bite. We have begun identifying odor receptor genes by PCR amplification directly from hemocyte genomic DNA using degenerate PCR primers. Preliminary efforts have yielded 23 unique OR genes from leatherback (*Dermochelys coriacea*) turtles, 12 unique OR genes from green turtles, and 6 unique OR genes from the American alligator (*Alligator mississipiensis*). Analysis underway includes an assessment of the numbers of OR genes by Southern blot analysis, the number of expressed OR genes by pseudogene analysis (presence of internal stop codons) and an estimate of the degree of evolutionary selection through population analysis. It has been suggested that vertebrates have two classes of ORs. A Type I class is thought to support the detection of water soluble odorants, and a Type II class is thought to support the detection of airborne odorants. The reptilian OR sequences we have identified belong to the Type II class.

Experimental evaluation of the attractiveness of swordfish-fishing devices on loggerhead sea turtles: testing the floats' effect

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INTRODUCTION

One of the main goals of the EU-Life Project "Urgent conservation measures for *Caretta caretta* around the Pelagie Islands" was to evaluate the impact of local fisheries on loggerhead turtle mortality rates, in the waters surrounding the islands of Lampedusa, Lampione and Linosa, in the South of Italy (35°51'N 12°51'E) (Balletto et al. 2001). Reports of bycatches of *C. caretta* collected around the Pelagie Islands since 1994, show that boulter long-line fishing has a strong impact on the local loggerhead population (more than 150 turtles were reported as by-captured by only 3 small fishing boats in 2 months – Dominici et al. 2000, Dominici et al. 2001). In order to try and reduce loggerhead bycatch without impacting negatively on swordfish (*Xiphias gladius*) catch sizes, we initially surveyed local fishing methods and finally set out an experimental program aimed at testing (i) the attractiveness of fishing devices, (ii) the attractiveness of various types of bait and (iii) the effect of acoustic deterrents. In this paper we present some preliminary results on impact of floats on the swordfish longline fishery on loggerheads. Many interactions between turtles and floats, in fact, were reported by N. Beideman (Blue Water Fishermen's Association, in NOAA Tech-Mem NMFS-OPR-7, 1996) and Hawaiian observers collected some preliminary data revealing a high preference for loggerhead to be caught on hooks adjacent to or near the floats. Kleiber and Boggs presented some preliminary data on this subject at the Miami Workshop on reducing sea turtle takes in longline fisheries (August 31-September 1, 1999). Also some Italian fishermen working in the Sicilian waters (FederCoopPesca, AGCI Pesca, UNCI Pesca) reported that bycatches seem to occur more often on the hooks set nearer to the floats. To evaluate the floats' attractiveness we tested sea turtle's behaviors with respect to lit as well as unlit white floats.

MATERIALS AND METHODS

Experiments were carried out at the Delphynarium of "Fondazione Cetacea" in Cattolica (Italy) as well as at the Centro Recupero Tartarughe Marine in Linosa (Italy). We used open circular tanks having 10 m in diameter and 1.9 m depth. The seawater inside the tank was about 1.1-1.3 m deep. The water temperature was about 25°C (24°-26°C). To simulate the float used in the waters surrounding the Pelagie islands, we used white floats of 32x32x18 cm, having a central hole in which we lodged a pulsing light similar to those used by local fishermen.

Tests were carried out on 11 loggerheads. Four of these were juveniles (mean CCL=28 cm, SD=6.98, range=22-30 cm) and 7 subadults (mean CCL=49 cm, SD 11.79, range=38-69 cm). Experiments were conducted between 21 May and 15 August 2001. We subdivided the upper surface of the tank with white and red ropes in order to create a sampling grid having a $1 m^2$ mesh. Each sea turtle was lodged in the tank at least 12 hours before the experiment started (acclimatization time). During the following night, we observed and recorded for total of 2½ hours:

1) Control (no float in tank). We recorded the individual's spatial position with respect to the sampling grid every 2 minutes for a total of 30 minutes.

2) Experiment 1 (unlit white float). After control sampling, we put an unlit float in the tank. Then we recorded the individual's spatial position with respect to the sampling grid every 2 minutes for a total of 30 minutes.

3) Experiment 2 (white float with pulse light). After control sampling, we put on the pulse light on the float that was already present in the tank. Then we recorded the individual spatial position with respect to the sampling grid every 2 minutes for a total of 30 minutes.

Experiments 1 and 2 were repeated twice, non-consecutively, with the float located in 2 different point. We analyzed the collected data by Chi-square and Wilcoxon's test.

RESULTS

Experiment 1. No statistically significant difference in the spatial distribution of the loggerheads has been observed between control (float absence) and experiment 1 (presence of an unlit float) (Table 1). The general distribution (turtle's presence in the near zone or in the far zone from the float) does not change significantly relative to the presence of the unlit float (χ^2=3.181, g.l.= 1, P= 0.074).

This is confirmed by the analysis of the spatial distribution of individual subadults and juveniles in the control and the test situation (Wilcoxon's test: Z=1.074; P=0.283; Fig. 1).

Experiment 2. Also in this case, no significantly difference in the spatial distribution of tested loggerheads has been observed between control (float absence) and experiment 2 (presence of a lit float) (Table 2). The general distribution (presence in the near zone or in the far zone from the float) does not significantly change relative to the presence of the unlit float (χ^2=0.139, g.l.= 1, P= 0.709).

This is confirmed by the comparative analysis of the spatial distribution of individual subadults and juveniles, in the presence or absence of a light-bearing float (Wilcoxon's test: Z=0.674; P=0.500) (Fig. 2).

CONCLUSIONS

Fishermen have often suggested that hooks set closer to the floats have a higher probability of catching turtles accidentally (Kleiber and Boggs, see above). Our experiments, however, show that the spatial distribution of turtles in our tank was unchanged after introducing a white float, either lit, or unlit. Results therefore demonstrate that the floats' presence or absence does not influence turtle behavior significantly (i.e., floats are neither attractive nor repulsive for turtles).

In order to analyze the impact of floats more in detail, our future work will concentrate on acquiring more exact data on the number of turtles caught on the different segments of the fishing gear, as well as on the influence of the floats on the hooks' depth. Floats, in fact, will probably keep some segments of the longline more superficial than others and consequently, hooks in their proximity may be nearer to the surface. Some anecdotal reports, in fact, suggest that depth influences the probability of turtle catches and that bycatches tend to decrease with increasing depth. An alternative hypothesis that should also be tested in the open sea is that the pulse light on the float may have an indirect attractive effect. They may attract loggerheads preys, and consequently turtles.

LITERATURE CITED

Balletto, E., B. Barone, M. Cecconello, A. D'Andrea, L. Dell' Anna, S. Di Marco, A. Dominici, C. Giacoma, F. Mari, F. Miglietta, G. Nicolini, S. Piovano, L. Pozzi, M. Solinas. 2001. Azioni urgenti di conservazione di *Caretta caretta* nelle isole Pelagie. In Atti 3 o Congresso nazionale S.H.I. Pianura 13:223-226.

Beideman, N. 1996. Operations of and challenges facing the longline fishery. In: Pelagic Longline Fishery – Sea Turtle Interactions, Proceedings of an Industry, Academic and Government Experts, and Stakeholders. NOAA Tech-Mem NMFS-OPR-7: p. 39-45.

Dominici, A., S. Nannarelli, L. Pozzi, A. Zannetti, C. Giacoma, E. Balletto, L. Dell'Anna, S. Di Marco, and M. Solinas. 2000. Il Progetto LIFE sulla conservazione di *Caretta caretta*: dati preliminari sull'interazione tra la pesca con i palamiti e la tartaruga marina *Caretta caretta* nel Canale di Sicilia. Abstracts First Italian Meeting on Sea Turtle Biology and Conservation, Policoro (MT), 19-20 ottobre 2000:10.

Dominici, A., F. Miglietta, S. Nannarelli, L. Forni, S. Pont, S. Di Marco. 2001. Abstracts First Mediterranean Conference on Marine Turtles, Rome, Italy, 24-28 October 2001:18.

Table 1. Loggerhead turtle spatial distribution in the presence or absence of a white unlit float within the experimental tank.

	observed	
	near zone	far zone
control	120	209
unlit float	143	185

Table 2. Loggerhead turtle spatial distribution in the presence or absence of a pulse-light bearing float within the experimental tank.

	Observed	
	near zone	far zone
control	120	209
lit float	126	204

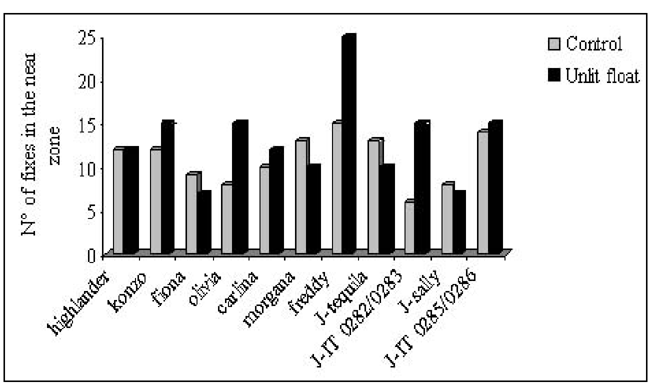

Fig. 1. The analysis of the spatial distribution of individual subadults and juveniles (names beginning by J) has shown that the turtle's presence in the "near zone" does not vary as a consequence of the presence or absence of an unlit float.

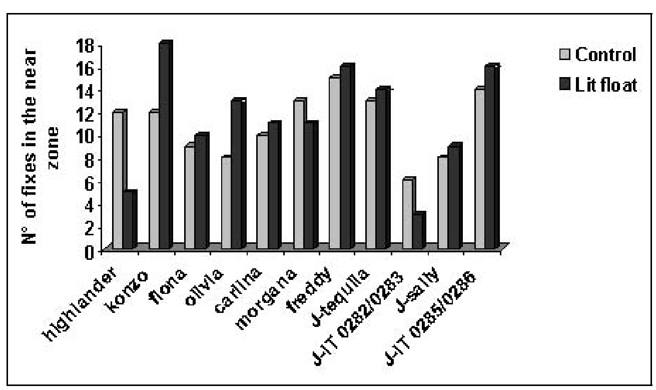

Fig. 2. Total number of fixes per individual recorded in the test zone in the presence and absence (control) of a float bearing a pulsating white light. The spatial distribution analysis of individual subadults and juveniles (names beginning by J) has shown that the turtle's presence in the "near zone" does not vary as a consequence of the presence or absence of a pulse-light bearing float.

TICO TED: process for US approval

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As of March 1997, the Costa Rican government formally requested the National Marine Fisheries Service (NMFS) the approval of the 6 inch bar spacing TED modification for use in the Costa Rican shrimp fishery. This request was based on studies carried out from April 1995 to December 1996, which recorded unacceptable loss of shrimp when using TEDs in the white shrimp fishery in coastal shallow waters. The large amount of debris in coastal waters was held responsible for obstructing TEDs and impairing proper functioning. Wider deflector bar spacing (from 4 to 8 inches) proved to reduce shrimp loss. Additional morphometric information proved that wider bar spacing did not pose a threat to juvenile olive ridley sea turtles. As of July of 2000, NMFS issued a temporary permit for Costa Rica to use 6 inch deflector bar spacing TEDs, on the condition that by July of 2002 the Costa Rican authorities would provide additional information based on observer data.

Twenty years of partnerships: WIDECAST, the Wider Caribbean Sea Turtle Conservation Network

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BACKGROUND AND RATIONALE

WIDECAST was founded in Santo Domingo, Dominican Republic, in 1981 to work on behalf of six species of sea turtle encountered in the Wider Caribbean Region. The network embraces 39 States and territories in the Gulf of Mexico and Caribbean Sea, and includes Bermuda and Brazil as well. There are WIDECAST Country Coordinators resident in 32 of these states and territories. Country Coordinators are drawn from governmental and non-governmental sectors and must have sea turtle research and/or management experience. To achieve WIDECAST objectives, Country Coordinators work in partnership with a national coalition of stakeholders, including scientists, conservationists, resource managers, resource users, policymakers, coastal landowners, educators and others.

WIDECAST's five primary areas of activity (field research and conservation, management and policy intervention, training and capacity building, public awareness, fund-raising) support a unifying mission "to realize a future where all inhabitants of the Wider Caribbean Region, human and sea turtle alike, can live together in balance". Why sea turtles? The Region's six species play uniquely important roles in the ecology and economy of the Region, and all are severely reduced from historical levels. Persistent over-exploitation, especially of adult females on nesting beaches and the widespread collection of eggs, are largely responsible for the current IUCN global classifications of "Endangered" for the green, loggerhead and olive ridley sea turtles and "Critically Endangered" for the leatherback, hawksbill and Kemp's ridley sea turtles.

In addition to a largely unregulated harvest that has spanned more than a millennium in the Caribbean basin, sea turtles are accidentally captured in active or abandoned fishing gear, resulting in death to uncounted thousands of turtles annually. Widespread coral reef and seagrass degradation, oil spills, chemical waste, persistent plastic and other marine debris, high density coastal development, and an increase in ocean-based tourism have damaged or eliminated nesting beaches and feeding areas.

Reversing population decline is complicated. Threats to sea turtle populations can accumulate over long periods of time, and can occur anywhere in a population's range. Because most sea turtle populations are characterized as highly migratory, what appears as a decline in a local population may, in fact, be a direct consequence of the activities of peoples many hundreds or even thousands of kilometers away. Thus, while local conservation is crucial, co-operative action is also called for at regional and international levels.

FACILITATING REGIONAL ACTION

WIDECAST effectively integrates national and international conservation priorities for sea turtles and the habitats upon which they depend. For example, as a long-established Partner Organization of the UNEP Caribbean Environment Programme (CEP), WIDECAST ensures that local concerns and expertise are directly incorporated into international decision-making and policy.

UNEP's 1983 Convention for the Protection and Development of the Marine Environment of the Wider Caribbean Region ('Cartagena Convention') and its Protocol concerning Specially Protected Areas and Wildlife (SPAW Protocol) form an important regional framework for sea turtle policy and management. To assist countries in fulfilling the mandate of the SPAW Protocol, WIDECAST Country Coordinators work in partnership with stakeholders at all levels to develop national conservation strategies referred to as a "Sea Turtle Recovery Action Plans" (STRAP). Each STRAP is tailored specifically to local circumstances and discusses sea turtle status and distribution, major causes of mortality, the effectiveness of existing legislation, and the present and historical role of sea turtles in the local culture and economy, and then makes specific recommendations for local, national, and multilateral conservation action.

STRAPs have been published for Antigua and Barbuda (Fuller et al. 1992), Aruba (Barmes et al. 1993), Barbados (Horrocks 1992), Belize (Smith et al. 1992), the British Virgin Islands (Eckert et al. 1992), St. Kitts and Nevis (Eckert and Honebrink 1992), St. Lucia (d'Auvergne and Eckert 1993), St. Vincent and the Grenadines (Scott and Horrocks 1993), Suriname (Reichart and Fretey 1993), Netherlands Antilles (Sybesma 1992), and Venezuela (Guada and Solé 2000). Four additional STRAPs will be published in 2002 (Anguilla, Jamaica, Panama, and Trinidad and Tobago).

In addition to the national action plans, WIDECAST experts have played a strong role in the development of regional and subregional management guidelines (e.g., Eckert 1995, Eckert and Abreu 2001, Reichart et al. 2002) and a variety of technical assessments are currently in preparation, including "Meeting Ecological and Economic Goals: Best Practices for Sea Turtle Ecotourism in the Wider Caribbean Region", "An Assessment of Sources of Sea Turtle Bycatch in Commercial and Artisanal

Fisheries Operating in the Eastern Caribbean Region", and "Sea Turtle Product Use and Trade in Central America".

INVOLVING AND EMPOWERING PEOPLE

WIDECAST is rooted in the belief that conservation must be nurtured from within, it cannot be commanded from outside. Our programs prioritize capacity building and are always designed to encourage a technical understanding of sea turtle biology and management among local individuals and organizations. To facilitate the sharing of information, WIDECAST hosts two regional support centers (a Caribbean Marine Turtle Tagging Center in Barbados, and a Conservation Materials Distribution Center in St. Croix, USVI), offers an annual training course (in Venezuela), maintains a comprehensive website (www.widecast.org), and convenes an Annual Meeting of Country Coordinators and Partner Organizations to discuss issues of regional concern, identify gaps in research and management information, agree on priority conservation actions, and commit to collaborative initiatives.

WIDECAST emphasizes the best available science through STRAP development, ensuring regional distribution of the latest technical information and references (e.g., Lutz and Musick 1997, Eckert and Abreu 2001, Witherington and Martin 2000, Eckert et al. 1999, TRAFFIC North America 2001), developing database management software and other record-keeping tools, promoting exchange programs among field projects, hosting training workshops and courses, maintaining long-term ecological studies, evaluating community-based eco-tourism initiatives, and distributing public awareness materials. In all cases, network members initiate and implement project components.

CONCLUDING REMARKS

Sea turtles will not survive in the Caribbean Sea without unflinching regional cooperation and coordination of conservation and management programs. WIDECAST provides an effective, inclusive mechanism for such collaboration. The goal must be for information to be as decentralized as possible. Most sea turtles live or die at the hand of someone who encounters them far away from a conservation group or law enforcement officer. If sea turtles are going to survive, we have to find new ways of getting people - at all levels - to participate in decision-making that promotes and encourages the sustainable use and management of all biological resources, including sea turtles. Networking, information-sharing, and genuine capacity building is the first and perhaps the most important step in this process.

LITERATURE CITED

Barmes, T., K.L. Eckert, and J. Sybesma. 1993. WIDECAST Sea Turtle Recovery Action Plan for Aruba. CEP Technical Report No. 25. UNEP Caribbean Environment Programme, Kingston, Jamaica. xiv + 58 p.

d'Auvergne, C. and K.L. Eckert. 1993. WIDECAST Sea Turtle Recovery Action Plan for St. Lucia. CEP Technical Report No. 26. UNEP Caribbean Environment Programme, Kingston, Jamaica. xiv + 66 p.

Eckert, K.L. 1995. Draft General Guidelines and Criteria for Management of Threatened and Endangered Marine Turtles in the Wider Caribbean Region. UNEP(OCA)/CAR WG.19/ INF.7. Prepared by WIDECAST and adopted by the Third Meeting of the Interim Scientific and Technical Advisory Committee to the SPAW Protocol. Kingston, 11-13 October 1995. United Nations Environment Programme, Kingston. 95 p.

Eckert, K.L. and F.A. Abreu-Grobois, eds. 2001. Proceedings of the Regional Meeting: "Marine Turtle Conservation in the Wider Caribbean Region: A Dialogue for Effective Regional Management", Santo Domingo, 16-18 November 1999. WIDECAST, IUCN-MTSG, WWF and UNEP-CEP. 154 pp

Eckert, K.L. and T.D. Honebrink. 1992. WIDECAST Sea Turtle Recovery Action Plan for St. Kitts and Nevis. CEP Technical Report No. 17. UNEP Caribbean Environment Programme, Kingston, Jamaica. xiii + 116 p.

Eckert, K.L., K.A. Bjorndal, F. A. Abreu-Grobois, and M. Donnelly, eds. 1999. Research and Management Techniques for the Conservation of Sea Turtles. IUCN/SSC Marine Turtle Specialist Group Publication No. 4. Washington, D.C. 235 p.

Eckert, K.L., J.A. Overing, and B.B. Lettsome. 1992. WIDECAST Sea Turtle Recovery Action Plan for the British Virgin Islands. CEP Technical Report No. 15. UNEP Caribbean Environment Programme, Kingston, Jamaica. xv + 116 p.

Fuller, J.E., K.L. Eckert, and J.I. Richardson. 1992. WIDECAST Sea Turtle Recovery Action Plan for Antigua and Barbuda. CEP Technical Report No. 16. UNEP Caribbean Environment Programme, Kingston, Jamaica. xii + 88 p.

Guada, H.J. and G. Solé. 2000. Plan de Acción para la Recuperación de las Tortugas Marinas de Venezuela (A. Suarez, ed.). Programa Ambiental del Caribe. Programa de las Naciones Unidas para el Medio Ambiente /WIDECAST. Reporte Técnico No. 39, Kingston, Jamaica. xiv + 122 p.

Horrocks, J.A. 1992. WIDECAST Sea Turtle Recovery Action Plan for Barbados, K. L. Eckert, ed. CEP Technical Report No. 12. UNEP Caribbean Environment Programme, Kingston, Jamaica. xiv + 61 p.

Lutz, P.L. and J.A. Musick. 1997. The Biology of Sea Turtles. CRC Press. Boca Raton, Florida. 432 p.

Reichart, H.A. and J. Fretey. 1993. WIDECAST Sea Turtle Recovery Action Plan for Suriname, K.L. Eckert, ed. CEP Technical Report No. 24. UNEP Caribbean Environment Programme, Kingston, Jamaica. xiv + 65 p.

Reichart, H., L. Kelle, L. Laurent, H.L. van de Lande, R. Archer, R. Charles, and R. Lieveld. 2002. Regional Sea Turtle Conservation Program and Action Plan for the Guianas, K.L. Eckert, ed. World Wildlife Fund - Guianas Forests and Environmental Conservation Project, Paramaribo. WWF Technical Report GFECP No. 10.

Smith, G.W., K.L. Eckert, and J.P. Gibson. 1992. WIDECAST Sea Turtle Recovery Action Plan for Belize. CEP Technical Report No. 18. UNEP Caribbean Environment Programme, Kingston, Jamaica. xiii + 86 p.

Sybesma, J. 1992. WIDECAST Sea Turtle Recovery Action Plan for the Netherlands Antilles, K.L. Eckert, ed. CEP Technical Report No. 11. UNEP Caribbean Environment Programme, Kingston, Jamaica. xvii + 63 p.

Scott, N. and J.A. Horrocks. 1993. WIDECAST Sea Turtle Recovery Action Plan for St. Vincent and the Grenadines, K.L. Eckert, ed. CEP Technical Report No. 27. UNEP Caribbean Environment Programme, Kingston, Jamaica. xiv + 80 p.

TRAFFIC North America. 2001. Swimming Against the Tide: Recent Surveys of Exploitation, Trade and Management of Marine Turtles in the Northern Caribbean. Washington D.C. 161 p.

Witherington, B.E. and R.E. Martin. 2000. Understanding, Assessing, and Resolving Light-Pollution Problems on Sea Turtle Nesting Beaches (revised edition). Florida Fish and Wildlife Conservation Commission, FMRI Technical Report TR-2. 73 p.

Preventing illegal trade in sea turtle products by members of the traveling public: preliminary data from the Caribbean region

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INTRODUCTION

Although the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) has regulated international trade in endangered and threatened species for many years, illegal trade in some species listed in its Appendices, including sea turtles, continues to be an issue of concern. One important aspect of this illegal trade is the sale of products derived from protected wildlife, their purchase by members of the traveling public, and the subsequent transport of these products across international borders in violation of CITES protocols.

Two decades of assessments on commercial trade in sea turtle products, including shell (tortoiseshell, or bekko), skins/leather and oil, are available in the literature (e.g., Mack et al. 1982, Roet et al. 1983, Milliken and Tokunaga 1987, Canin 1989, 1991, Donnelly 1989a, 1989b, Greenpeace 1989, Groombridge and Luxmoore 1989, Jenkins and Broad 1994, JWCS 2000) and the most recent such study focused on the northern Caribbean (TRAFFIC North America 2001). But statistics on non-commercial trade, including the volume of sea turtle material illegally transported across international borders by tourists and other travelers, are unavailable.

Members of the Wider Caribbean Sea Turtle Conservation Network (WIDECAST) and others have been concerned with this trade for many years. A decade ago, WIDECAST's Executive Director participated in the "Caribbean CITES Implementation Training Seminar" (14-18 September 1992, Port of Spain, Trinidad) to assist in training Caribbean governments, particularly Customs officers, in the identification of sea turtle product items. More recently, WIDECAST has produced a variety of bilingual materials aimed at encouraging tourists to be aware of their purchasing decisions, to patronize vendors that do not sell sea turtle products, and to encourage conservation partnerships with the tourism industry.

Throughout the Wider Caribbean Region, governments and non-governmental organizations (NGOs) have developed their own programs to educate tourists, both at shops and places of departure and arrival, such as airports, of the plight of endangered species and the responsibilities of travelers for their conservation. As just one example, the "Buyer Beware" campaign sponsored by the U.S. the Fish and Wildlife Service, National Marine Fisheries Service and World Wildlife Fund has provided a valuable education and outreach tool to help travelers understand that protected species of fish and wildlife (including plants) - as well as any products derived from them - are subject to U.S. and international import and export restrictions, prohibitions, permit certificates and quarantine requirements.

Similar restrictions characterize virtually every other country in the Wider Caribbean Region. Indeed, 27 of the 28 sovereign states which comprise the Region are Party to CITES; the exception is Haiti (Andrade 2001), which, in any case, must comply with CITES restrictions by issuing comparable documentation in international trade. The "Buyer Beware" campaign and similar initiatives in other countries inspire hope that tourists are getting the message, but an evaluation of the successes (and failures) of current efforts is needed to ensure an effective regional response to what is, by definition, an international challenge. The purpose of this study is to characterize what Caribbean countries are doing to meet this challenge and to make recommendations. The data herein summarized are preliminary, and a more complete and peer-reviewed analysis will be published separately.

METHODS

A bilingual questionnaire was circulated to governments (specifically to CITES Management Authorities) and knowledgeable NGOs throughout the Wider Caribbean Region. Recipients were asked to describe existing public awareness programs, to indicate whether or not these programs were deemed successful (and by what measure), to describe the characteristics of successful and unsuccessful programs, to indicate whether the country has a "model" program suitable for replication elsewhere in the Region, and to make recommendations regarding what form of assistance would be most useful in developing a successful national program to educate the traveling public about relevant legislation and their role in protected species trafficking. In each case, a list of choices was provided and the interviewee was asked to check all that applied. Results from government and NGO sources were compiled by country.

RESULTS

Twenty-one responses provided information for the following nations and territories (hereafter referred to as "countries") - Bahamas, Barbados, Bermuda, Bonaire and Sint Maarten (Netherlands Antilles), British West Indies, Costa Rica, Cuba, Dominica, French Guiana, French West Indies, Grenada, Guyana, Honduras, Jamaica, Mexico, Nicaragua, Panama, St. Lucia, Trinidad and Tobago, and Venezuela. The data presented are from these countries only.

Most countries (n=15) use brochures or leaflets as the primary tool to communicate with the public. The second most preferred method (n=7 countries) is a port-of-entry display, followed closely (n=6) by the use of Internet tools (e.g., websites) and displays in markets or shops. There is comparatively little collaboration with hotels (n=5), and only Honduras reported collaborating with cruise ships or regional airlines. No country reported distributing information with visas or other travel documents.

The target audience for any outreach effort is most often the general public (n=12 countries), followed by schools/youth (n=11 countries); fewer countries (n=8) invested in similar outreach to law enforcement or customs officers. In some cases the use of radio and print media was noted, and several countries described providing relevant information to visitors as part of 'turtle camps' or nesting beach projects.

The most commonly cited reason (n=5 countries) for having no outreach program was "lack of human or financial resources" and/or a belief that "the education of tourists should take place in major ports of embarkation into the Caribbean region, such as in Miami, London or Amsterdam", followed (n=4 countries) by insufficient expertise regarding the issues and/or gaps in national legislation. In some cases (e.g., Bermuda, French West Indies) interviewees noted that sea turtles are totally protected and sea turtle products are not offered for sale, and thus outreach on the issue is unnecessary.

As for indications of the success of outreach efforts, eight countries cited declines in the number or volume of sea turtle products purchased and six countries cited declines in Customs seizures as evidence of success, but only two countries (Cuba, Trinidad and Tobago) indicated that they had statistics to confirm the trends. Bahamas cited phone calls from members of the public protesting the sale of turtle products in public markets, and complaining of poor treatment given to turtles offered for sale. St. Lucia cited an increase in the number of people reporting sea turtle nesting activity and Guyana noted an increase in the number of people willing to "help stranded turtles return to the sea instead of eating them" as evidence that awareness was rising, although this would not necessarily result specifically from outreach regarding sea turtle product trade.

There was a wide range in responses to the question, "In general, which programs do you feel are the most successful?" One suggestion was, "any program that reaches the most number of people"; others felt that the education of law enforcement and Customs officers was crucial, as were visual displays in airports and points of sale (boutiques, craft markets, hotels, restaurants). Mention was made of the need to work more closely with the tourism industry, and some interviewees suggested targeting children (because they adopt new policies most readily) and engaging communities on a more consistent basis. Nearly all countries indicated that they had no outreach campaigns suitable to serve as a model for others.

By far the most common reason, cited by 11 countries, for the lack or failure of programs was insufficient funding, followed closely (n=7 countries) by an inadequate or inconsistent regulatory framework and a general lack of follow-through (for example, arriving and departing travelers are not routinely asked whether they are carrying sea turtle items or other protected species). Six countries cited a lack of political will, while a few countries cited a lack of expertise and/or a general disinterest on the part of the tourism industry. One respondent lamented the fact that millions and millions of tourists enter and depart the Region every year, that the endless cycle of education that is required to make a measurable difference in their behavior (e.g., their purchasing habits) is overwhelming, and that the most practical approach would be to ensure that sea turtle products (and products made from other internationally protected species) are not offered for sale.

When asked what type of assistance would be most useful in developing a successful national education program, most countries (n=15) cited funding, followed closely (n=11) by the availability of model programs. Five countries indicated a need for qualified people to assist in training and program development.

CONCLUSIONS AND RECOMMENDATIONS

It is clear that concern is widespread about transborder trafficking in protected species products by tourists who are presumably unaware of the role they play in endangering depleted local resources. It is also clear that a variety of approaches to the problem have the potential to be successful, but that success is hindered by insufficient funding, a lack of educational tools and materials, comparatively low interest on the part of the tourist industry and policy-makers, an insufficient or inconsistent regulatory framework, and a general lack of follow-through on the part of law enforcement. Based on this preliminary assessment, our strongest recommendation is that broadly applicable, multilingual materials be developed for use throughout the Region.

LITERATURE CITED

Andrade, C.N. 2001. Caribbean marine turtles and international law. In: K.L. Eckert and F.A. Abreu, eds. Proceedings of the Regional Meeting: "Marine Turtle Conservation in the Wider Caribbean Region: A Dialogue for Effective Regional Management", WIDECAST, IUCN-MTSG, WWF and UNEP-CEP. p. 83-85.

Canin, J. 1989. International trade in sea turtle Products. In: S.A. Eckert, K.L. Eckert, and T.H. Richardson, comps. Proc. 9th Annual Workshop on Sea Turtle Conservation and Biology. NOAA Tech. Memo. NMFS-SEFC-232. p. 27-29.

Canin, J. 1991. International Trade Aspects of the Japanese Hawksbill Shell ('bekko') Industry. Marine Turtle Newsletter 54:17-21.

Donnelly, M. 1989a. Socio-economic importance of sea turtles: international trade in tortoiseshell, In: L. Ogren, ed. Proc. Second Western Atlantic Turtle Symposium. NOAA Tech. Memo. NMFS-SEFC-226. Panama City, Florida. p. 38-49.

Donnelly, M. 1989b. International trade in hawksbill sea turtle shell in the Wider Caribbean. In: S.A. Eckert, K.L. Eckert, and T.H. Richardson, comps. Proc. 9th Annual Workshop on Sea Turtle Conservation and Biology. NOAA Tech. Memo. NMFS-SEFC-232. p. 45-47.

Greenpeace. 1989. Sea Turtles and Indonesia. Prepared by Greenpeace International for the 7th Conference of Parties to CITES, Lausanne, Switzerland, 9-20 October 1989. 23 p.

Groombridge, B. and R. Luxmoore. 1989. The Green Turtle and Hawksbill (Reptilia: Cheloniidae): World Status, Exploitation and Trade. Secretariat of CITES, Lausanne.

Jenkins, M. and S. Broad, eds. 1994. International Trade in Reptile Skins: A Review and Analysis of the Main Consumer Markets, 1983-1991. TRAFFIC Intl., Cambridge. 68 p.

JWCS. 2000. Hawksbill Trade Revived?: Analysis of the Management System of Domestic "Bekko" Trade in Japan. Japanese Wildlife Conservation Society, Tokyo. 16 p.

Mack, D., N. Duplaix and S. Wells. 1982. Sea turtles, animals of divisible parts: international trade in sea turtle products, In: K. A. Bjorndal, ed. Biology and Conservation of Sea Turtles. Smithsonian Institution Press, Washington D.C. p. 545-562.

Milliken, T. and H. Tokunaga. 1987. The Japanese Sea Turtle Trade: 1970-1986. A Special Report Prepared by TRAFFIC (Japan). Tokyo. 171 p.

Roet, E., P.C. Escherich, R.E. McManus, and J. Teeple-Hewes. 1983. Sea Turtles in Trade: An Evaluation. Prepared by the Sea Turtle Rescue Fund. Center for Environmental Education. Washington, D.C. 40 p.

TRAFFIC North America. 2001. Swimming Against the Tide: Recent Surveys of Exploitation, Trade and Management of Marine Turtles in the Northern Caribbean. 161 p.

First steps for the conservation of marine turtles in southern Perú

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Despite legislation, direct take of marine turtles for trade in Pisco, southern Peru, is encouraged by people unaware of conservation problems faced by these species. To mitigate this situation, in April 2001 we started a public awareness campaign about marine turtles for the first time. A campaign named “We want to live” was launched, directed to the public involved in the marine turtle issue. The main turtle meat trading centers were identified. Basic information on marine turtles and legislation protecting them was included in materials distributed. This information was also provided at ACOREMA´s Interpretative Center, in both exhibits and speeches for the visitors. Actions within the campaign included lobbying with local authorities in charge of the control, and workshops with personnel of local agencies, and guides. Informal meetings were the tools for reaching fishermen. National coverage of the campaign was given by the media. Marine turtle conservation now is in the local agenda. Materials from the campaign are now showed at most commercial establishments, local agencies and institutions, including 25 restaurants identified as turtle meat traders. An important achievement was the participation of local agencies in joint actions at several trade centers. Other results include a more active participation of the public in controlling illegal capture and trade and marine turtle sighting reports made by fishermen. The campaign will continue, as well as monitoring of marine turtle/fisheries interactions and lobbying with local authorities, to maintain the current efforts for the benefit of marine turtles in Peru.

Sinks, sewers, and speed bumps: the impact of marina development on sea turtles in Baja California, Mexico

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The coast of the Baja California peninsula provides habitat for five species of sea turtle from all around the Pacific basin. Until now the main threats to sea turtles in the region were primarily direct and indirect take. The vast majority of the foraging grounds remain undeveloped and generally free of contamination. A recently proposed mega-project known as Escalera Nautical (Nautical Steps) plans to develop a system of 22 ports along the coast of northwest Mexico to attract nautical tourism from the U.S. to provide jobs in this economically depressed region. The potential benefits and costs of this project, in particular as they relate to sea turtles and sensitive terrestrial and marine ecosystems, should be considered prior to further construction.

Description of the Region. The coast of the Baja California peninsula and the Gulf of California are recognized as some of the most ecologically important coastal areas of the North American continent. This 3,000-mile stretch of coast is responsible for more than 40% of Mexico's landings of marine resources. For its high level of endemism and biological diversity Conservation International recognizes the region as a "biodiversity hotspot". The region, in particular the coast of the Baja California peninsula, is relatively pristine with vast areas falling within federally protected reserves. The most endangered group of marine animals that inhabit these waters are the sea turtles—all five species are endangered or threatened and are protected under Mexican law. Sea turtles migrate from as far away as Japan and southern Mexico to use these waters as foraging and developmental areas. Thus, the region is considered important to sea turtle recovery efforts around the Pacific basin.

Current Threats to Sea Turtles. The main contemporary threats to sea turtles are hunting and bycatch. The region is considered a sea turtles "sink" and we estimate as many as 35,000 dead turtles annually for this region. Despite intense nesting beach conservation effort over the past 3 decades an active, though illegal, market for sea turtle meat in northwestern Mexico has been a barrier to recovery. These threats are being affectively addressed through a network of fishermen, community members, researchers and governmental and non-governmental organizations known as the Sea Turtle Conservation Network of the Californias. Seven community-based monitoring projects are documenting sea turtle population trends throughout the region. Contamination, boat collision and injection of anthropogenic debris are considered secondary threats, particularly along the coast of the peninsula. The proposed Escalera Nautica, if realized, will bring new threats to sea turtles.

Proposed Mega-Project: "Escalera Nautica". According to FONATUR information, the proposed mega-project known as Escalera Nautica (Nautical Ladder) includes 24 new or improved marinas, Fuel distribution system for each port, 20 new or improved airports, 17,000 new hotel/condo rooms, 34 new golf courses, a network of new highways connecting development sites, and a "Land Bridge" or 4-lane highway from the Pacific to Gulf of California to transport yachts (Fig. 2). Escalera Nautica would be modeled after Cancun, Cabo San Lucas, Acapulco, and "Riviera Maya" FONATUR Mega-Projects.

The stated goals of Escalera Nautica include 50,000 new employees, 5 million tourists annually by 2010, a projected market of 91,210 yachts by 2014, a US $ 2 billion investment by FONATUR, and "unequalled opportunities for national/international investors" (Table 1).

Potential Impacts of Escalera Nautica on Sea Turtles. The proposed mega-project coincides with all of our long-term sea turtle research and monitoring sites. It is no coincidence that both sea turtles and marinas favor tranquil, pristine bays. Possible new threats to sea turtles related to this project include: (1) contamination of critical nursery and feeding areas; (2) habitat destruction w/in Marine Protected Areas; (3) boat traffic and strikes w/in Marine Protected Areas; and (4) increased poaching concomitant with an increase in the human population. Each of these potential impacts should be investigated and included as part of a comprehensive environmental impact assessment.

Fatal Flaws in the Escalera Nautica Mega-Project

1) Large tides, high winds, extreme temperatures at many of the proposed sites preclude the kinds of tourism the project proposes.

2) Lack of adequate potable water in region.

3) Market analysis based on 1997-1999 data. A new, independent, market analysis is currently being conducted and will be released in late 2002

4) Lack of consideration of protected areas. The Mexican conservation and environmental community, who has worked for the establishment and management of several protected areas in the region, will thoroughly scrutinize this project as 8 of the proposed sites occur with protected areas.

5) No ecological/social analysis or community consultation. Reports from many of the proposed sites suggest that the project directors have not thoroughly considered the interests and desires of the communities impacted.

Development Alternatives to the Mega-Project Paradigm

1) "Escalera Ecologica". The coastal desserts and waters of northwestern Mexico are world treasures. Expansion of low impact, locally owned, adventure, eco- or science tourism could be encouraged through a network known as "Escalera Ecologica" that highlights and maintains, rather than compromises, the region's ecological integrity. Sea turtles should be an important component of the region's ecological attractions.

2) Fisheries management. Many of the fisheries in the region have declined due to poor stewardship. Investment in sound management practices by cooperatives would bring desired jobs to an already established infrastructure.

3) Piracy reduction. By investing in anti-poaching efforts vast gains in legal fisheries production could be achieved. Those fishing coops currently investing in community-based anti-poaching programs have demonstrated significant gains.

4) Niche marketing for fisheries resources. As consumers become more aware of the eco-seafood market, opportunities will expand. Currently the Baja California lobster fishery is being considered for Marine Stewardship Council certification.

SUMMARY

The coast of northwestern Mexico and its ecological richness can be best balanced with the economic needs of the region by carefully reconsidering the Escalera Nautica proposal and adapting it to "Escalera Ecologica". Under this scenario, low impact tourism activities and sustainable fisheries can support the human population while maintaining biological diversity and encouraging recovery of endangered species such as sea turtles. The typical FONATUR mega-projects represent an old development model that is incompatible with Mexico's emerging culture of stronger environmental policies and democracy.

Table 1. Diverse views on Escalera Nautica.

"The 'Escalera Nautica' represents an attempt at land speculation financed by public funds, that will enrich a small number of officials and a select group of private investors, causing considerable damage to some of the most pristine natural areas of Mexico." (H. Aridjis, in La Reforma, Mexico City, 2000)

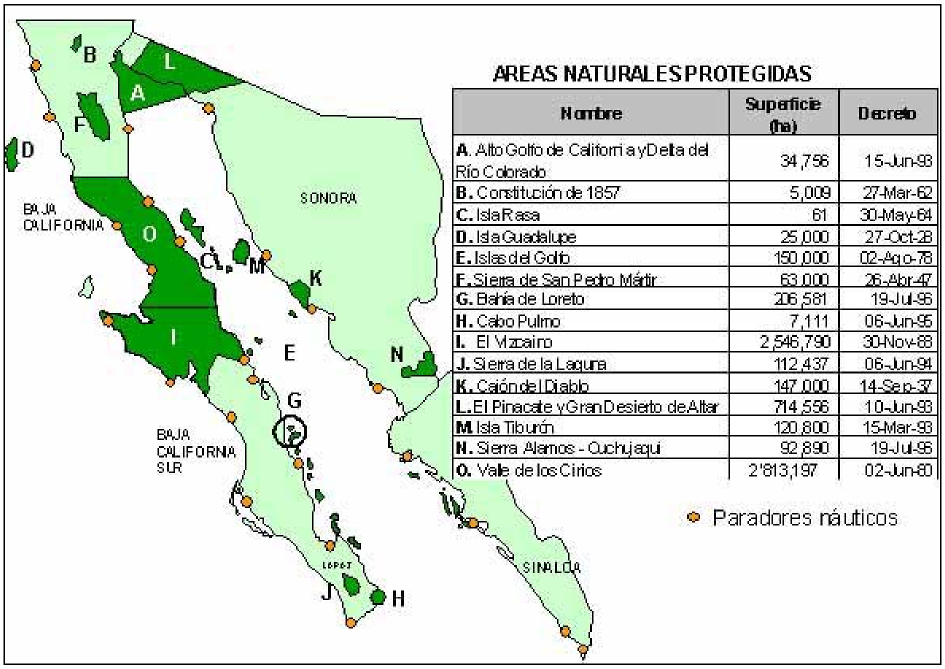
"FONATUR Director [John McCarthy] announced that in order to protect the natural resources and ecosystem of the Escalera Nautica, the master plan of the project will have special franchise license rules to regulate the tourist activity. This system may allow the Government to have a better control of the nautical and tourism activities and its relationship with the ecosystem." (FONATUR website 2001)

"Without the Escalera's infusion of tourist dollars, authorities doubt they can protect the natural beauty of these places. They express no doubt, on the other hand, about their own ability to maintain the integrity of the area through project designs that comply with all Mexican environmental regulations." (M. Spaulding, Borderlines newsletter 2001)

"…once underway the Nautical Ladder could become yet another of the never-finished tourist developments that scar the Mexican landscape. In Baja, for example, Puerto Escondido has remained since 1988 a wasteland of half-completed condominiums, pavement and cement covering what was once among the region's most biologically productive areas." (D. Russell, The Ecologist 2002)

For more information on Escalera Nautica:

www.escaleranautica.com
www.wildcoast.net.
www.propeninsula.org



Nombre	Superficie (ha)	Decreto
A. Alto Golfo de California y Delta del Río Colorado	34,756	15-Jun-93
B. Constitución de 1857	5,009	27-Mar-62
C. Isla Rasa	61	30-May-64
D. Isla Guadalupe	25,000	27-Oct-28
E. Islas del Golfo	150,000	02-Ago-78
F. Sierra de San Pedro Mártir	63,000	26-Abr-47
G. Bahía de Loreto	206,581	19-Jul-96
H. Cabo Pulmo	7,111	06-Jun-95
I. El Vizcaíno	2,546,790	30-Nov-88
J. Sierra de la Laguna	112,437	06-Jun-94
K. Cañón del Diablo	147,000	14-Sep-37
L. El Pinacate y Gran Desierto de Altar	714,556	10-Jun-93
M. Isla Tiburón	120,800	15-Mar-93
N. Sierra Alamos - Cuchujaqui	92,890	19-Jul-96
O. Valle de los Cirios	2'813,197	02-Jun-80

Fig. 1. Protected areas of northwestern Mexico (FONATUR 2002).

Fig. 2. Proposed Escalera Nautica mega-project (FONATUR 2002).

Assessing the impact of fishing pier construction on spatial patterns of sea turtle nesting in Palm Beach County, Florida

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This analysis attempts to quantify the effect of the construction of a 990-foot fishing pier on sea turtle nesting patterns at Juno Beach in Palm Beach County, Florida. We will consider 2 methods of analyzing the data- a traditional approach and a lesser utilized technique involving the spatial distribution of the emergences.

Construction initiated in November 1997 (prior to the 1998 nesting season). At the start of the 1998 season (May), an estimated 50%-75% of the pier was complete. The pier became operational prior to the start of the 1999 season. We will consider 1997 to be pre-construction, 1998 to be during construction and 1999-2000 as post-construction years.

During the late 1980's, the Florida Fish and Wildlife Conservation Commission divided the beach into 11 Index Nesting Beach Zones. Despite an attempt to allocate 0.5 miles per zone, zone length is quite variable (range: 0.27-1.1 miles). To compensate for this variability, we will not report emergences as raw zone counts but as number of emergences per mile. The Marinelife Center of Juno Beach measured nesting and non-nesting emergences for 1998, 1999, and 2000 using differential global positioning system (DGPS) with submeter accuracy.

Fig. 1 illustrates the number of total emergences per mile by INB zone. While there is the same general pattern of zone counts per mile throughout the time period, the zone where the pier is located (zone 4) has fewer emergences per mile than most of the other zones during 1998-2000. In 1999, it has the fewest. In contrast, in 1997 (pre-construction), zone 4 had one of the highest emergences/mile.

For an initial comparison of a continuous variable like number of emergences per mile within INB zone, we used the Kruskal-Wallis test which is a general non-parametric approach which tests the null hypothesis that the 4 years (1997, 1998, 1999, 2000) all have the same turtle nesting distribution against the alternative that the nesting distribution differs between years.

There is a significant difference between distribution of INB zone emergences per mile in 1997 and each of the 3 subsequent years ($p<.0001$). Also noteworthy is the difference in distribution between the 2 post-construction years, 1999 and 2000. Not surprisingly, the general test of whether there is any distribution difference among the 4 years is also significant. When emergence data are grouped by zone, the results indicate whether there are differences existing in zone to zone patterns. However, we are unable to specify the exact locations of changes in nesting patterns. The analysis of GPS data, in contrast, focuses on the exact locations of changes.

Local differences are assessed using kernel density estimation in Figs. 2-4. The top graph shows the kernel density estimates based on the GPS data for nesting and non-nesting emergences in 1998 along the linearized beach (north end at left) while the bottom graph shows the natural logarithm of the ratio of two intensity functions. The pier location and INB zone boundaries appear in the bottom figure and may be visually extended to the top of the figure. (The zones are distinguished by the dotted vertical lines and the numbers at the top; the pier is indicated by the dotted gray vertical line).

In the bottom graph in Figs. 2-4, for each location on the beach, the log ratio of the intensities of the 2 types of emergences is denoted by the black solid line. A log ratio of 0 corresponds to identical intensities. The black dashed lines correspond to the 2.5th and 97.5th percentiles (thereby creating a 95% tolerance region) of log ratios simulated under random assignment of each emergence to a particular year (a null hypothesis of no difference). The short vertical black and gray marks along the bottom of the lower graph correspond to those segments of beach when the log observed ratio is no longer contained in the 95% region (i.e. departure from zero). The solid gray lines denote the 50 simulated log ratios based on random assignment of year to each emergence (random labeling).

Figs. 2-4 illustrate the comparison between nesting and non-nesting emergences in a given year. In 1998, the nesting and non-nesting densities follow a very similar pattern as seen in the top graph of Fig. 2 below. As a result, the log ratio of the intensities is close to zero along the beach. There were no marked differences between nesting and non-nesting densities near the pier. In short, even though the pattern of emergences varied by location along the beach, the probability that any given emergence resulted in a nest was remarkably constant along the entire length of the beach.

In contrast, Figs. 3 and 4 highlight a shifting in the nesting success rates. In Fig. 3, the top graph shows oscillating peaks; likewise, the gray and black short marks in the bottom graph alternate. Unlike Fig. 2, the log ratio of intensities does have significant deviations away from zero. In 1999, around the vicinity of the pier, in addition to the decrease in total emergences, there were 20% more non-nesting than nesting emergences in the range of 922 to 1209 feet north of the pier.

The shifting of distribution continues in 2000 although it is even more extreme. In the vicinity of the pier there is a greater disparity between nesting and non-nesting than in 1999. From 1 to 432 feet south of the pier, there is 32% more non-nesting than nesting emergences. However in zone 9 (2.33 to 2.38 miles south of the pier) there are 52% more nesting than non-nesting emergences. For total, nesting, and non-nesting emergences, there is the least amount of density fluctuation when comparing 1998 to 2000. When we compare 1999 to either 1998 or 2000, there is a marked drop in density around the pier. However, in other locations, there are areas of marked increase in emergences in 1999 in contrast to 1998 and 2000 suggesting that the presence of the pier in 1999 serves to alter the distribution of emergences. In 1998, the density of non-nesting and nesting emergences are similar but in 1999 and especially in 2000, the locations where the turtles tended to nest were not the same locations where the emergence resulted in non-nesting.

Emergence density consistently decreases around the area of the pier between 1998-2000. Initially, regardless of location, the magnitude of nesting and non-nesting emergences was equivalent. However, with time, and especially at the vicinity of the pier, there is great disparity between nesting and non-nesting densities. Most of the year to year differences in emergence patterns occur from the immediate vicinity of the pier and southwards.

In summary, we detect statistical differences in nesting patterns between pre-construction, construction, and post-construction years. The overall patterns differ between years, and, more directly to the point of the study, there is a statistically significant reduction in emergences and the likelihood of any given emergence resulting in a nest in the immediate vicinity of the pier. However, the impact is fairly local to the pier and the data suggest that emergences and nesting may be deferred to areas south of the pier, where we observe more year-to-year local variation in both sets of emergences. Future work will involve adjustments for local confounding factors (e.g., lighting, slope, and human activity).

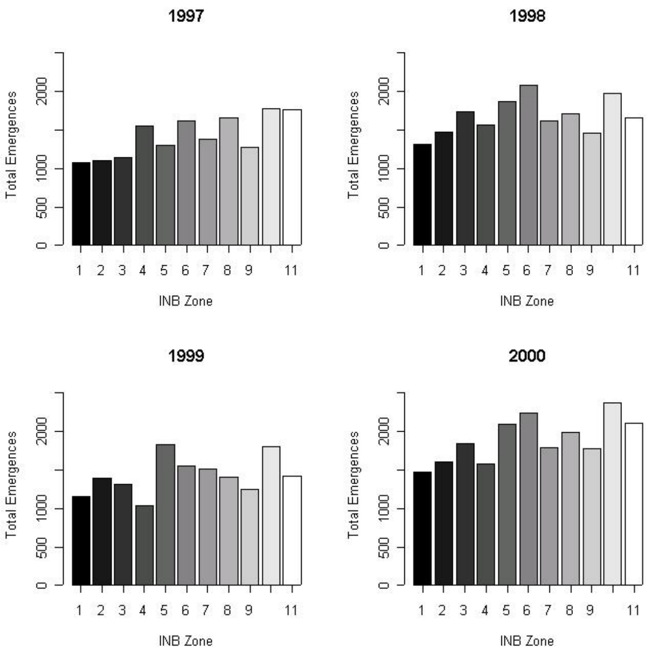

Fig. 1. Number of total emergences per mile.

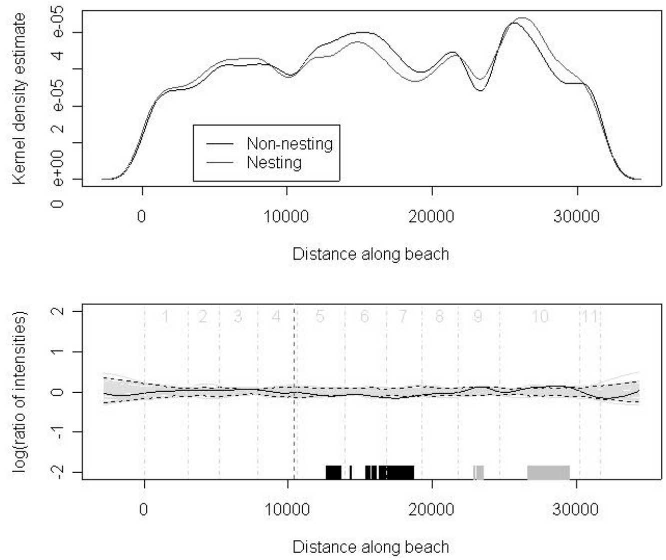

Fig. 2. Juno Beach sea turtle non-nesting and nesting emergences, 1998.

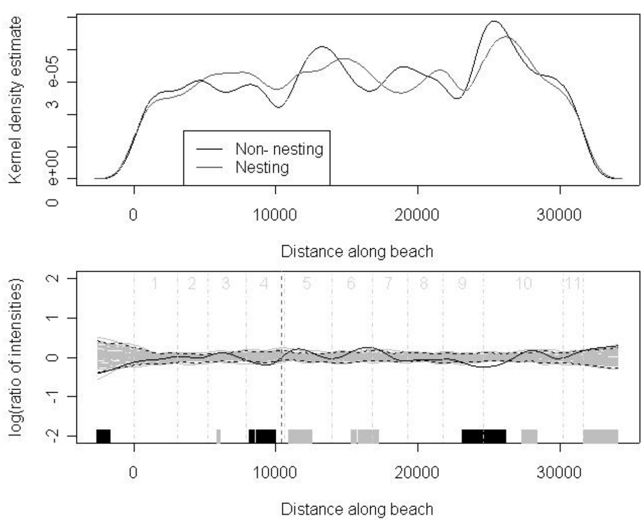

Fig. 3. Juno Beach sea turtle non-nesting and nesting emergences, 1999.

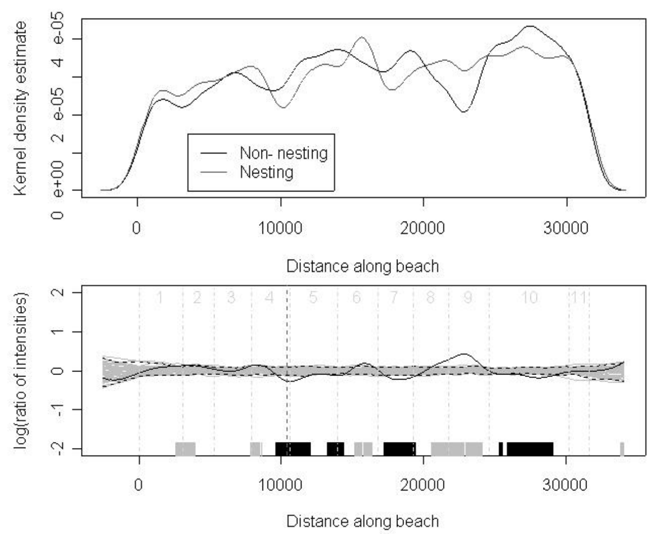

Fig. 4. Juno Beach sea turtle non-nesting and nesting emergences, 2000.

Costa Rica national strategy to reduce coastal light pollution

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Costa Rica boasts more than fifty-two beaches of importance to nesting marine turtles. These beaches also represent an attractive resource to tourism, which represents the second most important source of foreign income to the country.

All species of marine turtles, five of which nest in Costa Rica, are listed as endangered (IUCN). This situation can be directly attributed to the deterioration of the turtles' habitat and exploitation of their eggs, meat and other products.

The deterioration of terrestrial habitat may be directly associated with coastal zone development, especially beachside infrastructure and the attendant artificial illumination.

The precisely chosen nesting site constitutes, for the turtle, her most important endeavor to guarantee successful nest development. To this end, any artificial illumination directed towards the beach site, produces one of the major disturbances to nesting activity. This beach lighting also causes high impact to the behavior of hatchlings during their search for the ocean, producing disorientation and death.

The "Centro de Gestion Ambiental" and "Unidad de Servicio al Cliente*" (Environmental Services Center and Client Services Unit*) of "Instituto Costarricense de Electricidad – I.C.E. *(Costa Rican Electrical Institute)*, in conjunction with the Douglas Robinson Marine Turtle Research Center, have united efforts to design a National lighting strategy. The successful implementation of this endeavor will allow I.C.E. to supply electricity to coastal habitants without endangering marine turtles and other wildlife species which are affected by light pollution.

The proposed plan in the coastal zones, calls for a staged implementation to control artificial lighting:

Phase 1- Public Lighting Control. This phase has already been initialized in priority zones, on both the Atlantic and Pacific coasts, such as wildlife areas and those presenting massive and intensive nesting. These include National Parks, Reserves, Refuges and the beaches of Ostional, Baulas, Barú, Hermosa and Tortuguero. This effort will continue with the solitary nesting beaches and finally with the rest of the coast.

The strategy is based on a two-pronged approach of education and technical effort. The plan is implemented using the following guidelines: Education = Community Contact; Technical effort = 1) Cheapest, 2) Easiest, 3) Ideal Solution

Each site is evaluated to determine current conditions, problem lighting is identified and recommendations are formulated for future implementation. Implementation of the technical guidelines will be as follows: (1) paint the lenses to prohibit horizontal glare; (2) eliminate unnecessary lamp fixtures; (3) install lamp shades; (4) lower the lamp fixture; (5) install lamps which emit long wave-length; (6) install Low Pressure Sodium lamps; and (7) change the transmission line routing

Phase 2 – Private Lighting Control. This activity will be directed towards private homes and tourist development within coastal zones. For development within the coastal zone, Costa Rican laws allow for the implementation of measures to regulate any activities that may negatively affect the quality of life within this delicate area. However, an intensive and extensive educational program will be initiated so as to increase public awareness and appeal to individual conscience to undertake necessary remedies on a voluntary basis.

To guarantee the long-term implementation of protective measures and adherence of these measures for new development, a national regulatory strategy is being developed. The regulations will affect artificial lighting within the coastal zone and will serve as a guide for the design of environmentally friendly lighting.

To assure the ultimate success of this plan, it is important to involve all facets of the central government and local and regional Non Governmental Organizations in the effort to reduce superfluous artificial lighting.

This comprehensive effort will convert the National Lighting Strategy into a valuable tool to be used to guarantee the rational development of coastal areas without negatively affecting wildlife. This plan also strives to guarantee a dark sky with a view to promote another positive aspect of Costa Rica's beaches.

Dark beaches – FDOT's approach to resolving coastal roadway lighting and impacts to adjacent sea turtle nesting beaches

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The effects of artificial lighting on nesting female sea turtles and their offspring have been well documented in Florida for years. While federal and state regulatory agencies have pursued dark beaches to protect sea turtle habitat, Florida's coastline has continued to develop and degrade nesting beaches with artificial light. Currently, Florida Department of Transportation (FDOT) Design Standards do not take into account the biological conditions of adjacent properties. In 1998, FDOT funded a study that would (i) identify statewide coastal roadway lighting problems, (ii) determine how the lighting problems can be corrected, and (iii) use this information to develop new and improved lighting standards for use by design engineers, coastal communities and utility companies. From this study, an embedded roadway lighting demonstration project was funded to determine if embedded roadway lighting products could be considered for use in the sea turtle lighting zones. The elimination of the traditional overhead lighting systems could greatly reduce the impacts to sea turtle nesting beaches. In order to understand motorist and pedestrian response to this type of roadway lighting, a study will be conducted that will evaluate the safety aspects of the embedded lighting system and obtain user response to the new lighting system. This paper will discuss the development of Sea Turtle Lighting Zones, the proposed changes to the FDOT Lighting Standards for these zones, and the use of innovative lighting technology to illuminate the road for the traveling public and at the same time reduce impacts to adjacent sea turtle nesting beaches.

Sea turtles of Lakshadweep Islands, Arabian Sea, India

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INTRODUCTION

Four of the seven species of sea turtles occur in Indian waters. These include the olive ridley (*Lepidochelys olivacea*), green turtle (*Chelonia mydas*), hawksbill (*Eretmochelys imbricata*) and leatherback turtle (*Dermochelys coriacea*). All are reported to nest along the mainland and island beaches of India. The first survey in Lakshadweep which was conducted during 1976 (Bhaskar 1978, 1979) and stray records by the team of CMFRI team (Silas 1984, Lal Mohan 1989) indicated that these four species of sea turtles occur and nest in the Lakshadweep Islands but no detailed information was available on status or threats. Lakshadweep lies on the 2500 km long North-South aligned submarine Laccadive, Maldives and Chagos Archipelagoes, which form a continuous submarine bank. The migration of the turtles to this area from Seychelles, Maldives and Madagascar for nesting and feeding is therefore possible.

In the light of major lacunae in information, the Government of India and United Nations Development Programme's sea turtle project felt it appropriate to conduct a detailed survey of this group of islands and document the problems and prospects for sea turtles of Lakshadweep. The Wildlife Institute of India conducted a survey of sea turtles in the Islands from July 2001 to February 2002. Here we present the results of the survey.

METHODS

Study area. The Lakshadweep Islands are irregularly scattered in the Arabian Sea between 80 to 120°30' north latitude and between 710 to 740 east longitudes. There are 36 islands including 12 atolls, 3 reefs and 5 submerged banks covering an area of 32 km^2 land and 40,000 km^2 of oceanic zone. Among the 36 islands, only 10 are inhabited and the rest are partially inhabited or uninhabited (Mannadiar 1977)

Interviews. Extensive interviews with islanders and fishermen was carried out in all inhabited Islands. The standard questionnaire suggested by Schroeder and Murphy (1999) was followed. Approximately 25 people were interviewed in each island ranging from biologists to fishermen.

Foraging ground survey. The distribution of turtles in foraging areas was determined by surveys of lagoon and foreshore water by country boat and snorkeling. The presence of sea grass in shallow waters was documented.

Nesting beach survey. The direct procedure used was ground surveys of all Lakshadweep Islands. All beaches were covered by foot several times during the survey. The species nesting on the coast was confirmed from nesting pits, crawl marks, eggs, hatchlings and carcasses and remains (Shells and carapace) washed ashore. Threats to turtles and nesting beaches were determined by the presence/absence of habitation, beach vegetation, beach substratum, beach armoring and other developmental activities.

RESULTS AND DISCUSSION

Although there is some confusion in identifying the olive ridley and green turtle, the leatherback and hawksbill are clearly recognized in Lakshadweep waters. Nesting beaches in Lakshadweep were dominated by green turtles, followed by olive ridleys and hawksbill turtles (Fig.1). However, the nesting season of each species could not be ascertained. Most interviewees in Agatti Island stated that green turtles occur in the lagoon throughout the year whereas hawksbills are commonly seen during pre-monsoon and olive ridleys after December and rarely after April. Different size classes of green and hawksbill turtles are often caught in gillnets during lagoon fishing. During our survey, we also found juvenile, sub-adult and adults of both species in the lagoons of Agatti, Kavaratti and Minicoy.

Approximately 65 km of total coastline was surveyed and all sandy beaches with beach vegetation were found to be suitable for sea turtle nesting. All the beaches where turtle nesting was observed were narrow (5-10 m) with dense beach vegetation of *Scaevola sericea*, *Thespesia* sp. and *Pemphis acidula*. During the survey, nesting of three species was documented and the encountered number of nests in different Islands is presented in Table 1. This includes old and new nests and live nesting observed. The Green turtle nests were maximum in Suheli Valiakara followed by Tinnakara and Parali I Island, all uninhabited Islands.

Most of the juvenile, sub-adult and adult turtles (green and hawksbill) were seen in the lagoon and outside the reef between the depths of 2-5mts. The proportion of green to hawksbill in the lagoon was 1:10 where as olive ridleys were observed occasionally out side the reef. Most of the young green turtles were found swimming at the surface. Among the different Islands, Agatti had the maximum number of green turtles in the lagoon followed by Minicoy and Kadmat.

Green turtle carcasses were found in uninhabited/partially inhabited Islands of Tinnakara, Parali I and II, Suheli Valiakara and Cheriyam. According to fishermen, Green turtles are generally caught during nesting and slaughtered for extraction of oil, which is used for painting country boats as it works as an excellent waterproofing agent. Many people differentiate green and olive ridley by the quality and quantity of oil and the former is preferred because of its oil content. There is no consumption of turtle meat and eggs due to religious taboo. However, stuffing of juvenile hawksbill turtles is still in practice in many Islands. The stuffed specimen fetch about Rs. 500/- (US$ 12) to Rs. 1500 (US$ 36) and is sold by Islanders to the tourists or in the mainland. There is no incidental fishing related mortality, as the fishing method is very different from the mainland coast. The only method used for tuna fishing is pole and line, which pose no threat to the turtles. However, the immediate threat to sea turtles and their nesting beaches in Lakshadweep is beach armoring, human habitation close to the beach, lighting and clearing of beach vegetation for coconut plantation. Among all, the beach armoring is the most serious threats as no or limited spaces available to turtles for nesting once the concrete tetrapods are placed on the beach to check erosion. Tourism pressure is slowly becoming an additional pressure for sea turtles due to disturbance during the time of nesting.

CONCLUSIONS

All species of sea turtles occurring in Indian waters are listed as endangered and included in schedule I of the India Wildlife (Protection) Act, 1972. The Department of Environment and Forests, Lakshadweep has banned killing and poaching of turtles but is ineffective. The developmental activities such as human habitation, lighting and beach armoring need to follow the coastal zone management plan Act, 1997 of Lakshadweep. An effective, education campaign should be started in all islands on the importance and benefit of turtles to islanders. Tourism has a bright future in Lakshadweep, which in turn could benefit the islanders but it should be monitored properly. The turtle nesting intensify areas such as Suheli Valiakara, Tinnakara and the most important Green turtle foraging grounds and the lagoon of Agatti should be declared as protected areas with permission to artisanal fishing practice only.

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We acknowledge the Lakshadweep Administration for permits, logistic support and help during the survey work. We also acknowledge the financial support provided to us from the David and Lucile Packard Foundation and the Sea Turtle Symposium for opportunity and as travel assistance to make it possible to attend the Symposium.

LITERATURE CITED

Bhaskar, S. 1978. Turtles and other marine life in Lakshadweep. Hornbill (April - June). p. 21-26.

Bhaskar, S. 1979. Notes from Lakshadweep. Hamadryad 4:2-23.

Kar, C.S. and S. Bhaskar. 1982. The status of sea turtles in the Eastern Indian Ocean. In: K.A. Bjorndal, ed. The Biology and Conservation of sea turtles. Smithsonian Institution Press, Washington, D.C. p. 365-372.

Lal Mohan, R.S. 1989. Turtle Resources. Bull. Central Marine Fisheries Research Institute 43:176-178.

Mannadiar, N.S. 1977. Gazetteer of India – Lakshadweep, Administration of the U.T. of Lakshadweep, Govt. of India Press, 375 p.

Schroeder, B. and S. Murphy. 1999. Population survey (Ground and Aerial) on nesting beaches. In: K.L. Eckert, K.A. Bjorndal, F.A. Abreu-Grobois and M. Donnelly, eds. Research and Management Technique for conservation of sea turtles. IUCN/SSC Marine Turtle Specialist Group, Pub. No. 4.

Silas, E.G. 1984. Observation of turtles at Sea and in the Lakshadweep. Sea turtle Research and Conservation, Bull. Central Marine Fisheries Research Institute 35:59-61.

Table.1. Sea turtle nesting in different islands of Lakshadweep.

Island	No. of nests	Species
Kavaratti	2, 3	Green turtle, Olive ridley
Agatti	80, 16, 6	Green turtle, Olive ridley, Hawksbill
Kalpitti	4	Green turtle
Kiltan	3	Green turtle
Chetlat	7	Green turtle
Bitra	6	Green turtle
Andrott	2,6	Green turtle, Olive ridley
Kalpeni	8,6	Green turtle, Olive ridley
Kadmat	11,6	Green turtle, Olive ridley
Amini	8	Green turtle
Minicoy	10, 2	Green turtle, Olive ridley
Suheli Valiakara	358	Green turtle
Karingikuppu	5, 48	Green turtle, Olive ridley
Suheli Cheriyaka	4	Green turtle
Tinnakara	54	Green turtle
Parali I	38	Green turtle
Parali II	18	Green turtle
Bangaram	6, 2	Green turtle, Hawksbill
Viringili	2	Green turtle

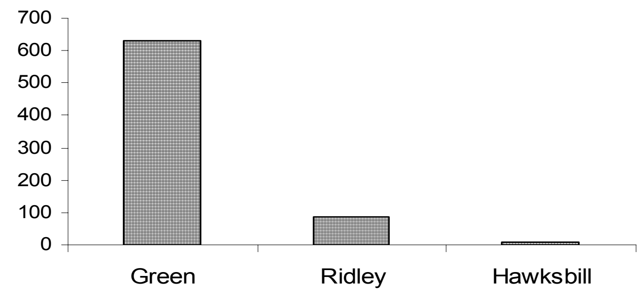

Fig. 1. Nesting of sea turtles observed in Lakshadweep (2002).

Changes in loggerhead demography after 25 years of nesting on the east coast of Florida

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Population demographic studies of nesting loggerheads at Canaveral National Seashore, Kennedy Space Center and Cape Canaveral Air Force Station beaches began in the late 1970s by Ehrhart. Since 1979, however, data have not been systematically collected on nesting individuals, until the present study that aims to document the status and demographic changes in this rookery that stretches 40 km along the east Coast of Central Florida. Morphometric data were collected from the 2001 nesters and their size classes were compared to those of the late 1970s to see how, and if, they changed. This project is slated to run for at least 3 years. Because we started it in 2001 and it was a low nesting year for green sea turtles, the data presented here are only for loggerhead sea turtles. Data were collected for carapace length (OC/SL), greatest carapace length (not collected in the 1970s), carapace width (OC/SL), and head width. Individuals were also biopsied for genetic analysis, flipper and PIT tagged. On a subsample of nests we also collected data on clutch size, egg weight, min/max diameter and hatching success. Results compare the 1976-78 data to the 2001. Nesting loggerhead sample sizes from the late 1970s (313, 247, 648, respectively), are larger than that of 2001 (157), however, the latter sample size is sufficient for sound statistical comparisons. Mean carapace length (straight-line) is statistically smaller (< 0.05) in 2001 than 1977, and 56% of the 2001 turtles were in the 85-94.9 cm class range. Overcurve carapace length also differed, and the 2001 was statistically smaller than those of 1976-77. Mean carapace width (straight-line) from 2001 nesters was smaller than those of all three past years, but only differed significantly from those of 1977. Approximately 73% of the 2001 turtles were in the 65-74.9 cm class range. Mean overcurve carapace width from 2001 was statistically smaller than all three years, and 73% of the 2001 turtles were in the 85-94.9 cm class range. Mean head width data show that the 2001 turtles were not significantly different from any others, however, 1978 turtles were smaller that those of 76 and 77. Although measurement errors could exist between the generations of sea turtle biologists, the sample sizes are large enough to accommodate any discrepancies. Also, the accuracy of the 2001 measurements was checked and calibrated by comparing repeated measurements and those from recaptured sea turtles. These data were also categorized depending on whether there was ample time to measure the individual sea turtle or if measurements were made in a hurry such as during a false-crawl. The overcurve measurements that were taken over barnacles were not included in statistical analysis. Therefore, we are confident in the accuracy of the 2001 data. Mean clutch sizes were not statistically significantly different amongst the 4 years. Minimum egg diameter was collected in the 1970s and differences were found between 1977 and all others. We collected maximum egg diameter in 2001, but we don't have 70s data for comparison. Average incubation time and percentage hatching success appear smaller in 2001, however, these comparisons must be carefully scrutinized because 1976-78 clutches were often incubated in protected hatcheries. Six turtles were recaptured twice and one on three occasions. Although the 2001 sample size is relatively small, average internesting intervals were slightly longer than those observed in the 1970s. Two noteworthy observations included 1) One turtle previously tagged in Florida Bay was observed nesting here; 2) Two nesting loggerhead turtles were afflicted with the fibropapilloma virus. Although these trends are based on one nesting season, and further sampling is required before solid conclusions can be made, the results can provide valuable information for regulatory agencies to assess trends in population stocks and viability of sea turtles nesting in Florida.

Marine turtle conservation in the Mediterranean: a first survey for *Chelonia mydas* and *Caretta caretta* nesting in Lebanon

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INTRODUCTION

During the last 20 years, there has been extensive monitoring along the Mediterranean in order to locate the nesting sites of the only two marine turtle species known to reproduce in the area, *Caretta caretta* (loggerhead) and *Chelonia mydas* (green turtle). Recent reviews on the nesting location of these two species include Greece and Turkey (Margaritoulis 2000, Yerli and Demirayak 1996); the overall status for *C. mydas* in the Mediterranean has also been separately assessed (Kasparek et al. 2001). With the exception of the Palm Islands Reserve where *C. caretta* was already known to nest, the Lebanese coast has been one of the least surveyed areas along the Eastern Mediterranean coastline. Groombridge (1990) considers it "uncertain" whether marine turtles actually nested there in the past, adding that "no nesting is known at present". The nearby Syrian coast lacks strong evidence for nesting as published data from preliminary surveys (Kasparek 1994) indicated only insignificant nesting, with the species identity remaining unknown. Nesting in Israel seems to occur only in low numbers according to observations over the last decade (Kasparek et al. 2001 and references therein).

In the summer of 2001, based on past nesting observations of *C. mydas* by the MEDASSET representative in Lebanon, the Lebanese Ministry of Environment with the support of the Regional Activity Centre for Specially Protected Areas (RAC/SPA) and MEDASSET organized a first survey of the entire Lebanese coast in order to locate potential nesting sites1. Estimates of nesting density would, if possible, take place. A qualitative assessment of egg and nest predation would also be undertaken and notes should be taken regarding the general condition of the Lebanese beaches. Further enquiries on marine turtle nesting and interactions with fisheries should include the fishermen and any other appropriate person. The aim of this preliminary survey was to provide some first-hand data to elucidate the current situation regarding marine turtle nesting along the Lebanese coast. The authors hoped that this assessment would provide the basis for more detailed work, if shown to be necessary.

MATERIALS AND METHODS

The main survey took place between the 23rd of July and the 5th of August 2001; short visits had also been paid at the end of May - beginning of June 2001 (El-Mansouri beach) and at the end of June 2001 (Qasmiye beach). As it is known from previous surveys in the same region such as in the northern part of Cyprus (Ilgaz and Baran 2001) and Turkey (Yerli and Demirayak 1996), the best period for the survey would have been between the 15th June and the 15th July, the peak nesting period; however, it was not possible to carry out the main survey then. The entire coast was divided into two sections: the Northern one (Jounie to Tripoli) and the Southern one (Sour to Saida) and investigated from the sea to identify the location of sandy beaches. Then the survey was carried out by foot patrols wherever access was available to look for any evidence of the presence of sea turtles. The beach investigations started at dawn and the afternoons were spent interviewing the local people, officials and fishermen. Out of the approximately 200 km of the Lebanese coast, only 30.3 km were accessible, sandy, non-urbanised areas and were thus considered potential nesting beaches. This coastline length (30.3 km) is used for the analysis presented in Tables 1 and 2. A complete descriptive list of these beaches is given in Demirayak et al. (2002). Topographical maps (1:20,000) prepared by the French National Geographic Institute in the 1960's were used during the field surveys. Beach coordinates were identified by GPS.

RESULTS

Nesting sites and nesting density: The total number of nests recorded during the survey is shown in Table 1. Five (5) different sites (total length 7.5 km) provide visual evidence of current use by marine turtles for nesting. The nesting species however remains unknown except for El-Mansouri where both *C. caretta* and *C. mydas* were observed to nest.

Turtle egg predation and nest predation. Turtle egg predation was observed in all 4 sites where nests were found (Table 1). Judging from the footprints and the remnants of the nests, the predators were thought to be canids and crabs.

Observations on the general condition of the Lebanese beaches surveyed. With the exception of the two reserve areas along the Lebanese coast, the Sour Reserve and the Palm Island Reserve, the rest of the Lebanese coast shows an escalating degree of urbanization and developing tourist facilities in several sites. Moreover, after comparing older cartographic data with the modern-day situation, it becomes evident that several sandy coastal areas have disappeared. Sand extraction is regarded as one of the major factors that have contributed to beach loss. The litter burden can exceed 1m in depth in certain areas along the coastline.

Interviews of fishermen and others. Interviews of fishermen and others throughout the survey revealed that a number of additional beaches (total length 9.2 km) -other than those where nesting signs had been seen by the authors- could be flagged as current nesting sites. Furthermore, the interviewees reported previous nesting on another 8.9 km of coastline (Table 2).

DISCUSSION

The Lebanese people are recovering from a conflict that ravaged the country for many years. Since, the conservation movement has developed and the Ministry of Environment has become empowered to investigate, propose and implement national environmental policies. Lebanon signed and ratified the Mediterranean Action Plan (UNEP) in 1975, the Barcelona Convention and protocols, the MARPOL 73/78 convention and adopted the revised Action Plan for the conservation of Mediterranean Marine turtles (1999). Marine turtle hunting is prohibited by law. Egg poaching, however, does take place illegally. The Lebanese fisheries are artisanal and traditional. Although trawling is prohibited there appears to be little control and explosives, although illegal, are still used. Fishermen generally consider marine turtles a nuisance and report catches of up to 70 turtles in the nets of just one fishing boat.

The 2001 survey along the Lebanese coastline provided evidence that both loggerheads (*Caretta caretta*) and green turtles (*Chelonia mydas*) nest in Lebanon in areas previously unknown to host nesting populations. It should be noted that several additional beaches were reported by third parties as current nesting sites although the authors had not witnessed any direct evidence there. If these reports are proven to be true, then the length of the marine turtle nesting area in Lebanon more than doubles (Table 2). However, it should be mentioned that the inadequate numerical data, attributed to the field work season, do not allow for any actual estimation of the scale of marine turtle nesting in Lebanon. Yet, the number of *C. caretta* nests in El-Mansouri appears to be similar to the figures from Turkish areas such as Patara, Dalyan, Cirali, Goksu Delta and Gazipasa for the corresponding time period (1994 data - Yerli and Demirayak 1996, Patara 1997 data -Taskin and Baran 2001); this can only be further assessed if full-season monitoring takes place. Regarding *C. mydas*, an optimistic scenario would involve nesting numbers from El-Mansouri being similar to the ones from Northern Karpaz for the corresponding time period (1996 data - Ilgaz and Baran 2001). Conversely, a more modest estimation would consider them as sporadic nesting, as in the case of the northern Sinai coast, Egypt (Campbell et al. 2001). Therefore, the importance of the Lebanese nesting sites reported in this paper for both *C. caretta* and *C. mydas* compared to other geographical zones of the eastern Mediterranean may only be revealed if full-season monitoring takes place during the next nesting season.

LITERATURE CITED

Campbell, A., M. Clarke, S. Ghoneim, W.S. Hameid, C. Simms, and C. Edwards. 2001. On status and conservation of marine turtles along the Egyptian Mediterranean Sea coast: results of the Darwin Initiative Sea Turtle Conservation Project 1998-2000. Zool. in the Middle East 24:19-29.

Demirayak, F., R. Sadek , S. Hraoui-Bloquet, and M.Khalil. 2002. Marine turtle nesting activity assessment on the Lebanon coast, Phase I: Survey to identify nesting sites and fishery interaction, Lebanese Ministry of Environment, Final draft - RAC/SPA and MEDASSET, 50 p.

Groombridge, B. 1990. Marine turtles in the Mediterranean: distribution, population status, and conservation. Nature and Environment Series No 48, 98 p.

Ilgaz, C. and I. Baran. 2001. Reproduction biology of the marine turtle populations in northern Karpaz (Cyprus) and Dalyan (Turkey) Zoology of the Middle East 24:35-44.

Kasparek, M. 1994. Marine turtle conservation in the Mediterranean - Marine turtles in Syria, MEDASSET and HCI, 17 p.

Kasparek, M., B.J. Godley, and A.C. Broderick.2001. Nesting of the green turtle *Chelonia mydas*, in the Mediterranean: a review of status and conservation needs. Zoology in the Middle East 24:45-74.

Margaritoulis, D. 2000. An estimation of the overall nesting activity of the loggerhead turtle in Greece. In: F.A. Abreu-Grobois, R. Briseno-Duenas, R. Márquez, and L. Sarti, comps. Proceedings of the Eighteenth International Sea Turtle Symposium. NOAA Tech. Memo. NMFS-SEFSC-436. p. 48-49.

Taskin N. and I. Baran. 2001. Reproductive ecology of the loggerhead turtle, *Caretta caretta*, at Patara, Turkey Zoology in the Middle East 24:91-100.

Yerli, S. and F. Demirayak. 1996. Marine turtles in Turkey: a survey of nesting site status, WWF and DHKD, p. 239.

Table 1. Sites along the Lebanese coast where nesting or nesting attempts were observed during the 2001 survey.

Beach	length surveyed	Survey period (no. of days)	Number of nests/tracks
El-Mansouri 33°11N' - 35°11E,	2 km	May - June 2001 (17)	9 nests *C. mydas*, 35 nests *C. caretta*
Qasmiye 34°20N' - 35°14E,	3 km	June - July 2001 (1)	8 nests, species unknown
Mahmoudiye 34°22N' - 35°15E,	1 km	end of July 2001 (1)	3 nests, species unknown
Aadloun 34°23N' - 35°15E,	1 km	end of July 2001 (1)	1 nest - 1 false track, species unknown
Damour 33°42N' - 35°26E,	0.5 km	beginning of August 2001 (1)	1 false track, species unknown

Table 2. Assessment of the marine turtle nesting data along the 30.3 km surveyed area of the Lebanese coast.

	Length (% of total surveyed coastline)	Beaches
current nesting observed by authors	7.5 km (29.75)	El-Mansouri, Qasmiye, Aadloun, Mahmoudiye, Damour
current nesting reported by others	9.2 km (30.4)	Saida, Jbail, El-Aabde, Cheikh Zennad[2], Palm Island Reserve
reported past nesting	8.9 km (29.4)	Sour, Yahoudiye, Er-Rmaile, Jiye, Al-Aaqaibe
no evidence of nesting in the past or currently	4.7 km (15.5)	North Sour, El-Aaddoussiye, El-Heri, El-Minie
	30.3 km in total	

[1] The Nile soft-shelled turtle *Trionyx triunguis* was also considered.

[2] reported nesting of *Trionyx triunguis*

The hawksbill turtle in Bermuda

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Hawksbill turtles have been documented opportunistically in Bermuda waters over the last 20 years through the efforts of the Bermuda Aquarium and the Bermuda Turtle Project. Live hawksbills were captured on coral reefs by recreational divers, hand-captured by aquarium staff, or taken in an entrapment net during sampling for green turtles. A sample of live-caught individuals from the Bermuda Platform ranges in size from 24.6 to 64.8 cm straight carapace length. Hawksbills from 8.7 to 69.7 cm straight carapace length were documented through the aquarium's stranding network. Three of the hawksbills examined so far approach the minimum size at maturity for hawksbills in the Atlantic. However, necropsies of stranded animals have yet to reveal any sexually mature individuals. Furthermore, no nesting by hawksbills has been documented in Bermuda. Thus, the hawksbills known from Bermuda appear to represent individuals from developmental habitat on the Bermuda Platform and stranded individuals from the pelagic life history stage.

In an effort to identify the nesting beaches of origin of these hawksbills, we have collected DNA samples and sequenced the mtDNA control region for 44 individuals. Haplotypes from 35 are known from nesting beaches and could therefore be used in the Maximum Likelihood Analysis program, CONSQRT, by Pella and Masuda. This is a smaller sample than would be ideal and it includes both live-caught and stranded animals. Results can only be examined in the context of what we currently know about nesting at nine beaches in the Caribbean and South Atlantic. The preliminary MLA suggests that at least four of these nesting beaches (Cuba 40%, U.S. Virgin Islands 40%, Mexico 10%, Costa Rica 5%) contribute individuals to this developmental assemblage in Bermuda. These preliminary estimates are likely to be adjusted as the sample size in Bermuda is increased and as nesting beaches are added to the analysis. Regardless of the limitations of the present analysis, it is clear that Bermuda is providing developmental habitat for multiple Caribbean nesting populations. The strong protection afforded hawksbills in Bermuda benefits those source populations in the Caribbean when these animals move to adult foraging grounds and to their natal beaches to reproduce.

Genetic data from Bermuda demonstrate that developmental migrations (from the nesting beach to developmental habitats and from developmental habitats to adult foraging grounds) of hawksbills in the wider Caribbean may be of greater length than currently known reproductive migrations. These developmental migrations must be more completely understood and their implications carefully considered in the development of any conservation plan for hawksbills in the Caribbean.

Mark-recapture of loggerhead turtles at sea: results of a 20-year program in Italy

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Historically, tagging was one of the first and most valuable tools for investigating several aspects of sea turtle biology worldwide. However, most of these studies were carried out on nesting beaches, and only adult females were investigated in this way. In general, as a consequence of the predominance of at-land studies, information about the juvenile phase of sea turtles is particularly limited and needed. In 1981, a tagging program started in Italy together with an awareness campaign to fishermen. In the period 1981-2000, 2,200 turtles, basically of juvenile class-size, were tagged and released; most of them were incidentally caught by fishing gears. Of these tagged turtles, 110 were subsequently reported to be found in different Mediterranean areas. The geographic distribution of these re-encounters shows wide-range movements but also suggests fidelity at least to large sub-areas, like western and eastern Mediterranean. These re-encounters consisted in specimens incidentally caught by fishing gears or stranded and found dead or alive, so diverging from the 'recaptures' usually considered by capture-mark-recapture studies. However, a recent model (Barker's model) can take advantage of all re-encounter types (recapture, live resight, and dead recover). Taking into account the occurrence of an unknown tag loss, this model was used, through the program MARK, to provide a conservative estimate of annual survival rate in the juvenile size class of 67.21% (95% CI = 60.56% - 73.23%). Tagging programs commonly receive reports of live resights and dead recoveries, which are usually used to provide insights on movement/fidelity only; however, the possibility to use such re-encounter types can improve the number and accuracy of survival estimates.

Occurrence of leatherback sea turtles off the coast of Central California

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Leatherback turtles (*Dermochelys coriacea*) are known to forage in waters off central California, a region that is strongly influenced by coastal upwelling during early summer. When upwelling diminishes at the end of summer, sea surface temperatures along the coast may rise markedly. The frequency, duration, and relaxation of upwelling-favorable winds can influence food web development in this region, including the occurrence and concentration of leatherback prey, such as scyphomedusae. To investigate patterns of leatherback turtle abundance and distribution off central California, sightings were recorded during aerial line-transect surveys conducted during the late summer and fall months of 1990-2001. Transects followed a zigzag pattern between the coast and roughly the 50-fathom (92 m) isobath between Point Conception (N34:27°) and the California-Oregon Border (N42:00°). Over 25,000 kilometers of trackline were surveyed by three observers at altitudes of 650-700 feet. Because leatherbacks may spend significant time beneath the surface, a correction factor derived from a leatherback turtle carrying a time-depth recorder was applied to the aerial survey abundance estimates. During the course of several weeks within the study area, this tagged turtle averaged about 62% (SD=0.12) of daytime periods at or near the water surface (<3m). A corrected average of 170 (95% CI = 130-222) leatherback turtles was estimated to have been present in nearshore waters of central California during late summer and fall of 1990-2001. Abundance was highly variable between years, ranging from 20 (95% CI = 6-65) in 1995 to 366 (95% CI = 289-463) in 1990. Densities were greatest in waters off Point Reyes, south of Point Arena, in the Gulf of the Farallones, and in Monterey Bay. These areas represent upwelling shadows or regions where larval fish, crabs, and gelatinous organisms are retained during upwelling relaxation. We hypothesize that leatherback turtle abundance is linked to the hydrographic retention of zooplankton and subsequent concentration of scyphomedusan prey in these coastal areas during relaxation of upwelling-favorable winds.

Living on the edge: pelagic distribution and habitat of olive ridleys in the Eastern Tropical Pacific

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We analyzed oceanographic and distributional correlates for sex and age classes of olive ridley sea turtles (*Lepidochelys olivacea*) from data collected during seven research vessel cruises in the eastern tropical Pacific from 1989 to 2000. During each cruise, turtles were opportunistically captured from a small boat behind the vessel while it was underway. Using this method, a total of 679 turtles (4.8 cm to 74.1 cm SCL) were captured. Turtles were measured, sexed (based on tail length and SCL), tagged and released. At capture we recorded habitat variables such as distance to land, water depth, sea surface temperature, and sea surface currents. Additionally, topographic features including continental shelf and slope, the east Pacific rise, the Pacific trench, and upwelling regions were used to determine habitat. Analyses revealed high numbers of adult (male 59% and female 61%) turtles on the continental shelf and slope (near major nesting beaches) next to the Pacific trench in upwelling regions. Turtle numbers decreased with distance from the mainland at 100 km, which correlates with the edge of the continental shelf and slope. Furthermore, adult olive ridleys were found frequently in shallow water, with peak numbers in depths from 0 m to 1000 m (males 42% and females 41%). In deeper water adults were frequently found at 4000 m to 5000 m (males 29% and females 24%). However, juveniles (41%) were found more often in deeper water (off the continental shelf-slope), with only one single peak in numbers at 4000 m to 5000 m.

The new ridley riddle: where have all the Kemp's ridleys gone in the northwestern Gulf of Mexico?

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The Sea Turtle and Fisheries Ecology Research Laboratory at Texas A&M University-Galveston has conducted in-water entanglement netting surveys in shallow waters off Sabine Pass, Texas and Calcasieu Pass, Louisiana since 1993 to evaluate population status and dynamics of juvenile and subadult Kemp's ridley sea turtles (*Lepidochelys kempii*). Post pelagic and juvenile Kemp's ridleys annually recruit to nearshore waters of the northwestern Gulf, which they utilize as developmental feeding grounds. Ridley abundance [i.e., catch-per-unit-effort or CPUE] at Sabine Pass between 1993 and 1998 was relatively high and ranged from 0.61 to 1.13 ridleys/km-hr, with peaks in 1994 (1.07) and 1997 (1.13). Catches at Sabine Pass in subsequent years exhibited notable declines, with CPUE in 2000 and 2001 measuring 0 and 0.03, respectively. Ridley abundance at Calcasieu Pass during 1993-1995 failed to exceed that at Sabine Pass, but gradually did so by peaking at 0.97 CPUE in 1999. Subsequent catch rates at Calcasieu Pass decreased to 0.07 by 2001. This study examines trends in biotic and abiotic factors that may explain fluctuations in ridley abundance at these historically productive index habitats. An analysis of factors including food availability (measured by blue crab, *Callinectes sapidus*, CPUE), predator abundance (measured by bull shark, *Carcharhinus leucas*, CPUE), temperature, and salinity yielded only a significant relationship between ridley abundance and annual mean size of crabs (mm) taken in 5-minute trawl tows at Sabine Pass (r^2=0.63). These abundance trends suggest a food-related shift in ridley distribution from Sabine Pass to Calcasieu Pass by 1997. Additional investigations are needed to ascertain the role of other larger scale factors including nesting activity at Rancho Nuevo, Mexico and Gulf circulation patterns influencing ridley dynamics in nearshore waters of the northwestern Gulf.

Inter- and intra-annual variation in plasma steroids and metabolic indicators in female *Chelonia mydas*

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Annual breeding rates for *Chelonia mydas* fluctuate annually in response to climatic conditions, presumably this variation in breeding numbers reflects proximate conditions within foraging areas. In addition, the physical conditions facing a female at a nesting beach may change annually with alterations in local weather, numbers of nesting turtles and the ability for females to successfully oviposit. The broad objectives of this project were twofold. First, we compare intra and inter-seasonal variation in condition of females at three foraging areas in the southern Great Barrier Reef. Second, we compare annual variation of metabolic and hormonal indicators in foraging female *C. mydas*. Plasma triglyceride levels were higher, and plasma cholesterol levels lower in non-vitellogenic females from Moreton Bay than those from Heron Reef. Furthermore, triglyceride levels were higher in 1997 (El Niño year) than in 1998 (La Niña year). Plasma steroid and protein levels remained unchanged between or within years. Collectively, these data indicate that variation in proximal conditions at foraging areas may be reflected at a physiological level. It also provides preliminary data supporting the hypothesis that variation in ENSO events is altering nutritional pathways and turtles feeding during El Niño years are able to attain higher levels of body condition.

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Cardiopulmonary structure and function in leatherback and green sea turtles

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Sea turtles are secondarily aquatic, migratory specialists that possess suites of morphological, behavioral, and physiological adaptations for prolonged swimming and diving. We focused upon an unusual adaptation in the circulatory systems of marine turtles, the pulmonary artery sphincters (Buren 1905, Koch 1934, O'Donoghue 1934) that permit blood flow to be selectively shunted toward or away from the lungs. Blood shunting from the pulmonary to the systemic circuit is likely to be controlled via selective partial or complete constriction of the pulmonary artery sphincters.

Sea turtles have a single ventricle with incomplete separation between pulmonary and systemic blood flow. Blood leaving the ventricle is routed via morphological adaptations, at least at the level of the pulmonary arteries. To identify how sea turtles direct blood flow in the pulmonary arteries, we dissected and analyzed gross and microscopic structure of the great vessels in hatchling leatherback (*Dermochelys*) and green (*Chelonia*) turtles as well as adult leatherbacks.

Discrete, robust pulmonary artery sphincters occur in marine turtle pulmonary arteries. We have not found these structures in several freshwater or terrestrial turtles examined to date (*Trachemys*, *Apalone*, and *Terrapene*). In leatherbacks the sphincters are located closer to the lung than in green turtles and are more robust. The smooth muscle layers are very thick in leatherbacks and muscle fibers are variously longitudinally, circumferentially, and helically wound, a characteristic of vessels that are exposed to high blood pressure and or need to produce strong contraction (Rhodin 1980). Gross and microscopic anatomy reveal that the sphincters are more robustly developed in deep-diving leatherbacks than in shallower diving green turtles.

Our comparative study suggests similar mechanisms exist for controlling pulmonary blood flow in the two species examined. We also hypothesize that blood flows freely through the pulmonary arteries and aortas during breathing and when lung oxygen levels are high. However, during prolonged apnea (e.g., during diving or prolonged locomotion), pulmonary artery sphincters constrict and either reduce flow, or shunt blood away from the pulmonary circuit and into the systemic circuit. This mechanism of systemic and pulmonary blood flow control is unlike those of other vertebrates.

LITERATURE CITED

Burne, R.H. 1905. Notes on the musculature and visceral anatomy of the leathery turtle, (*Dermochelys coriacea*). Proc. Zool. Soc. London 291-324.

Koch, W. 1934. Pulmonary vessels and the circulatory system of turtles. Biologia Generalis (Vienna) 10:359-382.

O'Donoghue, C.H. 1934. The heart of the leathery turtle, *Dermochelys* (*Sphargis*) *coriacea* with a note on the septum ventriculorum in the Reptilia. 1918. Journal of Anatomy LII:467-680.

Rhodin, J.A.G. 1980. Architecture of the vessel wall. In: Handbook of Physiology, section 2: The Cardiovascular System. Vol II. American Physiological Society. Bethesda, Maryland. 1-31.

Temporal synchronization in first-clutch nesting dates by the hawksbill sea turtle, *Eretmochelys imbricata*, Jumby Bay, Long Island, Antigua: why must they be so precise?

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Sea turtles are known universally for their regional nesting site fidelity, returning season after season to a restricted geographic location, if not to the same beach where observed in previous nesting seasons. Some sea turtles also exhibit temporal nesting fidelity, particularly a synchronized nesting species such as the loggerhead on Southeastern US nesting beaches. Asynchronous nesting species, such as the hawksbill, have been predicted to lack the temporal precision of first nesting between seasons. To the contrary, fifteen seasons of intensive tagging at Jumby Bay reveal a precise temporal fidelity of the first clutch of the season for each female. A sample of 50 individuals with three or more nesting seasons (maximum of 7 nesting seasons) permit statistical analysis of mean and variance for temporal fidelity. Possible reasons for this highly structured behavior pattern are discussed.

Investigations into the basis of the reproductive behavioral polymorphism in *Lepidochelys olivacea*

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INTRODUCTION

Lepidochelys olivacea are well known for their spectacular synchronized mass nesting emergences commonly known as arribadas. Arribadas occur at only a few beaches worldwide, however the nesting range for this species extends far beyond these few select beaches. For example, in the eastern Pacific, arribadas occur annually at one beach in Mexico and two beaches in Costa Rica from June through December. During the same time, solitary *L. olivacea* emerge individually to nest along nearly the entire coastline from Mexico to Panama. Two clearly distinct reproductive behaviors exist within the genus as well as within populations; some females are solitary nesters, while others are arribada nesters. Very little is known about this reproductive behavioral polymorphism and how it is maintained in populations.

METHODS

We studied reproductive behavior and characteristics of female *L. olivacea* to determine if there are detectable life history differences between solitary and arribada nesters. We conducted field work at Nancite Beach, Guanacaste National Park, Guanacaste Province, Costa Rica from June through August 1998. We sampled 24 solitary nesters and 24 arribada nesters. For each turtle, we counted total number of eggs per clutch, weighed 15 eggs per clutch, and measured the straight carapace length (SCL) and weight of each turtle.

RESULTS

Females ranged in size from 58.5 to 69.5 cm SCL and 31 to 46.8 kg in mass. The average sizes of solitary and arribada nesters did not differ in SCL or mass, but solitary nesters were more variable in mass. Arribada nesters produced marginally larger clutches than solitary nesters (clutch size arribada = 112.3 ± 3.18, n=23, CV=13.58; clutch size solitary = 104 ± 4.10, n=19; CV=17.19) but the average difference was not significant. However, ANCOVA indicated that clutch size was related to female size. After accounting for the allometric effect of female size, mean clutch size showed a stronger and significant difference between solitary and arribada nesters.

Egg size varied substantially within a female's clutch and among females, but did not differ between solitary and arribada nesters. Of 41 females for which we were able to obtain egg size estimates, the mean egg size ranged from 27.54 g to 36.77 g, with an overall mean egg mass among females of 31.95 ± 0.31g. Coefficients of variation of egg mass within a clutch ranged from 1.67 to 10.85, with a mean CV of 4.05. Neither mean egg mass, nor its variability differed between solitary and arribada nesters.

Egg size was not related to female size in terms of either SCL or mass. Nor was there any support for a trade-off between egg size and number either or overall, or after accounting for effects of female size using ANCOVA. Although there appears to be a different relationship between clutch size and egg size for solitary versus arribada nesters, this difference was not significant.

CONCLUSIONS

Arribada nesters produced larger clutches than solitary nesters. The relatively larger clutch sizes of arribada nesters may have evolved to sate predators. A diverse and abundant predator assemblage exists at Nancite Beach and intense predation occurs there when hatchlings emerge from nests and crawl toward the ocean. If predators can kill only a limited number of hatchlings, then the proportion of each clutch that survives predation increases with clutch size. Alternatively, the relatively smaller clutch sizes of solitary nesters may be a result of higher energetic cost during the internesting period. If the solitary nesters we sampled had low site fidelity, as has been reported by Kalb (1999), their movements among beaches might have reduced energy resources that would have been allocated for reproduction, resulting in smaller clutch sizes. In contrast, arribada nesters have relatively lower energetic cost during the internesting period. Arribada nesters have high site fidelity, stay nearshore during the internesting period, and are relatively inactive (Plotkin et al. 1991, Plotkin et al. 1995, Kalb 1999).

LITERATURE CITED

Kalb, H.J. 1999. Behavior and physiology of solitary and arribada nesting olive ridley sea turtles (*Lepidochelys olivacea*) during the internesting period. unpublished Ph.D. dissertation. Texas A&M University, College Station, TX.

Plotkin, P.T., R.A. Byles, D.C. Rostal, and D.W. Owens. 1995. Independent vs. socially facilitated migrations of the olive ridley, *Lepidochelys olivacea*. Marine Biology 122: 137-143.

Plotkin, P., M. Polak, and D.W. Owens. 1991. Observations on olive ridley sea turtle behavior prior to an arribada at Playa Nancite, Costa Rica. Marine Turtle Newsletter 53:1.

Investigation of the scatter-nesting hypothesis in leatherback turtles (*Dermochelys coriacea*) from French Guiana

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For animals that lay their eggs in a nest, the selection of a nest site may strongly influence offspring survival and therefore have important consequences for the reproductive success of the adult. In sea turtles, there exist potential counter-balancing selection pressures, in that there are risks associated with nesting too close to the water as well as risks associated with nesting too close to the supra-littoral vegetation. This study quantitatively describes nest placement in leatherback turtles nesting at Yalimapo beach, French Guiana by monitoring individual females' nest placement patterns throughout the peak nesting season. It tests the hypothesis that in the face of unpredictable environmental conditions, leatherbacks have adopted a scattered pattern of nest placement, as safe nesting areas can change within and among seasons. The adaptive value and potential consequences of this behaviour within the realm of reproductive strategies will be discussed.

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Nesting physiology and hatching success of leatherbacks at two nesting beaches in Trinidad

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Leatherback nesting frequency has increased in Trinidad in recent years. In 1991, approximately 300 leatherback nests were deposited in Trinidad by the end of July. In 2001, during peak season, beaches at both Matura and Grande Riviere had approximately 300 nesting leatherbacks in one night. Nesting physiology was studied on two major nesting beaches. Nesting physiology is determined by measuring incubation temperature, water content of the sand and gas exchange between sand particles across the eggshell. Substrates at the two beaches, Matura and Grande Riviere, exhibit different physical characteristics that affect hatching success. Incubation temperature was measured in 10 nests by placing a data-logger in each clutch. Water content of the substrates was measured by weight difference between wet and dried sand samples taken from areas adjacent to the clutches. Sand samples were also taken for sediment grain size analysis. Grain size was used to determine porosity, which is an indicator of relative gas exchange. Hatching success was determined by counting the number of hatched eggs and dividing by the total yolked eggs in the nest. Hatching success was higher on Matura than on Grande Riviere. Both sites were subject to biotic and abiotic factors that affected hatching success. Erosion was the major abiotic factor at both beaches. Erosion was measured at Matura by using a beach profile, and taking the percentage of marked nests that eroded. Biotic factors such as turtles digging up other turtles nests, domestic dogs and other natural predators contributed to the low hatching success.

Patterns of egg failure: timing and implications for sea turtle populations

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Studies of sea turtle embryology have revealed the main causes of egg failure to be infertility, intra-oviductal death, and microbial invasion. Under field conditions, such data are obtained through nest excavations. From this, it has been possible to estimate hatching success and the developmental stage of unsuccessful eggs. These data indicate that fertility within sea turtle clutches, as detected by gross signs of embryonic development, is typically greater than 80%. However, it has been estimated that the actual fertility of clutches probably exceeds 95%, but the difficulty on separating infertility and intra-oviductal death has prevented a full assessment to date. Despite this, it is generally considered possible to differentiate between eggs which are truly infertile and intra-oviductal mortalities, from those displaying gross signs of development (GSD) (e.g. a definable blood spot / embryo). Subsequently, we set out to assess egg failure and neonate mortality in loggerhead (*Caretta caretta*) clutches at a Mediterranean nesting site over five seasons. Our aims were two-fold: to assess whether particular females where characterized by consistent levels of egg failure both within and between nesting seasons and secondly, to identify whether pronounced variability in egg failure and neonate mortality existed at a population level over intra- and inter-seasonal scales. The principal finding was that first clutch deposited by females was more likely to contain a higher proportion of eggs displaying no GSD. Possible factors, both ecological and physiological, underpinning this finding are explored as are its implications for declining sea turtle populations in general.

Egg mass, egg composition, clutch mass, and hatchling mass of leatherback turtles (*Dermochelys coriacea*) nesting at Parque Nacional Las Baulas, Costa Rica

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Maternal investment in offspring via eggs can have significant effects on the size and vigor of hatchlings. However, in-depth studies of within- and among-female variation in egg size, and its impact on hatchlings, have not been reported frequently. Leatherback turtles (*Dermochelys coriacea*) nesting at Parque Nacional Las Baulas, Costa Rica, provide an excellent opportunity to study effects of intrapopulation variation in maternal investment because they are tagged annually. During the 2000-2001 and the 2001-2002 nesting seasons we measured mass of individual eggs and total mass of all "yolkless eggs"(which we call "shelled albumen gobs" (SAG) because, lacking ova, they are not eggs) from nests of known females. We measured mass of hatchlings from the same nests to quantify relationships between egg size and hatchling size. We also measured egg composition (i.e. masses of shell, albumen, and yolk) during the 1993-1994 nesting season. Average egg mass, total clutch mass, and total SAG mass varied significantly among females. Hatchling mass also varied significantly among females, but did not parallel the variation in egg mass. Yolk comprised approximately 35% of egg contents, but varied little with egg mass. Nearly 80% of the increase in mass from smallest to largest eggs was due to additional albumen in egg contents. Finally, hatchling mass seems to covary with yolk mass. Unlike patterns observed in other oviparous amniotes, egg mass may not be a reliable measure of maternal investment by leatherback turtles.

Green turtle grazing: effects on seagrass ecosystems

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Green turtles (*Chelonia mydas*) are the only herbivorous sea turtles and were once the primary grazers in Caribbean seagrass beds. They can maintain grazing plots for a year or longer, in which they re-crop seagrass (*Thalassia testudinum*) blades near the substrate. This pattern of grazing has been thought to cause a substantial decrease in plant growth and to stress the plants physically and structurally. Today, green turtles represent perhaps 1% of pre-Columbian populations, which numbered in the tens of millions, and are endangered throughout the Caribbean. Productivity, structure, and biodiversity of seagrass habitats are undoubtedly different today than when they were grazed by millions of green turtles. Green turtle grazing was simulated in Thalassia plots from July 1999 - November 2000 at Lee Stocking Island, Exumas, Bahamas. Seagrass physical structure, productivity, and nutrient composition were quantified initially and at intervals during the grazing experiment, along with composition of faunal communities in the sediment and on seagrass blades. Some of these parameters changed, as re-cropping stressed the plants. As efforts are made to increase green turtle populations, realistic goals of population size are needed for management programs. Incorporating grazing-induced changes in *Thalassia* productivity and nutrient composition can improve current estimates of seagrass carrying capacity for green turtles.

Evidence for near shore nocturnal foraging by green turtles at Honokowai, Maui, Hawaii Islands

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A creative methodology was employed to attach Time-Depth Recorders (TDRs) on large green turtles resting at 10-15m depths in benthic habitats off Honokowai, West Maui. The objective of this study was to determine diving profiles for insight into the turtles' diel behavior associated with foraging/resting patterns and locations. Honokowai hosts nearly 100 turtles known to be long term residents, many of which have been afflicted with fibropapilloma disease (Bennett et al. 2002, Davidson 2001). This underwater area and the honu ohana (turtle family) have been documented photographically two months each year since 1989. Individual turtles have been benignly ID'ed and assigned names for permanent recognition using images of facial scale patterns (by UK-B/PB, see for comprehensive details). This effort, requiring an enormous investment of time, resources, and patience, has resulted in a unique dataset for longitudinal research of the Honokowai turtle assemblage.

Green turtles in the Hawaiian Archipelago (19°N,155°W to 28°N,178°W) have shown a significant increase in numbers since annual monitoring was initiated 29 years ago at the population's principal nesting site of French Frigate Shoals (FFS). At some locations prominent changes in the adaptive behavior of the turtles have occurred concomitant with the recovery trend. This includes shifts in near shore foraging from night to daytime, exceptional tolerance to humans, emergence ashore for resting or basking, and formation of underwater cleaning stations (Balazs 1996).

At Honokowai, certain turtles of known identity are undisturbed if carefully approached by a scuba diver. This acceptance offers the unique opportunity to deploy and retrieve small instruments without capture or restraint. TDRs by Wildlife Computers (MK5/MK7), programmed to sample depth once a minute, were placed into small soft pouches on an adjustable pet collar fitted with a quick attach/release buckle. A segment of cotton cloth was sewn into the collar as a break-away link for safety. The resulting "anklets" were easily placed on and retrieved from the femoral region of the hind flipper of three healthy turtles resting on the bottom. This resulted in the collection of nine days of dive profiles for an 80cm subadult (Fig. 1 "Uwapo"), four days for an 80cm subadult male (Fig. 2 "Amuala"), and six days for a 95cm adult female (Fig. 3 "605C") originally tagged in 1997 while nesting at FFS. All turtles demonstrated movements to shallower water at night (1900-0700h). The numerous short dives carried out to 1-4m were indicative of foraging. In contrast, the longer and deeper daytime dives took place where the TDRs were deployed and the turtles are routinely seen resting, but seldom feeding. Turtle 605C differed from this pattern on two days (8/23 and 8/24/01) by moving to shallow depths at 1100-1200h and staying there for 19h each time, presumably feeding, until 0700 the following day. Daytime resting and night-time foraging dives were often separated by a short transition period (<1h) consisting of dives limited to 1-2m deep. This may be when the turtles are swimming near the surface in transit between the two habitat locations, thereby suggesting a distance of about 2km or less.

The identification of food contents of turtle fecal pellets collected where the TDRs were deployed revealed the benthic algae *Melanamansia*, *Cladophora*, and *Pterocladiella*. The latter alga is found almost exclusively in water 1-4m deep and has long been known as prime forage for Hawaiian green turtles.

Shallow water 1-4m deep only exists close to shore, since the ocean bottom descends to great depths seaward of Honokowai and there are no offshore shoals. Turtles in numbers, especially ones of large size, are not seen feeding during the daytime along West Maui. Further investigations are needed to ascertain why turtles at Honokowai, acclimated to the presence of a few scuba divers in resting habitat, would continue to forage mainly in the dark, when many others throughout Hawaii feed openly during the day. Nevertheless, it is now clear that the turtles seen at Honokowai, as featured at , mainly consist of a bedroom community. And, when the sun sets, the turtles come in to pasture.

LITERATURE CITED

Balazs, G. H. 1996. Behavioral changes within the recovering Hawaiian green turtle population. In: J.A. Keinath, D.E. Barnard, J.A. Musick, and B.A. Bell, comps. Proceedings of the Fifteenth Annual Symposium on Sea Turtle Biology and Conservation, NOAA Tech. Memo. NMFS-SEFSC-387. p. 16-21.

Bennett, P.A., U. Keuper-Bennett, and G.H. Balazs. 2002. Remigration and residency of Hawaiian green turtles in coastal waters of Honokowai, West Maui, Hawaii. In: A. Mosier, A. Foley, and B. Brost, comps. Proceedings of the Twentieth Annual Symposium on Biology and Conservation. NOAA Tech. Memo. NMFS-SEFSC-477. p. 289-290.

Davidson, O.G. 2001. Fire in the turtle house: The green sea turtle and the fate of the ocean. The Perseus Books Group, Cambridge, Massachusetts, 258 p.

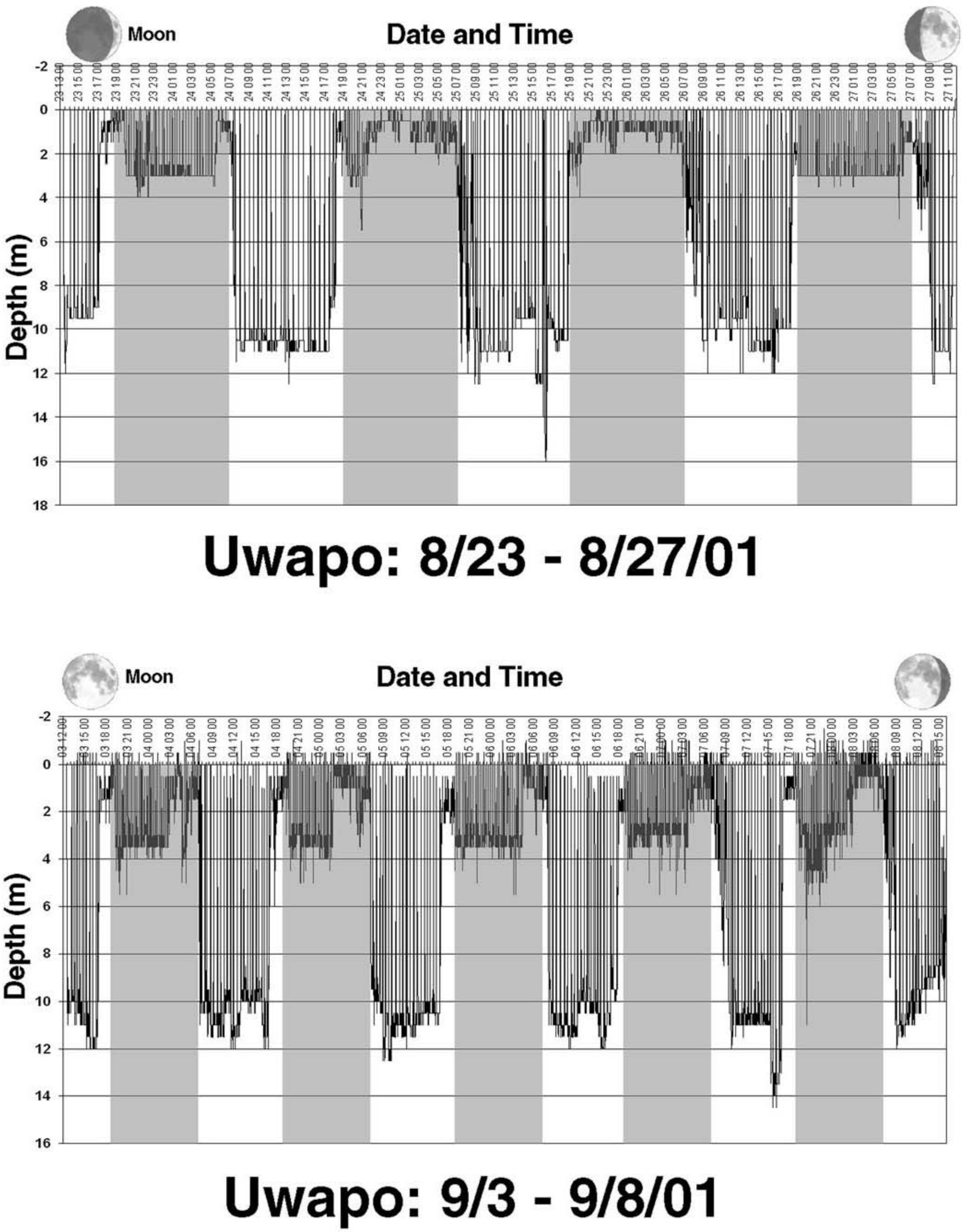

Fig. 1. Dive profiles for subadult green turtle "Uwapo" at Honokowai, West Maui. Shaded areas indicate nocturnal hours.

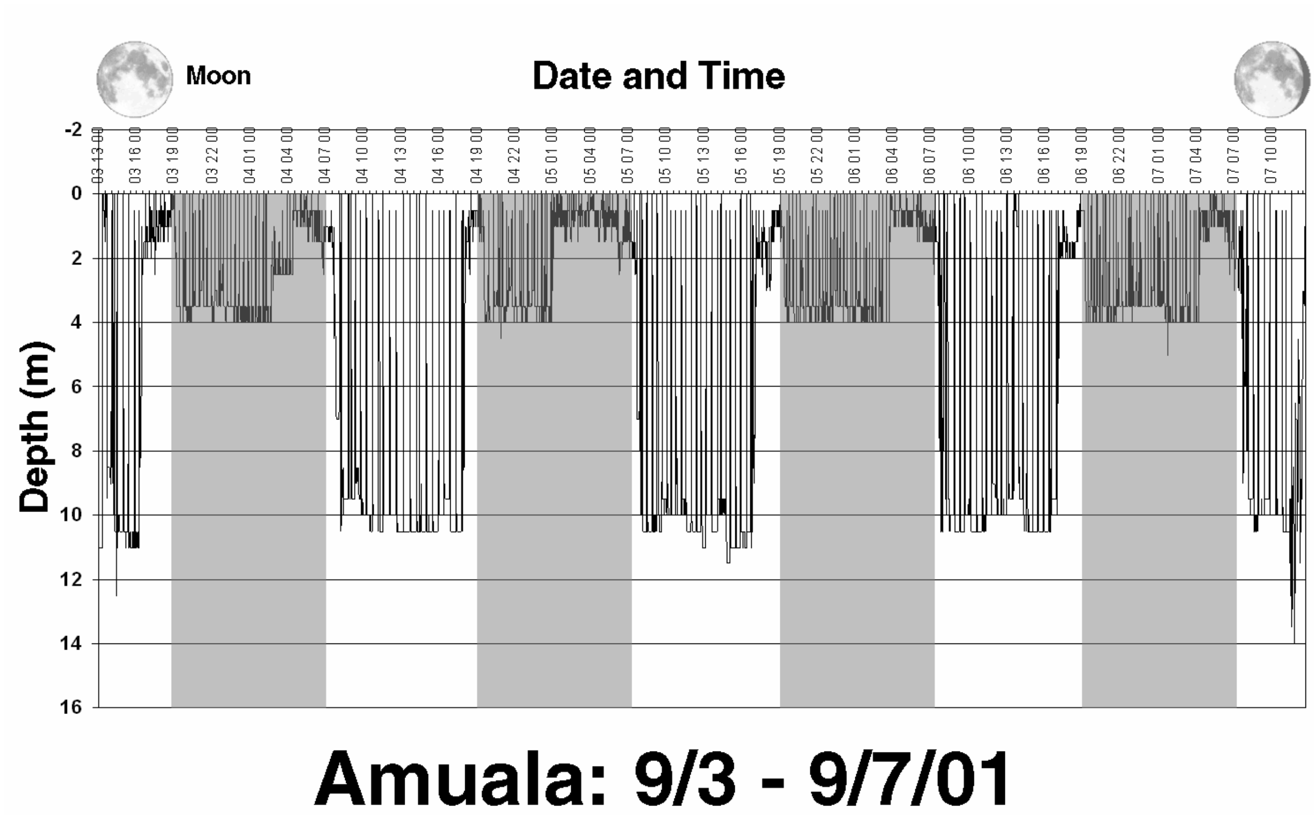

Fig. 2. Dive profiles for subadult male green turtle "Amuala" at Honokowai, West Maui. Shaded areas indicate nocturnal hours.

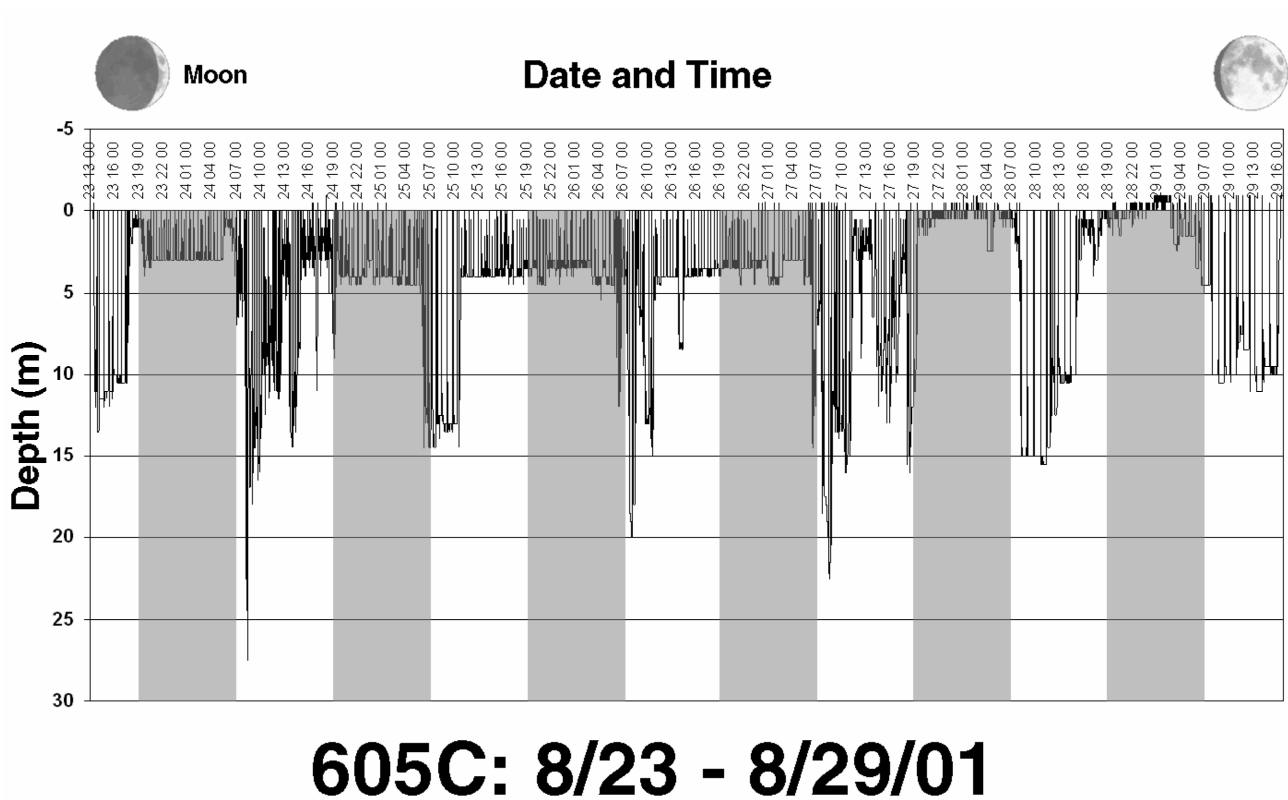

Fig. 3. Dive profiles for adult female green turtle "605C" at Honokowai, West Maui. Shaded areas indicate nocturnal hours.

Spatial and temporal variation in Hawaiian green turtle somatic growth behavior

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The spatial and temporal somatic growth behaviour of green sea turtles resident in several Hawaiian foraging grounds was explored using a robust local regression modelling approach. The sampling design in this long-term mark-recapture program was mixed longitudinal and included growth records for turtles from the Hawaiian genetic stock ranging between 28 and 89 cm SCL. The expected size-specific growth rate function at all sampled foraging grounds was nonmonotonic rising from mean recruitment size (25-35 cm SCL) to maximum growth ca 52-55 cm SCL before declining to negligible growth at carapace sizes greater than 70 cm SCL that were foraging ground dependent. The expected age-specific growth functions derived by numerical differentiation showed that the juvenile growth spurt for immature greens resident in the various foraging grounds occurs from 7-15 years-at-large since recruitment with the immature developmental phase for the Hawaiian green turtle ranging from 25-50 years since recruitment from the pelagic developmental phase. Significant temporal variability in growth behaviour was also found at all sampled foraging grounds that probably reflects local population density-dependent effects and the fact that the nesting population of this stock has increased significantly since the 1980s. The juvenile growth spurt and slow size- , age- and foraging ground specific growth rates for immatures observed for the Hawaiian green sea turtle genetic stock are also growth characteristics for green sea turtles resident in southern Great Barrier Reef waters.

Hawksbill sea turtles: islands of marine biodiversity

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INTRODUCTION

As more sea turtles research is directed towards habitat utilization, we have been able to observe a variety of ecological interactions as they occur in nature. The meaning of these relationships may lead to a better understanding of the host, its habitat, and other aspects related to habitat interactions. Besides predator prey relations there are a variety of interactions within sea turtle habitat, which may include commensal, parasitic, or mutualistic relationships. The close interaction between sea turtles and epibenthic organisms may reveal a great deal about the Chelonian host and it's surroundings. Ecological information of epibiota, and their symbiosis with marine turtles may shed new light on the biogeographical and evolutionary theories of marine benthic organisms, particularly for those with short dispersal capabilities. Sea turtles may provide connectivity between epibiotic populations separated by oceanic currents or basins.

When sea turtles were numerous (Jackson et al. 2001) there was significantly more sea turtle surface area available for epibiota. This may have influenced the evolution of marine biodiversity and biogeographic patterns of epibiotic species. For example hard shelled barnacles (Family Balanidae), have been found in sea turtle fossils from the Eocene (Ross and Newman 1967). Therefore we can assume that co-evolution has been taking place for a long time and has resulted in varying degrees of symbioses among marine turtle epibiota. A few species of epibionts are reported only from sea turtles including a red alga (Hollenberg et al. 1977), an amphipod (Thomas 1992), and some barnacles (Monroe and Limpus 1979).

All species of marine turtles host a species rich epifaunal community and *Eretmochelys imbricata* (Linnaeus 1766) supports species rich aggregations due to its tropical distribution and benthic habitat utilization. The epibiota of nesting and stranded marine turtles has been used to identify the hosts' range assuming these must overlap for colonization to occur. Caine (1986) was able to differentiate two sub populations of *Caretta caretta* based on epibiotic community composition. These results are supported by mDNA findings of Bowen et al. (1996). Other analyses of epibiotic associations have revealed temporal colonization patterns of gravid *Dermochelys coriacea* related to their movements in tropical waters associated to nesting areas (Eckert and Eckert 1987, 1988). The epibionts of nesting marine turtles are the most commonly described (Sentíes et al. 1999, Matsuura and Nakamura 1993, Frick et al. 1998) due to the accessibility of this stage of the host's life cycle. The organisms associated with pelagic marine turtles are as difficult to document as the 'lost years' they represent, yet some pelagic host epibionts have been described for *C. caretta* (Davenport 1994, Dellinger et al. 1997, Frick et al. 2000). Stranded and dead turtles also provide a situation for epibiont analysis which may shed light on the cause or time of death (Bugoni et al. 2001). Unfortunately it is difficult to describe the normal epibiotic community from stranded or nesting marine turtles as they may undergo desiccation or other alterations when emerged.

Epibiotic communities overgrowing adult turtles may differ from those of juvenile or non-nesting individuals and these differences probably reveal important ecological information about the host. It was my objective to describe the epibiotic community associated with non-nesting *E. imbricata* of known foraging areas of 2 different habitats. I collected samples of the epibiotic community from one hundred and five individuals captured for tagging studies (van Dam and Diez 1998) in coral reef and rocky wall habitats of Mona Island, Puerto Rico. I also include data from observations of samples collected from *E. imbricata* of Desecheo and Culebra Islands, Puerto Rico.

METHODS

Specimens of the epibiotic community growing on *E. imbricata* were classified to the lowest possible taxon. In order to minimize errors in species identification the major phylogenetic groups were pooled and the algae were classified into functional groups (filamentous, calcareous erect, calcareous encrusting, and foliose).

To depict habitat associations of epibiotic taxa I assumed that the host turtles remain within a 1 km^2 home range, and therefore occupy the same general habitat throughout their developmental life stage (van Dam and Diez 1998, León and Diez 1999). This may lead to an epibiotic community structure specific of each habitat, similar to the hypothesis that recruitment plates reflect habitat. In order to detect habitat association of epibiota, the presence and absence of each epibiotic taxon was compared among two habitats; coral reef and rocky wall, by Chi squared contingency tables.

RESULTS AND DISCUSSION

Epibiota of a great diversity of algae and at least 12 animal phyla were identified, including new findings for marine turtle associates (Schärer 2001). These results provide the highest phylogenetic diversity reported for sea turtle epibiota. At least 90 operational taxonomic units were identified, which is probably more than 90 species of epibiota. Previously unreported marine turtle epibionts include foraminiferans, nematodes, sipunculids, ostracods, dipterans (*Clunio* sp. and *Pontomyia* sp.), and echinoderms. The most frequently encountered algae were filamentous and calcareous encrusting forms. Annelids, barnacles, bryozoans and harpacticoid copepods were most frequent among all invertebrate epibionts.

Eight taxa (foraminifers, nematodes, sipunculids, mollusks, amphipods, decapods, tanaids, and dipterans) and one functional group of algae (calcareous erect) were significantly more frequent in coral reef habitat. Two taxa (sponges and bryozoans) were significantly more frequent in cliff wall habitat. Clustering analysis (Bray Curtis) of the epibiotic community components showed discrimination by habitat. It is worth noting that the epibiotic community composition of an aggregation of non-nesting sea turtles may differ greatly due to habitat variability. Changes in epibiotic composition through time (succession) need to be assessed for a better understanding of the dynamics of epibiota.

The differential associations of epibiota on (non-nesting) *E. imbricata* seems to depend on the presence of unconsolidated sediment accumulations on the carapace. Carapace morphology and the rugose texture of the bekko scute plays an important role in the entrapment of sediments and causes microhabitat heterogeneity, which provides diverse niches for epibiotic species. Some of the taxonomic groups that were more frequent on turtles from coral reef habitat seem to be responding to the presence of fine unconsolidated sediments. For example some species of foraminiferans, nematodes, sipunculids, dipterans, amphipods, tanids, isopods, and mollusks are considered meiofauna, associated to unconsolidated sediments in the marine benthos. The sponges and bryozoans, on the other hand, are filter feeders and dominate in hard bottom or sediment poor habitats. This difference in the epibiotic community may indicate that the host turtle is from a specific sedimentary regime, which could be related to bathymetry.

Marine turtle-specific barnacles of the family Balanidae may demonstrate a specialized symbiosis, as it is the most ancient epibiont of sea turtles that we know of. This genus of barnacle is commonly found on the carapace of Cheloniid turtles, yet in Puerto Rico it was not observed on juvenile or sub-adult (<50 cm SCL) *E. imbricata.* Forty six percent (46%) of nesting *E. imbricata* at Mona Island are colonized by *Chelonibia caretta* while *C. testudinaria* was observed on just one non-nesting *Chelonia mydas* at Culebra Island. At higher latitudes *C. testudinaria* is most common and apparently abundant on foraging and nesting *C. caretta* (Gramentz 1988, Matsuura and Nakamura 1993, Frick et al. 1998). DNA studies of *Chelonibia* sp. are currently underway, and may help identify distinct populations and their global distribution. If sea turtles are the only substratum of *Chelonibia* sp., they share the same risk of extinction as their hosts and more information on their distribution, abundance, and biology is urgently needed. Please do not remove epibiota from wild turtles, as it is part of their natural habitat. Collections should be restricted to stranded or rehabilitating individuals, to help preserve turtle specific epibionts before we find out how endangered they really are. All sea turtle researchers should try to correctly identify barnacles (see Monroe and Limpus 1979) in order to learn as much as possible from them.

LITERATURE CITED

Bowen, B.W., J.C. Avise, J.I. Richardson, A.B. Meylan, D. Margaritoulis, and S.R. Hopkins-Murphy. 1996. Population structure of loggerhead turtles (*Caretta caretta*) in the northwestern Atlantic Ocean and Mediterranean Sea. Conservation Biology 7:834-844.

Bugoni, L., L. Krause, A. Oliveira de Almeida, and A. de Pádua Bueno. 2001. Commensal Barnacles of Sea Turtles in Brazil. Marine Turtle Newsletter 9:6

Caine, E.A. 1986. Carapace epibionts of nesting loggerhead sea turtles: Atlantic coast of USA. Journal of Experimental Marine Biology and Ecology 95:15-26.

Davenport, J. 1994. A cleaning association between the oceanic crab *Planes minutus* and the loggerhead sea turtle *Caretta caretta*. Journal of Marine Biology Ass. U. K. 74:735-737.

Dellinger T., J. Davenport, and P. Wirtz. 1997. Comparisons of social structure of columbus crabs living on loggerhead sea turtles and inanimate floatsam. Journal Marine Biology Ass. UK. 77:185-194.

Eckert, K.L. and S. Eckert. 1987. Growth rate and reproductive condition of the barnacle *Conchodrma virgatum* on gravid leatherback sea turtles in Caribbean waters. Journal of Crustacean Biology 7:682-690.

Eckert, K.L. and S.A. Eckert. 1988. Pre-reproductive movements of leatherback sea turtles (*Dermochelys imbricata*) nesting in the Caribbean. Copeia 1988:400-406.

Frick, M., K. Williams, and M. Robinson. 1998. Epiboints associated with nesting loggerhead sea turtles (*Caretta caretta*) in Georgia. Herpetological Review 29:211-214.

Frick, M.G., K.L. Williams, and D. Veljacic. 2000. Additional evidence supporting a cleaning association between epibiotic crabs and sea turtles: How will the harvest of *Sargassum* seaweed impact this relationship? Marine Turtle Newsletter 90:11-13.

Gramentz, D. 1988. Prevalent epibiont sites on *Caretta caretta* in the Mediterranean Sea. Il Naturalista Siciliano 12:33-46.

Hollenberg, G.J. and J. Norris. 1977. The red alga *Polysiphonia* (Rhodomelaceae) in the northern Gulf of California. Smithsonian Institution Press 1:16.

Jackson, J.B.C., M.X. Kirby, W.H. Berger, K.A. Bjorndal, L.W. Botsford, B.J. Bourque, R.H. Bradbury, R. Cooke, J. Erlandson, J.A. Estes, T.P. Hughes, S. Kidwell, C.B. Lange, H.S. Lenihan, J. M. Pandolfi, C.H. Peterson, R.S. Steneck, M.J. Tegner, and R.R. Warner. 2001. Historical Overfishing and the Recent Collapse of Coastal Ecosystems. Science 293:629-638.

León, Y.M. and C.E. Diez. 1999. Population structure of hawksbill turtles on a foraging ground in the Dominican Republic. Chelonian Conservation and Biology 3:230-236.

Matsuura, I. and K. Nakamura. 1993. Attachment pattern of the turtle barnacle *Chelonibia testudinaria* on carapace of nesting loggerhead turtle *Caretta caretta*. Nippon Suisan Gakkaishi 59:1803.

Monroe, R. and C. Limpus. 1979. Barnacles on turtles in Queensland waters with descriptions of three new species. Memoirs Queensland Museum 19:197-223.

Ross, A. and W. Newman. 1967. Eocene Balanidae of Florida, including a new genus and species with a unique plan of "Turtle-Barnacle" organization. American Museum Novitates 2288:1-21.

Schärer, M.T. 2001. A Survey of the epibiota of hawksbill sea turtles (*Eretmochelys imbricata*) of Mona Island, Puerto Rico. M.Sc. Thesis, University of Puerto Rico, Recinto Universitario de Mayagüez, 92 pp.

Sentíes, A., J. Espinoza-Avalos, and J.C. Zurita. 1999. Epizoic algae of nesting sea turtles *Caretta caretta* (L.) and *Chelonia mydas* (L.) from the Mexican Caribbean. Bulletin of Marine Science 64:185-188.

Thomas, J.D. 1992. *Podocerus chelonophilus* a testudinous amphipod newly recorded from the western Atlantic Ocean. Bulletin of Marine Science 50:108-116.

van Dam, R.P. and C.E. Diez. 1998. Home range of immature hawksbill turtles (*Eretmochelys imbricata* (Linnaeus)) at two Caribbean Islands. Journal of Experimental Marine Biology and Ecology 220:15-24.

Compensatory growth in the green turtle (*Chelonia mydas*): effects of transient food restriction and subsequent refeeding in hatchlings

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Understanding growth dynamics in sea turtles is central to evaluating the effects of fluctuations in dietary intake due to nutrient dilution from ingested debris, injury to the digestive tract, or limited food availability. Compensatory growth, or "catch-up growth", is a period of accelerated growth during increased food intake following a period of nutritional deprivation. It is currently unknown whether sea turtles possess the ability to compensate for a previous food restriction through compensatory growth. The purpose of this study was to evaluate the capacity of green turtle hatchlings for compensatory growth, to elucidate differential responses to various feeding regimens, and to provide insights into growth dynamics in green turtle hatchlings. In this study, conducted at the Cayman Turtle Farm, three groups of hatchling green turtles were fed according to different feeding regimens over twelve weeks. One group of turtles was fed on an ad libitum basis for the duration of the study, another group of turtles was fed on a restricted diet for the duration of the study, and the third group of turtles was fed on the restricted diet for five weeks followed by an ad libitum diet for seven weeks. Throughout the course of the experiment, intake rates were determined on a daily basis, and growth measurements in the form of mass, straight carapace length, straight carapace width, and plastron length were taken on a weekly basis. The effects of the various dietary regimens on intake, growth rates, and food conversion efficiency will be discussed.

The crab *Polybius henslowii* (Decapoda: Brachyura) as a main resource in *Caretta caretta* diet from North Africa: environment implications and conservation

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INTRODUCTION

It is well known that *Caretta caretta* is an omnivorous species that can feed on many different prays (see Dodd 1988, Van Nierop and Den Hartog 1984). However we find out that in the north shore of the Strait of Gibraltar, and possibly along the main part of Moroccan Atlantic coast (O. Ocaña pers. obs.), they prey on the bentho-pelagic crab *Polybius henslowii* Leach, 1820. Very little is known about the biology of this crab, but according to the consulted specialized bibliography the species has been recorded from Canary Islands, Moroccan coast, Strait of Gibraltar and Western Mediterranean. Furthermore, *P. henslowii* is able to constitute large pelagic concentrations in order to reproduce them (González-Gurriarán 1987, González-Gurriarán et al. 1991, González Pérez 1995). Although our research is been carrying out along the Ceuta region (Cape Negro to Beliones bay) we also have recorded some data from others areas along the Moroccan littoral.

This research has been partly supported economically by the Department of Education and Culture of Ceuta Autonomic Government, which also has been supported a one year (2001) research project in order to study the turtles in its habitat. The Institute of Ceuta Studies (CECEL-CSIC) also helped with a grant for this subject. Some of the Moroccan data were obtained thanks to the friendly collaboration with Professor Dr. Younes Saoud from Tetuan University.

MATERIAL AND METHODS

The present study is based on an examination of the gut content of 70 loggerhead turtles stranded at Ceuta region (Cape Negro to Beliones bay) along the years 2000 and 2001. All the turtle gut contents were examined and sampled by ourselves taking all of the solid gut content (90 to 100%) and leaving the fluid portion in the intestine. Once the content is removed from the stomach, we keep it in plastic bags and freeze until the study can be done. To be study, the gut content has to be previously sieved in order to avoid the remains of gastric fluids and other stomach detritus. After this, we store them in alcohol 70%. The sample is examined under the binocular dissecting microscope to check the density of crabs in the gut content and to obtain the weight, the rest of crabs are dried previously. The habitat data and observations of alive specimens were partly recorded by the "Project for the study of cetaceans and marine turtles populations around the Ceuta marine region"(de Stephanis et al. 2001) (more than 1200 miles searched), and partly thanks to the volunteer net and the cooperation of the Tetuan University and also personal travels to Moroccan Atlantic coast.

RESULTS

After checking the gut contents of our specimens we noticed the presence of *P. henslowii* during all seasons, being July the month with the biggest number of turtles stranded that showed the crab in there gut contents. Only in spring and summer and also on the first of autumn high quantities of this crab occurred on the stomach of the specimens examined. Some aspects of the crab biology, as the concentrations and the reproduction pathways, remain still unknown González-Gurriarán et al. (1993), although those authors has remarked the importance of this species as a seasonal resource in Galicia. González-Pérez (1995) has been recorded those crabs forming concentrations of thousands of specimens in February off Lanzarote coast, and Wirtz (com. In litt.) has recorded this crab from Azores. In our littoral the crabs has been observed forming concentrations from May to August, meanwhile we have been observed in March and April similar concentrations in the Moroccan Atlantic coast, from the south (near Sahara) to the north (Larache). Furthermore, in the south of Morocco, there are so many crabs that they become a problem for the fishermen nets, however, in the Strait of Gibraltar the fishermen use them as a bait, keeping high quantities of crabs on shallow waters in sheltered bays.

We have observed crabs in the stomach of the sea bird *Larus argentatus* (Ocaña and de Los Ríos unpublished data) and several fishes such as *Thunnus thynnus* (Linnaeus 1758), *Dicentrarchus* sp., *Dentex dentex* (Linnaeus 1758), *Sparus aurata* (Linnaeus 1758) and *Pagellus bogavareo* (Brünnich 1768) (De Los Ríos and Ocaña unpublished data) and *Alepisaurus ferox* Lowe, 1833 (see González Pérez 1995).

DISCUSSION

The find of this crab as a main gut content of *C. caretta* in this part of the world is a remarkably fact that has remained unknown till now. Although there are a number of papers about the diet in *C. caretta* (see Dodd 1988) the presence of this crab in loggerhead turtle has never been reported. However, attending to the crab distribution and concentrations, a well known phenomenon from Galicia to Canary Islands (see González Pérez 1995) and Alboran sea, the absence of data about this crab in relation with this turtle could be due to the absence of postmortem studies in Europe and Africa, furthermore the crabs could have been overlooked, remaining in the gut content papers as 'unidentified crabs'. The prevalence of *P. henslowii* in the gut content of our *C. caretta* populations sets up the importance of this crab as a main resource for this species for six months, during this time the turtles could be able to stock fat reserves. The crab is a nutritive food (González-Gurriarán 1987) being easily caught by the turtle with a low energetic cost, as *P. henslowii* occurs normally from 0 to 5 meters deep not having a high movement capability. The most important crab-watching in our region are coincident with the abundance of marine turtles that is during spring and summer, when we find the stomachs of *C. caretta* full with crabs. The occurrence of crabs in the gut content of some specimens of *C. caretta* stranded on January sets up its importance as a regional resource during all the year, further away than a seasonal phenomenon. In a general perspective, it is a plausible option that the turtles can follow and feed specifically on crabs concentrations as it is known for this species in other geographic regions (Ripple 1996, Mortimer 1976) changing the cliché about the generalist diet of *C. caretta*. Although very little is known about the occurrence and abundance of this crab along the Atlantic Moroccan coast, we confirm it forms large pelagic concentrations near to the Sahara coast in spring. What happens during the year along the Atlantic coast of Morocco is something that remains unknown, however when the crab occurs abundantly it becomes a problem for a number of Moroccan fishermen (Ocaña and de los Ríos unpubl. data). *P. henslowii* is a resource with much more regional importance for a number of pelagic and benthopelagic species (see results), even during spring and summer the crab is a very important resource for the colonies of the sea bird *Larus argentatus*, settled at Ceuta coast. There is a number of other species than can feed constantly or just as opportunists on this crab, although we aware that it is not the last word in this subject extending the results to Moroccan coast. In this context, it seems suitable to mention that *P. henslowii* is certainly important for the Ceuta region marine ecosystems and possibly also for Moroccan Atlantic coast. According to this, we think that any natural or artificial events (contamination) that decreases the crab concentrations will affect drastically to *C. caretta* populations, and this has to be considered seriously for the conservation of this species in this part of the world.

CONCLUSIONS

(1) *P. henslowii* is the main resource for *C. caretta* in this part of world; (2)The loggerhead turtle feed on this crab along the year, although when the turtles present high quantities of crabs in its gut content is from April to September; (3)Our find sets up that *C. caretta* presents a very specific diet in north Africa, opposite to the extended perspective about this species; (4)The species *P. henslowii* is a regional resource not only for *C. caretta* but for a number of marine species including birds and also pelagic and benthopelagic fishes; and (5) We recorded concentrations of *P. henslowii* from Sahara, Larache and the Strait of Gibraltar.

LITERATURE CITED

Dodd, C.K. 1988. Synopsis of the biological data on the loggerhead sea turtle *Caretta caretta* (Linnaeus 1758). Fish and Wildlife Service, U.S. Department of the Interior. Biological Report 88(14).

De Stephanis, R., M. Fernandez, A. De los Rios and O. Ocana. 2001. Informe preliminar de la consultoría y asistencia técnica relativa al estudio de las poblaciones de cetáceos y de tortugas marinas de las aguas adyacentes al litoral de la Ciudad Autónoma de Ceuta. 68 pp.

Gonzalez-Gurriaran, E. 1987. El patexo, *Polybius henslowii* Leach (Decápoda-Brachyura), en las costas de Galicia (NW de España): I. Distribución espacial y cambios temporales. Inv. Pesq. 51 (Supl.1):361-374.

Gonzalez-Gurriaran, E., L. Fernandez, J. Freire, R. Muino, and M. Rodriguez Solorzano. 1991. Estructura de la comunidad megabentónica (crustáceos decápodos-Brachyura- y peces demersales) de la Ría de Ferrol (Galicia, NW España). Bol. Inst. Esp. Oceanogr. 7:89-99.

Gonzalez-Gurriaran, E., J. Freire, and L. Fernandez. 1993. Geostatistical analysis of spatial distribution of *Liocarcinus depurator*, *Macropipus tuberculatus* and *Polybius henslowii* (Crustacea: Brachyura) over the Galician continental shelf (NW Spain). Mar.Biol., 115:453-461.

Gonzalez-Perez, J.A. 1995. Catálogo de los crustáceos decápodos de las Islas Canarias. Publicaciones Turquesa. 282p.

Mortimer, J.A. 1976. The feeding ecology of the sea turtles. Department of Zoology, University of Florida, Gainesville.

Ripple, J. 1996. Sea turtle World Life library, Great Britain, 84 p.

Van Nierop, M.M. and J.C. Den Hartog. 1984. A study on the gut contents of five juvenile loggerhead turtles, *Caretta caretta* (Linnaeus), from the south-eastern part of the north atlantic ocean, with emphasis on coelenterate identification. Zoologische Mededelingen 59:35-54.

Ecology of the loggerhead – Columbus crab relationship: a review and new information

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Columbus crabs (*Planes minutus*) are reliant on buoyant material for survival and are often found on the postero-ventral surfaces of sea turtles, particularly pelagic stage loggerheads (*Caretta caretta*). Fifty-six pelagic stage loggerhead sea turtles were sampled for epibionts and Columbus crabs from 1986 to 1994, from the waters surrounding the Azores in the North Atlantic. Ten epibiotic species were identified from juvenile loggerheads, representing the first qualitative epibiont study on the pelagic life stage of the loggerhead turtle. Sixty-four Columbus crabs were collected from turtles; most representing heterosexual crab pairs including ovigerous females. Through a preliminary analysis of this data and review, we attempt to identify and define the relationship that exists between these epibiotic crabs and loggerheads. Data indicate that epibiotic crabs help to rid young host turtles of gregarious and potentially debilitating epibionts. Additional data suggests that turtles represent the most prolific breeding substrate for crabs when compared to reproductive data collected from crabs inhabiting local, inanimate flotsam. Such data is important to consider when making management decisions regarding any activities that could affect this potentially important relationship (i.e. the harvest of *Sargassum* seaweed, a nursery habitat for juvenile Columbus crabs).

Phylogeograpy of hawksbill rookeries in the Yucatan Peninsula (Mexico) as revealed by mitochondrial DNA analysis

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Using hawksbill specific primers that span known variable sites in over 520 bp of mtDNA dloop, we sequenced 239 individuals (11 nesting colonies) from Yucatan Peninsula, Mexico. Genetic diversity and its geographic distribution among rookeries were compared with those from other populations in the Caribbean. Four endemic haplotypes previously reported in Mexico (Bass et al. 1996, Diaz et al. 1999) were observed (Q/Mx1, Q10bp/Mx1a, Q/Mx2, P/Mx3), as well as a previously described haplotype (q, Diaz et al. 1999) at a foraging site but hitherto unassigned to source. Haplotype A/Cu1 (a common haplotypes in the Caribbean) and a new haplotype were also found but only single samples. The common haplotype (Q/Mx1) occurred at high frequencies in all rookeries except Punta Xen and San Lorenzo (Campeche), where haplotype q predominated. With a single exception, haplotype q was found in Campeche rookeries, but was totally absent from Yucatan. Remaining haplotypes were only found in Yucatan state, at very low frequencies (<0.10). Geographic structuring for haplotype q distribution is puzzling given the relatively small span involved (about 660 kms) and may reflect a recent evolutionary event, centered in Punta Xen, currently undergoing a slow diffusion process that parallels the very low rates and extent of nesters translocating between different beaches observable from tagging studies. The uniqueness of Peninsular haplotypes, indicating a strong breeding independence from other rookeries in the region, provides for an unequivocal identification of Mexican haplotypes in local and regional foraging sites where mixed stocks have been revealed. Management implications of our findings are discussed.

LITERATURE CITED

Bass, A.L., E.A. Good, K.A. Bjorndal, J.I. Richardson, Z.M. Hillis, J.A. Horrocks, and B.W. Bowen. 1996. Testing models of female reproductive migratory behavior and population structure in the Caribbean hawksbill, *Eretmochelys imbricata*, with mtDNA sequences. Mol. Ecol. 52:321-328.

Diaz, R., T. Okayama, T. Uchiyama, E. Carrillo, G. Espinosa, R. Márquez, C. Diez, and H. Koike. 1999. Genetic sourcing for the hawksbill turtle, *Eretmochelys imbricata*, in the northern Caribbean Region. Chel. Cons. Bio. 3:296-300

Green turtle (*Chelonia mydas*) nesting and feeding populations along the Atlantic Coast of Africa described through Mitochondrial DNA

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Due to their high levels of philopatry, marine turtle populations are subdivided into geographically and genetically distinct assemblages, which can be resolved using appropriate molecular markers. A 489 base pair fragment of the mitochondrial DNA D-loop was sequenced in 798 green turtles (*Chelonia mydas*) collected in 11 countries along the Atlantic coast of Africa and in the Indian Ocean. Although the majority of individuals exhibited haplotype CM8, several rare and previously undescribed haplotypes were found among the samples. In addition, one highly divergent haplotype may suggest rare inter-oceanic movements. The distribution and frequencies of haplotypes were used to define genetic stocks of the nesting and feeding populations present in the region. Ten rookeries (Ascension, Bioko-Equatorial Guinea, Sao Tome, Principe, Poilao-Guinea Bissau, Comoros, Matapica-Surinam, Atol das Rocas-Brazil, Yucatan-Mexico and Aves-Venezuela) were used in a Mixed Stock Analysis of the feeding population found in Corisco Bay (Equatorial Guinea and Gabon). The software BAYES was used to calculate the probability density distribution of contributions from each rookery to the mixed stock. We suggest preliminary conservation strategies for these highly endangered populations and recommend that further sampling be undertaken in many rookeries. This study highlights the usefulness of genetic analysis, as a complement to ecological and demographic studies, particularly in measuring gene flow.

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Preliminary genetic data from foraging hawksbills (*Eretmochelys imbricata*) and nesting loggerheads (*Caretta caretta*) in the Cayman Islands

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The Cayman Islands provide foraging habitat for immature hawksbill turtles (*Eretmochelys imbricata*) and green turtles (*Chelonia mydas*), and to a small extent, nesting habitat for hawksbills, greens, and loggerheads (*Caretta caretta*). Nesting in the Cayman Islands was considered in recent decades to be non-existent due to exploitation, but surveys over the past few years have shown that residual rookeries remain. Although sample sizes are still small, we are able to offer preliminary genetic data on nesting loggerheads and foraging hawksbills in the Cayman Islands. Samples from the nesting population of loggerheads and foraging assemblages of hawksbills were collected in cooperation with the Cayman Islands Department of Environment. Analysis of the mitochondrial DNA control region was conducted at Eckerd College. Control region sequences were determined in order to elucidate the haplotype composition of the loggerhead nesting population on Grand Cayman and the nesting-beach origins of hawksbills inhabiting the foraging grounds in Little Cayman.

Mitochondrial DNA control region sequences were obtained from 24 foraging hawksbills from Little Cayman. Alignment of sequences with known haplotypes resulted in 16 haplotype A, one haplotype F, four haplotype Q (MXII), and two of the same possibly novel haplotype (near haplotype zz but with additional variable sites). In addition, one hawksbill/loggerhead hybrid was discovered.

Maximum Likelihood Estimation (MLE) was used to determine the relative contributions of possible source populations of hawksbills to the foraging ground. The program CONSQRT by Pella and Masuda generated the estimate that 20% (+/- 8.5%) of the immature hawksbills inhabiting developmental habitat in Grand Cayman originated from Mexico, 5% (+/- 5%) originated from the US Virgin Islands, and 75% (+/- 5%) originated from Cuba. The package Statistics Program for Analyzing Mixtures (SPAM Version 3.5, Alaska Department of Fish and Game) estimated Cuban contribution to the Little Cayman foraging ground was 71% with a 95% Non-Symmetric Percentile Bootstrap confidence interval of 60-100%. Estimated contribution of nesting beaches in Mexico to the Little Cayman foraging ground was 19%, with a 95% Non-Symmetric Percentile Bootstrap Confidence Interval of 0.01-33%. Other Caribbean and Brazilian nesting beaches did not appear to contribute significantly to the Little Cayman foraging ground.

The impacts on nesting beach populations of exploitation on foraging grounds will be best understood when the genetics of all nesting beach populations, large and small, are known. Thus, the small loggerhead rookery in Cayman is of conservation interest. Mitochondrial DNA control region sequences were obtained for thirty-five loggerhead clutches from Grand Cayman. Twenty-two represented haplotype B, nine represented haplotype J, and four represented the same unidentified and possibly novel haplotype. The Cayman loggerhead rookery is qualitatively similar to that known from the Yucatan Peninsula of Mexico. However, because female loggerheads nest several times each season, some of these clutches represent re-nesting by the same female. Examining variable nuclear DNA (microsatellites) would assist in eliminating possible duplication in the sample set, providing a more complete assessment of the loggerheads nesting in Grand Cayman.

This research represents the first genetic study of hawksbill and loggerhead sea turtles in the Cayman Islands, and has the potential to provide information relevant to the conservation and management of these species in the wider Caribbean. Preliminary foraging ground assessment suggests that hawksbills from Cuba and Mexico recruit to developmental habitats in the Cayman Islands. The impacts of the past, present, and proposed exploitation are difficult to assess, but given the highly migratory nature of marine turtles it is likely that exploitation in Cuba and other areas, even on a small scale, will impact hawksbill populations in other geopolitical units. Therefore exploitation on nesting beaches and adult foraging grounds could extinguish small and vulnerable foraging assemblages in the Cayman Islands.

Green turtle fisheries in Australasia: assessing the extent of their impact using mtDNA markers

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INTRODUCTION

Marine turtles are highly significant culturally and as a source of nutrition and income in local communities throughout the world. Green turtle meat in particular is highly valued. Typically, subsistence turtle fisheries operate in a local area and catches are small, although the accumulative effect of several adjacent subsistent fisheries can amount to a substantial regional take. However, with expanding discovery voyages, colonialism and increasing populations, the demand for turtle products and associated markets has increased (Jackson et al. 2001). As a result, pressure on existing populations increased and fisheries expanded to exploit more distant populations. Breeding populations of green turtles have declined throughout much of their range indicating that past levels of exploitation were unsustainable.

In Australasia, Bali (Fig. 1) has long been known as one of the biggest markets for turtle meat worldwide with annual landings of 10 to 30 thousand (Salm 1984, WWF unpubl. data). The Balinese predominantly adhere to Hinduism and traditional religious ceremonies require the use of turtle meat. Hindu high priests have estimated that 300 to 500 turtles annually would serve that purpose (WWF unpubl. data). With the opening of markets, this subsistence and culturally significant fishery has become increasingly driven by commercial interests. Originally, Bali supported its own population of nesting and feeding green turtles but these populations have been systematically eradicated over the past few decades. To meet an increasing demand, the fishery has subsequently expanded incorporating more distant feeding and nesting populations throughout the entire Indonesian archipelago involving large vessels and a complex network of hunters, traders and shippers.

In the Torres Strait (Fig. 1) a composite commercial and subsistence turtle fishery operates (Shug 1995). The subsistence component utilizes green turtles as a source of food particularly for traditional feasts and operates on a local level within each island community. The Islanders use small aluminum dinghies to catch turtles typically within a day's journey from their home village using small nets or traditional gear. The commercial component of this fishery is marketed through Daru in PNG with annual estimates of between 5,000 – 10,000 turtles (Limpus and Parmenter 1986, Groombridge and Luxmoore 1989). Compared to Bali, the Torres Strait fishery operates over a narrower geographic scale and takes substantially less turtles. In this paper we assess the impact of two green turtle fisheries, Bali and the Torres Strait. As the Bali fishery operates within a wider geographic range we expected a greater diversity of stocks contribute to this catch. We therefore incorporated samples from a distant feeding ground (Aru – Fig. 1) frequently visited by the Balinese fishery (Dethmers 1999). We used mtDNA markers that define 17 genetic stocks throughout the Australasian region (Moritz et al. 2002). Detailed pictures are beginning to emerge about the extent of these impacts from the cumulative results of decades of tag return data (C. Limpus pers. comm.). However, these studies can be limited by unequal tagging intensities of contributing stocks and thus the contribution of untagged or under-tagged stocks in fisheries remains elusive. By having a population rather than an individual focus, genetic studies compliment tagging studies by offering a means to infer broad geographic patterns of the extent and impact of a particular fishery on regional green turtle stocks.

METHODS

One hundred-ninety-nine Green turtle (*Chelonia mydas*) samples were analyzed from the Bali (n= 90) and Torres Strait (n=109) fishery and 40 from a feeding aggregation in Aru. DNA was extracted from skin tissue using standard salting out procedures. A 384bp fragment of mtDNA control region was PCR amplified using TCR5 and TCR6GC primers (modified after Norman et al. (1994) with the latter primer containing a 41bp GC clamp). To process large numbers of samples we used Denaturant Gradient Gel Electrophoresis (DGGE) to detect DNA variants and applied heteroduplex analysis to increase the sensitivity of this technique (Broderick and Moritz 1997). Representatives from each genotype/locality combination were sequenced using the ABI automated sequence facility following standard protocols for final verification and to test sensitivity.

A maximum likelihood model implemented in the software package SPAM (Alaska Department of Fish and Game 2000) was fitted to identify the mixture of contributing stocks that best explain the distribution of mtDNA variants at Bali, Torres Strait and Aru. A broad genetic survey of 28 breeding aggregations that identified 17 genetic stocks throughout the region (Moritz et al. 2002) was used as baseline data for this mixed stock analysis. The primary assumption of mixed stock analysis is that all of the potentially contributing stocks are known and adequately characterized. While we cannot entirely rule out the presence of unsampled stocks, we think it reasonable to assume that their presence is negligible given our extensive sampling and knowledge of green turtle rookeries throughout Australasia.

RESULTS AND DISCUSSION

The screening of the Bali, Torres Strait and Aru samples identified 10, 5 and 7 of the 24 mtDNA variants previously identified in Australasian genetic stocks and 3, 0 and 1 new variants, respectively (Table 1). The mixed stock analysis clearly demonstrated that different fisheries impact multiple stocks and that the extent of that impact differs between fisheries (Table 2). While there are substantial variances surrounding these estimates, they are useful to identify those stocks that are likely to be impacted by a particular fishery. The corollary, to identify those stocks that are not represented or barely so, is of perhaps equal management importance.

The Bali fishery comprises four major contributing stocks (>10%), Sulu Sea, Gulf of Carpentaria, Aru and PNG. With its expansive fishing grounds, the Bali fishery is impacting several stocks throughout the region with few stocks unaffected by this fishery. The Torres Strait fishery has a local focus and influences the NGBR stock, almost to the exclusion of all other stocks, a pattern is consistent with tag return data (Limpus et al. 1992). The Aru foraging area has three major contributors (Aru, PNG and NGBR) with approximately half of the recruitment into this population being sourced from the adjacent Aru genetic stock and a substantial proportion is being sourced from the PNG stock to the east. Despite their close proximity, contributions from adjacent stocks to the west appear to be minor. This diversity of stocks at a feeding ground contributes to the diversity of stocks in a catch.

An alternative way of looking at the impact of a particular fishery is ask how many stocks are required to explain say, 90% of the data. By ranking the estimates and calculating cumulative totals we find that 9 and 2 stocks are required to explain 90% of the data at Bali and Torres Strait respectively. This approach provides a relative measure of the geographic impact of each fishery. Not surprisingly, it is apparent that large fisheries (like

Bali) operating over expansive areas will have the greatest impact on the greatest number of genetic stocks. Fisheries that operate over restricted areas (like Torres Strait) will impact those stocks that are locally present, whether they be nesting or foraging. However, should the Torres Strait fishery expand, there is a reasonable expectation that it will begin to impact more stocks. One wonders about the capacity of the Bali fishery to expand any further, however if it continues on its eastward trajectory then the worlds largest fishery may begin to impact one of the worlds largest stocks, the NGBR.

This qualitative study allowed us to identify the geographic extent of the impact of turtle fisheries. The actual (i.e. quantitative) impact can only be elucidated when population sizes and catch figures are incorporated. Although we acknowledge that subsistence fisheries account for a substantial proportion of the turtles consumed throughout this region, we believe that an indigenous subsistence take of turtles is several-fold less likely to result in the extinction or severe depletion of a resource than its commercial counterpart. Efforts directed at limiting the turtle fisheries in this region may prove more successful if they focus on regulating commercial fisheries rather than intruding upon long established and socially significant patterns of indigenous turtle consumption. Moreover, because patterns of consumption are highly variable between communities, no single management strategy will be suited to all areas. However, there exists a continuum between subsistence and commercial fisheries and managers should be aware of emergent commercial fisheries. Subsistence fisheries, given the right set of circumstances, have the potential to evolve into a market driven fishery or to at least take on some of those characteristics.

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LITERATURE CITED

Alaska Department of Fish and Game. 2000. SPAM (Statistics Program for Analyzing Mixtures), V 3.2.

Broderick, D. and C. Moritz. 1997. Considerations for Mixed Stock Analysis Using MtDNA Markers. In: S.P. Epperly and J. Braun, comps. Proceedings of the Seventeenth Annual Sea Turtle Symposium. NOAA Tech. Memo. NMFS-SEFSC-415. p. 151-153.

Dethmers, K. 1999. The need for co-operation in conservation of SE Aru turtles. In: N. Pilcher and G. Ishmail, eds. Sea Turtles of the Indo-Pacific: Research, Management and Conservation. Universiti Malaysia Sarawak. Published by ASEAN Academic Press, Ltd., London. p. 107-115.

Jackson J.B.C. et al. 2001. Historical overfishing and the recent collapse of coastal ecosystems. Science 293:629-637.

Groombridge, B. and R. Luxmoore. 1989. The green turtle and the hawksbill turtle (Reptilia: Cheloniidae) world status, exploitation and trade. CITES, Lausanne, Switzerland.

Limpus, C.J. and J. Parmenter. 1986. The sea turtle resources of the Torres Strait Region. Proc. Torres Strait Fisheries Seminar, Port Moresby, p. 95-107.

Limpus C.J., J.D. Miller, J. Parmenter, D. Reimer, N. McLachlan, and R. Webb. 1992. Migration of green (*Chelonia mydas*) and loggerhead (*Caretta caretta*) turtles to and from eastern Australian rookeries. Wildlife Research 19:347-358.

Moritz, C., D. Broderick, K. Dethmers, N. FitzSimmons, and C.J. Limpus. 2002. Migration and genetics of Indo-Pacific marine turtles. Unpublished Final Report to UNEP/CMS.

Norman J.A., C. Moritz, and C.J. Limpus. 1994. Mitochondrial DNA control region polymorphisms: genetic markers for ecological studies of marine turtles. Molecular Ecology 363-373.

Salm, R.V. 1984. Sea turtle trade. WWF-IUCN. Bogor, p. 56.

Schug, D.M. 1995. The marine realm and the Papua New Guinean inhabitants of the Torres strait. SPC Traditional Marine Resource Management and Knowledge Information Bulletin 5:16-23.

Table 1. mtDNA variants detected among sampling locations.

	Haplotype																
n	A2	A3	B1	B3	C1	C3	C4	C5	C8	C9	Caru	D2	J1	J1738	J1764	J2396	J14191
90	0.01	0.18	0.02		0.06	0.21	0.06	0.04	0.02		0.24	0.12		0.01	0.01	0.01	
109	0.08		0.80	0.03						0.06			0.04				
40		0.23	0.10		0.08	0.05		0.03			0.48	0.03					0.03

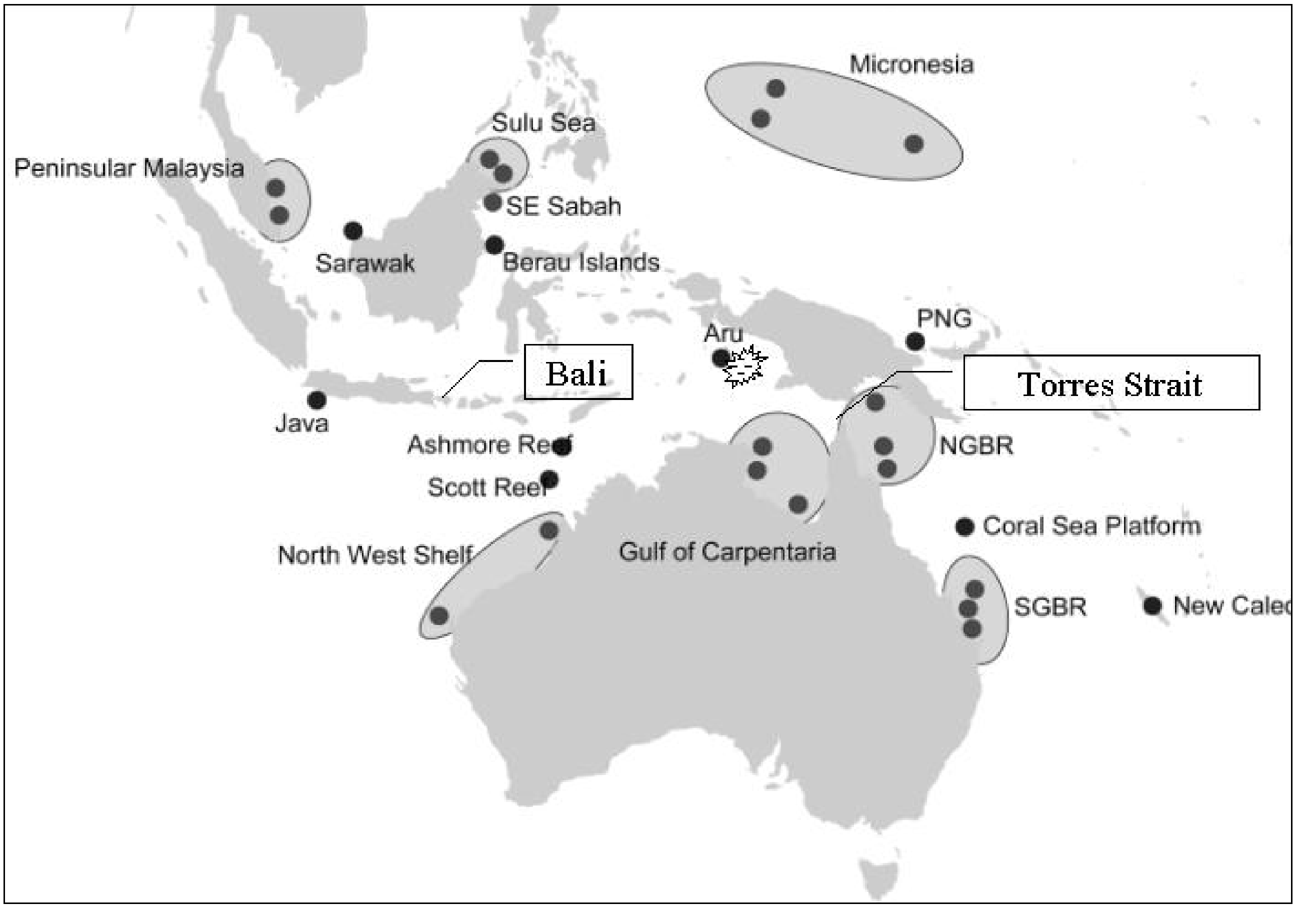

Fig. 1. Australasia with identified Management Units and sampling locations for this study.

Table 2. Proportion contributions of genetic stocks in Bali, Torres Strait and the Aru feeding ground.

Stocks	Bali		Torres Strait		Aru	
	Estimate	S.E.	Estimate	S.E.	Estimate	S.E.
Berau Islands	0.0539	0.0637	0.0000	0.0000	0.0335	0.0466
SE Sabah	0.0714	0.0732	0.0000	0.0000	0.0043	0.0170
Peninsular Malaysia	0.0064	0.0197	0.0000	0.0000	0.0018	0.0095
Sarawak	0.0437	0.0275	0.0000	0.0000	0.0000	0.0000
Sulu Sea	0.1141	0.0533	0.0000	0.0000	0.0217	0.0284
Gulf of Carpentaria	0.1254	0.0634	0.0000	0.0000	0.0060	0.0209
Aru	0.2425	0.0520	0.0000	0.0000	0.4933	0.0913
North West Shelf	0.0018	0.0085	0.0121	0.0259	0.0640	0.0475
Ashmore Reef	0.0839	0.0988	0.0002	0.0082	0.0514	0.0838
Scott Reefs	0.0018	0.0094	0.0466	0.0358	0.0029	0.0147
Java	0.0622	0.0570	0.0000	0.0000	0.0197	0.0350
Micronesia	0.0001	0.0003	0.0001	0.0031	0.0002	0.0031
PNG	0.1310	0.0698	0.0000	0.0000	0.1867	0.0917
Coral Sea Platform	0.0003	0.0013	0.0126	0.0307	0.0000	0.0002
NGBR	0.0204	0.0158	0.8765	0.1094	0.0967	0.0489
SGBR	0.0066	0.0090	0.0409	0.0384	0.0000	0.0002
New Caledonia	0.0020	0.0077	0.0266	0.0858	0.0018	0.0129
Other	0.0325		0.0000		0.0161	

Genetic population structure of leatherbacks in the Atlantic elucidated by microsatellite markers

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INTRODUCTION

The goals of most of the recent population genetic research on sea turtles have been to provide an understanding of stock structure and to identify molecular markers that can be used in mixed stock analysis. For leatherbacks, molecular analyses are critical due to a decline in breeding populations and current questions regarding the impacts of fisheries on these populations. Previous work has shown that mtDNA data by itself is inadequate for distinguishing many leatherback nesting populations in the Atlantic and Indo-Pacific (Dutton 1996, Dutton et al. 1999). The objective of this project is to incorporate nuclear DNA markers known as microsatellites, to resolve ambiguities in defining population structure among nesting populations of leatherbacks in the Atlantic and Indo-Pacific. Microsatellites are useful for assessing the genetic contributions of both males and females, unlike mtDNA analyses that are based only on maternal lineages. Using a combination of these multiple markers provides a broader picture of gene flow among populations and identifies relationships in natural populations that may enable a more useful definition of stock boundaries than one based on a single marker system.

METHODS AND RESULTS

Samples representing key nesting populations around the Atlantic/Indo-Pacific, including St. Croix, Costa Rica, Trinidad, Florida, Suriname/French Guiana (FG), West Africa, and South Africa (n=23-232) were screened using primers designed for 13 polymorphic microsatellite loci. Alleles (defined by fragment lengths) were quantified using the polymerase chain reaction (PCR) and polyacrylamide gel electrophoresis on an ABI 377 automated sequencer. There were significant geographic differences in allele frequencies at most loci, and unique alleles were present in different populations, as illustrated for locus LB133 that distinguished Suriname/FG and West Africa (Fig 1), and LB106, which showed similar differences between South Africa and St. Croix populations (Fig 2).

Statistical analyses were performed with data from all 13 loci combined using the computer program Arlequin (Schneider et al. 2000). Fst (Wright 1969) and Rst (Slatkin 1995) values were highly significant ($p < 0.001$) for the microsatellite data indicating population sub-structuring. Pairwise comparisons revealed significant differences between all of the populations except for between Trinidad and Suriname/FG. In contrast, Trinidad and Suriname/FG were significantly different ($p<0.001$) based on mtDNA data. Since mtDNA analysis reflects patterns of maternal gene flow, these results suggest that due to their geographic proximity, there is nuclear gene flow between Trinidad and Suriname/FG rookeries mediated by males mating with females from both areas. A tendency of females to home to natal beaches meanwhile maintains the genetic distinction between these two rookeries detected by the mtDNA analysis. This illustrates the importance of using both nuclear and mtDNA data to obtain a holistic analysis of stock structure.

CONCLUSION

Microsatellites show distinct population structure between nesting populations however limitations are possible when rookeries are geographically close. The combinations of both mtDNA and microsatellite data can be a useful approach for determining stock origin. A method to assign stock origin would give us the capability to address mixed stock analysis in bycatch, forage grounds, and strandings. Additional prospective applications include the ability to further identify and define individual management units and assess fishery impacts on specific stocks.

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LITERATURE CITED

Dutton, P.H. 1996. Use of molecular markers for stock identification, fingerprinting, and the study of mating behavior in leatherbacks. In: B.W. Bowen and W.N. Witzell, eds. Proceedings of the International Symposium on Sea Turtle Conservation Genetics. NOAA Tech. Memo. NMFS-SEFSC-396. p. 79-86.

Dutton, P.H., B.W. Bowen, D.W. Owens, A. Barragan and S.K. Davis. 1999. Global phylogeography of the leatherback turtle (*Dermochelys coriacea*). Journal of Zoology, London 248:397-409.

Schneider, S., D. Roessli, L. Excoffier. 2000. Arlequin ver.2.000: A software for population genetics data analysis. Genetics and Biometry Laboratory, University of Geneva, Switzerland.

Slatkin, M. 1995. A measure of population subdivision based on microsatellite allele frequencies. Genetics 139:457-462.

Wright, S. 1969. Evolution and the Genetics of Populations, vol. 2, p. 295, Chicago, University of Chicago Press.

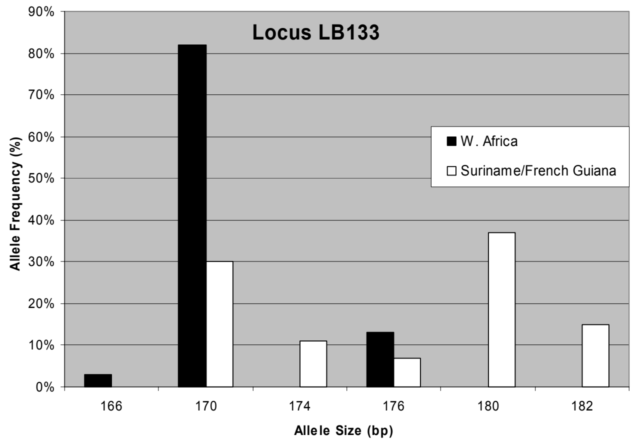

Fig. 1. Comparison of allele frequencies at microsatellite locus LB133 between W. Africa and Suriname/French Guiana (FG) nesting populations. Three alleles are only found in the Suriname/FG population (174 bp, 180 bp, 182 bp) and one is unique to the W. African population (166 bp).

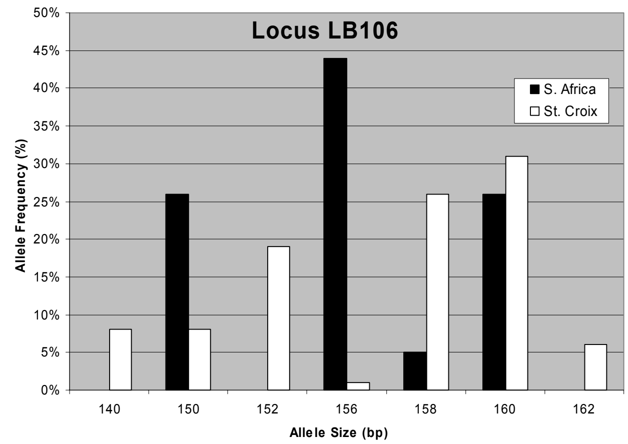

Fig. 2. Comparison of allele frequencies at microsatellite locus LB106 between S. Africa and St. Croix nesting populations. Three alleles are only found in the St. Croix population (140 bp, 152 bp, 162 bp). The most common allele (156 bp) in S. Africa is almost absent from the St. Croix population.

Pivotal temperatures of loggerhead turtles from Greece

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Eggs from two clutches of loggerhead turtles nesting at Kyparissia Bay, Greece, were transported to Toronto for assessment of the transitional range of temperature, pivotal temperature, and pivotal incubation duration. The results should help increase confidence of estimates of hatchling sex ratios in the Mediterranean. Some remarks will also be made about the assessment of pivotal temperatures, and relationships of pivotal temperatures for Greece to the values found in other parts of the world. Support came from the Natural Sciences and Engineering Council of Canada and the Sea Turtle Protection Society of Greece.

Two alternatives for improving studies of mating systems in marine turtles: a genetic approach

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Genetic studies have contributed greatly to knowledge of sea turtle biology. Molecular data has been applied to phylogenetics, population structure, inferring migratory behavior and the study of mating systems. We present results of new approaches to elucidating mating systems in the eastern Pacific green turtle, *Chelonia mydas*, using microsatellite data collected from nesting females and their offspring. We found evidence of multiple paternity in the Mexican nesting population sampled at Colola, Michoacan. The statistical model used to estimate probabilities of detecting alleles contributed by more than one father in a clutch has been flawed; we first apply a new approach of DeWoody et al. to reassess multiple paternity in this population and evaluate the precision of the results. A second approach involves estimation of the number of clutches that are required to be sampled in order to accurately assess multiple paternity, given the measured variability of the 3 microsatellite loci for this population. We make recommendations on the minimum sample sizes needed to optimize cost-benefits of paternity studies without losing statistical power.

Sea turtle captures at the St. Lucie nuclear power plant: a 25-year synopsis

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Over the last 25 years, thousands of sea turtles have been entrained into the St Lucie Nuclear Power Plant's intake canal. The plant is located on Hutchinson Island, Florida and operates two 850 net Mwe nuclear-fueled electric generating units. Ocean water is used for cooling and is drawn through three large diameter pipes into a 1,500 m intake canal. Sea turtles are pulled into this canal and, typically after one to five days, they are caught in tangle nets or hand captured. They are then measured, tagged and released. From May 1976 to November 2001, 7,795 turtles have been captured in the intake canal. Most have occurred in the last 10 years (70.3%). Loggerheads (*Caretta caretta*) make up the majority (57.4%) followed by green turtles (*Chelonia mydas*; 41.5%), Kemp's Ridleys (*Lepidochelys kempii*; 0.5%), Hawksbills (*Eretmochelys imbricata*; 0.4%) and Leatherbacks (*Dermochelys coriacea*; 0.2%). Almost all of these turtles have been in good condition (89.2%), but a few have been found dead (2.6%). Refinements in capture methodology has kept the mortality rate below 1% since 1990 even though the number of entrained turtles has risen dramatically. Through cooperative efforts with scientists and managers, we hope we can continue to decrease mortalities while providing essential information on these important nearshore populations.

How deep do hatchling green turtles swim?

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For the first few days after entering the water, hatchling green turtles swim near continuously in order to get as far away from land as possible, a behaviour termed the swimming frenzy. It is generally thought that hatchlings attempt to maximise their distance from land because of the high inshore predator abundance. Since hatchlings rely on stored energy reserves throughout their swimming frenzy, factors that reduce their cost of transport will similarly increase the distance covered during the frenzy. Hence, optimising their swimming depth would be expected to have a strong selective advantage by minimising the probability of mortality. As hatchlings swim both day and night during their frenzy and, as they are small, they do not swim very fast, direct observation of their swimming depths is possible. The swimming depth of 47 hatchling green turtles (*Chelonia mydas*) at Ascension Island was measured by direct observation. In support of predictions for the depth at which surface wave drag would be minimized, it was found that hatchlings tended to swim about 6 cm below the surface, which equals about 3 times their body thickness. This behavioural adaptation will reduce the cost of transport for hatchlings swimming offshore, allowing them to maximise their swimming distance before their limited energy reserves are exhausted.

Use of multiple orientation cues by juvenile loggerhead sea turtles

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Throughout their lives, sea turtles undergo extensive migrations that often take place across vast expanses of seemingly featureless ocean. Although the migratory feats of hatchling and adult sea turtles have attracted the most attention, juvenile turtles inhabiting temperate to sub-tropical inshore waters are also known to undergo lengthy migrations between summer and winter feeding grounds. While recent studies have yielded information regarding the sensory basis of hatchling sea turtle orientation, the cues used by both juveniles and adults to orient during their long-distance movements remain unknown. The comparatively small size of juvenile loggerheads and their relative abundance in the inshore waters of North Carolina has made it possible to begin studying their orientation. Juvenile loggerheads displaced from their capture sites in Core Sound, NC, and allowed to swim in a large, water-filled, orientation arena were found to exhibit consistent orientation in a preferred direction in the absence of familiar landmarks or chemical gradients. This behavior then made it possible to begin altering other sensory cues available to the animals to look for corresponding changes in orientation. Despite not having access to chemical information, juvenile loggerheads were able to maintain a consistent direction of orientation when either the magnetic field surrounding the anterior portion of the body was distorted or when the turtles were denied access to visual cues. However, when the turtles experienced a simultaneous disruption of magnetic and visual cues, their orientation was altered. These results show that juvenile loggerheads are capable of compass orientation and use a redundant system of cues to orient which involves both visual and magnetic information.

Why did the turtle cross the ocean? Pelagic red crabs and loggerhead turtles along the Baja California coast

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The loggerhead turtle (*Caretta caretta*) connects the entire Pacific basin through its developmental and reproductive migrations. Previous studies have demonstrated that the majority of *C. caretta* which occur off of California, USA, and the Baja California peninsula, Mexico are of Japanese origin, and in the midst of their transoceanic developmental migration (Nichols et al. 2000a, Bowen et al. 1995). Despite strong national and international laws and agreements protecting sea turtles and long-term protection efforts on nesting beaches, *C. caretta* numbers continue to decline. Annual censuses on Japanese beaches indicate a grave reduction in the number of nesting *C. caretta* between 1990 and 2000 (Kamezaki et al., in press).

In the northeast Pacific Ocean, *C. caretta* are found primarily along the 1,000 mile Pacific coast of the Baja California peninsula. Rich in nutrients due to upwelling, these waters host a variety of marine algae and invertebrates and once supported vast populations of five different sea turtle species. Hunting and bycatch of *C. caretta* has occurred along the peninsula for nearly a century, leading to severe depletion.

Baja California's shark and halibut fisheries are by far the greatest known cause of loggerhead turtle mortality in the North Pacific. These causes, plus poaching of loggerhead turtles, result in a mortality rate estimated to be in excess of 1,950 loggerhead turtles per year. Mortality off of the Baja California Peninsula is double that of all other reported North Pacific loggerhead turtle mortality sources combined (NMFS 2000).

The impact of this astounding mortality is exacerbated by the fact that loggerhead turtles killed off the Baja California peninsula are immature, and thus never get the chance to reproduce back in Japan. Sampling stranded, consumed, and live-captured loggerhead turtles off Baja California between 1994 and 2001, we found a mean straight carapace length (SCL) of 61.4 cm (N=606; SE=0.41; range 63.6cm). Stranded, consumed, and live-captured *C. caretta* were pooled because no significant differences in length-frequency were found between them. According to recent population modeling, mortality of sub-adult sea turtles does the most harm to populations (Heppell 1998).

Loggerhead turtles primarily feed on pelagic red crabs (*Pleuroncodes planipes*) off Baja California (Nichols et al. 2000b), which makes them especially susceptible to being caught in the nets and longlines of shark and halibut fishermen. Longline and gillnet fishing for sharks and halibut peaks in summer months when loggerhead turtles are most abundant off Baja California (Ramirez-Cruz et al. 1991). Loggerhead turtles are caught on hooks or entangled in nets and drown.

Stomach contents of seven loggerhead turtles collected near Bahía Magdalena, BCS, Mexico, contained only *Pleuroncodes planipes*. This finding echoes results reported by Villanueva that eighteen of nineteen loggerhead turtle stomachs from Baja California which he sampled contained only *P. planipes* (Villanueva 1991). The broad size range of juvenile loggerhead turtles found off the Baja California peninsula combined with their exclusive consumption of *P. planipes* suggests they may remain in the area for extended periods to feed on *P. planipes* before returning to Japanese waters as adults to breed. *P. planipes* is a critical diet component for loggerhead turtles during the North American coastal portion of their transoceanic developmental migration.

Loggerhead turtle movement data, sightings and stranding patterns suggest that foraging patterns off Baja California may be tightly associated with *P. planipes* reproduction and seasonal movement. *P. planipes* has been shown to be the most abundant micronektonic species in the area of the Baja California peninsula, one of the most important consumers of phytoplankton, and the most common prey for many marine vertebrates, includi ng cetaceans, pinnipeds, birds, fish, and two species of turtle in addition to *C. caretta* (Aurioles 1992).

In contrast, in the Central North Pacific (CNP), loggerhead turtles appear to be omnivorous, opportunistic predators of the neuston layer. Parker et al. (2000) report that stomach contents of loggerhead turtles caught in the Central North Pacific driftnet fishery include a wide array of floating organisms and organisms riding on floating objects such as the predatory gastropod (*Janthina*) species, its prey (*Velella velella*), gooseneck barnacle (*Lepas* species), and the pelagic crab *Planes cyaneus*. Through satellite tracking Polovina et al. (In Review and 2000) have shown that loggerhead turtles in the CNP associate with convergent fronts and eddies of high productivity, probably reflecting the distribution of their prey. Proposed trawling for *P. planipes* off the Baja California peninsula would disrupt the feeding of *C. caretta* as well as many other species which depend on *P. planipes*.

Selective feeding of juvenile loggerhead turtles off the Baja California peninsula on *P. planipes* may represent a shift in both feeding preference and foraging ecology. Elucidating the ecological relationships between loggerhead turtles and pelagic red crabs will be of importance in reversing the decline of loggerhead turtle populations of the North Pacific.

LITERATURE CITED

Aurioles-Gamboa, D. 1992. Inshore-offshore movements of pelagic red crabs *Pleuroncodes planipes* off the Pacific coast of Baja California Sur, Mexico. Crustaceana 62:71-84.

Bowen, B.W., F.A. Abreu-Grobois, G.H. Balazs, N. Kamezaki, C.J. Limpus and R.J. Ferl. 1995. Trans Pacific migrations of the loggerhead turtle (*Caretta caretta*) demonstrated with mitochondrial DNA markers. Proc. Natl. Acad. Sci. 92:3731-3734.

Heppell, S. 1998. Application of life-history theory and population analysis to turtle conservation.Copeia1998:367-375.

Kamezaki, N. et al. In press. Current status of Japanese loggerhead turtles, *Caretta caretta* . In: A. Bolten and B. Witherington, eds. Biology and Conservation of Loggerhead Sea Turtles, Smithsonian Institution Press.

National Marine Fisheries Service. 2000. Section 7 Consultation on Authorization to take Listed Marine Mammals Incidental to Commercial Fishing Operations under Section 101(a)(5)(E) of the Marine Mammal Protection Act for the California/Oregon Drift Gillnet Fishery. 2000.

Nichols, W.J., A. Resendiz, J.A. Seminoff, and B. Resendiz. 2000a. Transpacific migration of a loggerhead turtle monitored by satellite telemetry. Bull. Mar. Sci. 67:937-947.

Nichols, W.J., A. Resendiz, and C. Mayoral-Russeau. 2000b. Biology and Conservation of Loggerhead Turtles in Baja California, Mexico. In: H.J. Kalb and T. Wibbels, comps. Pro ceedings of the Nineteenth Annual Symposium on Biology and Conservation. NOAA Tech. Memo. NMFS- SEFSC-443. p. 169-171.

Parker, D.M., Cooke, W., and Balazs G.H. 2000. Dietary components of pelagic loggerhead turtles in the north Pacific Ocean. In: A. Mosier, A. Foley, and B. Brost, comps. Proceedings of the Twentieth Annual Symposium on Biology and Conservation. NOAA Tech. Memo. NMFS-SEFSC-477. p. 148-151.

Polovina, J.J., D.R. Kobayashi, D.M. Parker, M.P. Seki and G.H. Balazs. 2000. Turtles on the edge: movement of loggerhead turtles (*Caretta caretta*) along oceanic fronts spanning longline fishing grounds in the Central North Pacific, 1997-1998. Fish. Oceanogr. Vol 9.

Ramirez-Cruz, J.C., Ramirez, I.P. and Flores, D.V. 1991. Distrbución y abundancia de la tortuga perica, *Caretta caretta* en la costa occidental de Baja California Sur, Mexico. Archelon 1:1-4.

Villanueva, D. 1991. La tortuga perica *Caretta caretta gigas* (Deraniyagala 1939) en la costa de Pacifico de Baja California Sur, Mexico. Departamento de Biologia Marina. Univ. Autonoma de Baja California Sur, La Paz, BCS, Mexico. Tesis de Licenciatura. 68 p.

Movement and dive behavior determined by satellite telemetry for male and female olive ridley turtles in the Eastern Tropical Pacific

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Olive ridleys have a worldwide distribution in mainly tropical areas. Nesting occurs along continental margins in all oceans. The largest nesting areas in the Eastern Pacific are along the coasts of Mexico and Costa Rica. Many studies have been done on nesting populations and movement from the nesting grounds, but few studies have been done on the movement of olive ridleys in the open ocean (Plotkin et al. 1994, Beavers and Cassano 1996). This paper summarizes the movement and dive behavior of male and female olive ridleys tracked during 1999-2000.

Satellite-linked Time-Depth Recorders (SDRs, Wildlife Computers) were deployed on eight olive ridley turtles, four adult females, three adult males, and one juvenile, during the 1999 *Stenella* Abundance Research Survey (STAR) in the Eastern Tropical Pacific. Turtles were spotted from NOAA ships traveling set course lines. Small boats were deployed to capture turtles rodeo style by hand, and turtles were brought back to the ship for measurements and satellite attachment. The SDRs were attached using fiberglass cloth and polyester resin based on the methods by Balazs et al. (1996). Dive data from the SDRs were compiled using Wildlife Computers SatPak30 and duration of dives and time-at depth were examined. The time-at-depth bins recorded the amount of time spent at each preset depth. Three of initial SDRs were programmed with parameters starting at 1-meter (m) depth (depth histogram bins: 1, 5, 10, 15, 20, 25, 30, 40, 50, 60, 80, 100, 150, 150+ meters). However, since an objective for this on-going study was to be able to link the dive data with visual surveys, the parameters were changed. The final five SDRs were programmed to include a bin that specifically counted time on surface (depth histogram bins: 0, 1, 5, 10, 15, 20, 30, 40, 50, 60, 80, 100, 150, 150+ meters). However, for purposes of analysis in this presentation, the 0 and 1 meter depth bins were combined for these five SDRs so the data could be compared to the previous three. T-test analyses were done to determine significant differences in dive behaviors between male and female turtles.

The movements of all of the olive ridleys are seen in Fig. 1. The three mated female olive ridleys moved directly to or offshore of a major nesting area. The two males captured mating with two of the females were seen to continue to move along the coast. The non-mating female and male both stayed offshore. While all of the turtles recorded a high percentage of short dives, 60% of the dives were 2 min or less in duration, table 1 shows the maximum dive duration for each turtle. The average of the longest dive time for females was 120-180 minutes, 75 minutes for males, and 45-60 minutes for the one juvenile. There were no significant difference between male and females for any of the dive duration bins.

Visual observations of olive ridleys at sea have indicated that they may spend a large amount of their time on the surface. Average time-at-surface calculated for the five SDRs that recorded 0-m data indicated surface times of 10-22%, and even with depths to 1-m included, times near the surface were still low, 19-44%. However, daily, diurnal and variations between turtles were seen. Daily time-near surface averages ranged between 10 and 50%, and this varied between turtles. A diurnal dive behavior was seen where most turtles spent more time near the surface during daylight hours, which were between 9am-2 pm, between 22-56% (mean of 37%) of the total dive time was spent near the surface during this 6-hour period. There was no difference seen for time spent near the surface between male and female turtles.

There were no significant differences in time-at-depth and dive duration between turtles that had mated and not mated. Although all turtles had the opportunity to make deep dives, the mated females and males did not make dives greater than 150m, even while over open ocean. The non-mated, pelagic male and female both made dives greater than150m with a number of dives over 200m, some which registered at the limit that the SDR could record (250m). On the other hand, a mated female that had moved inshore and possibly nested spent 6 months off the coast of Nicaragua. During that time, it stayed in waters that were less than 150m in depth and made regular dives to depths that would have reached the bottom - possibly either resting or foraging on the bottom.

Fig. 2 shows the average time-at-depth profiles for female and male olive ridley turtles. Females spent significantly more time at 40 and 80m depths than did males. It has been shown by Donguy and Meyers (1987) and also Fiedler (1992), that within the Eastern Tropical Pacific there is a permanent thermocline between 20 and 100m (around the 20° C isotherm). All of our adult turtles spent significant amounts of time, at least 25% of total dive time, in the area of the thermocline.

An SDR transmitter put on only one juvenile turtle unfortunately had a very short track, only 5 days in length. The juvenile stayed near shore in waters that were between 100 - 200m in depth. During the track, the daily and diurnal differences in time spent near surface were similar to that of the adult turtles, but there were visual differences between the juvenile and adult dive profiles. The juvenile made no dives greater than 80m even though it was in water where deeper dives could be made, and 75% of its time was spent within 10m of the surface.

In conclusion, the low average times that the turtles spent near the surface were a combination of diurnal and daily difference in dive behavior. Female olive ridleys in this study spent significantly more time at 40 and 80 meters than did the males, and the thermocline is an important foraging area for the olive ridley as both male and female turtles spent a significant amount of time in the region of the thermocline - between 20-100m. The significance of these findings are that the data obtained for time at surface when taking into account the diurnal variability will be able to be combined with observers visual counts to gain a better estimate of pelagic numbers of olive ridleys in the Eastern Tropical Pacific. Also the information on dive depths and behavior can be also be used as a tool to help mitigate and reduce bycatch in fisheries.

LITERATURE CITED

Balazs, G.H., R.K. Miya, and S.C. Beavers. 1996. Procedures to attach a satellite transmitter to the carapace of an adult green turtle, *Chelonia mydas*. In: J.A. Keinath, D. Barnard, J.A. Musick, and B.A. Bell, comps. Proc. of the Fifteenth Annual Symposium on Sea Turtle Biology and Conservation, NOAA Tech. Memo. NMFS-SEFSC-387. p. 21-26.

Beavers, S.C. and E.R. Cassano. 1996. Movements and dive behavior of a male sea turtle (*Lepidochelys olivacea*) in the eastern tropical Pacific. Journal of Herpetology 30:97-104.

Donguy, J.R. and G. Meyers. 1987. Observed and modeled topography of the 20°C isotherm in the tropical Pacific. Oceanol. Acta 10:41-48.

Fiedler, P.C. 1992. Seasonal climatologies and variability of eastern tropical Pacific surface waters. NOAA Tech. Rep., NMFS 109

Plotkin, P.T, R.A. Byles, and D.W. Owens. 1994. Post-breeding movements of male olive ridley sea turtles *Lepidochelys olivacea* from a nearshore breeding area. In: K.A. Bjorndal, A.B. Bolten, D.A. Johnson, P.J. Eliazar, comps. Proceedings of the Fourteenth Annual Symposium on Sea Turtle Biology and Conservation, NOAA Tech. Memo. NMFS-SEFSC-351. p. 19.

Table 1. Maximum dive duration recorded for four female, three male, and one juvenile olive ridley turtles. Data were received from satellite time-depth recorders attached to each turtle before release during the 1999 Stenella Research Cruise in the Eastern Tropical Pacific.

Turtle ID	Sex	Maximum Dive Duration
21128	Female	60 - 75 minutes
21130	Female	120 - 180 minutes
21136	Female	180 - 240 minutes *
24645	Female	120 - 180 minutes
21129	Male	75 – 90 minutes *
21138	Male	60 - 75 minutes
21143	Male	60 - 75 minutes
24644	Juvenile	45 – 60 minutes

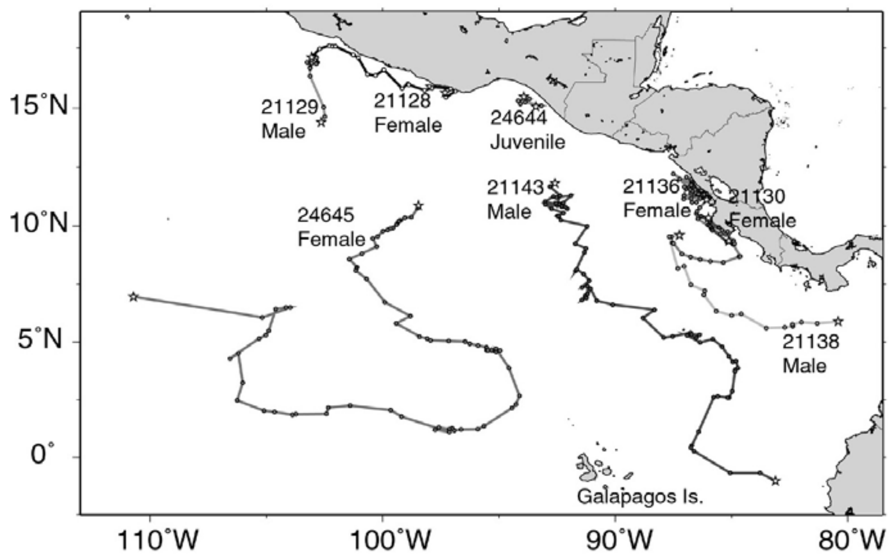

Fig. 1. Map of the movement of eight olive ridley turtles (four female, three male, and one juvenile) that were released with satellite time-depth recorders during the 1999 Stenella Research Cruise in the Eastern Tropical Pacific.

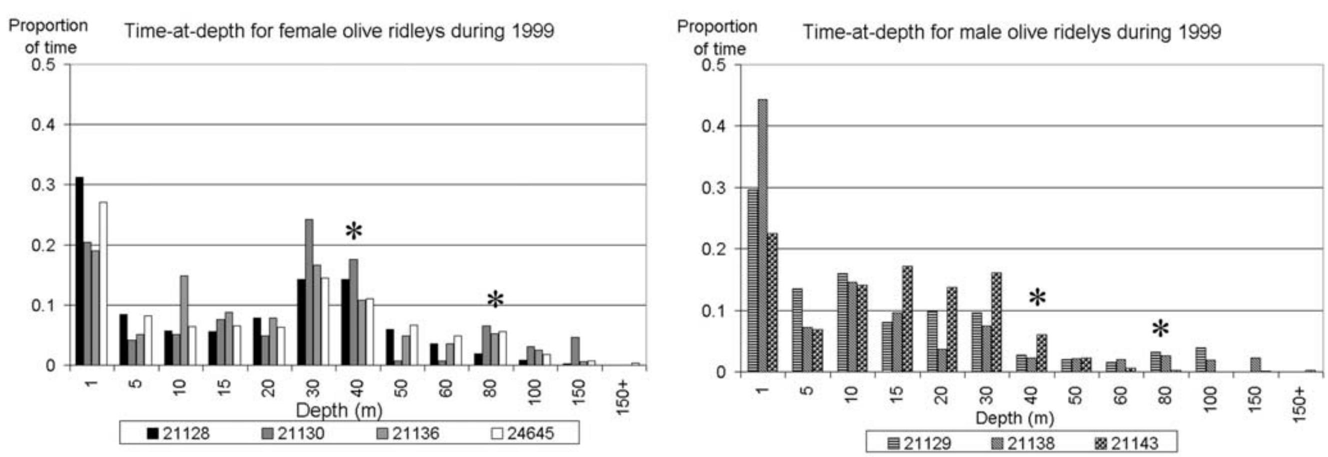

Fig. 2. Average time-at-depth dive profiles for four female (left) and three male (right) olive ridleys during 1999-2000. Time-at-depth was averaged for each depth bin over the complete track of an individual turtle (one bar indicates one turtle). Significant differences ($p<0.05$) were found between male and female turtle's time-at-depth for the 40 and 80-m depth bins shown by an asterisk.

Tracking olive ridley turtles from Orissa

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INTRODUCTION

Current knowledge of sea turtle life history suggests that individual turtles occupy a series of different habitats during the course of their life cycles. Satellite telemetry and other modern techniques have made it possible to monitor the movements of free ranging sea turtles on the open oceans.

The olive ridley sea turtle, *Lepidochelys olivacea,* nests in low densities all along the Indian coast. However, the most important nesting beaches lie in Orissa where these turtles are known to nest en-masse. There are three mass nesting sites at Rushikulya, Devi River Mouth, and Gahirmatha in Orissa (Pandav et al. 1994). Olive ridleys arrive in the coastal waters off Orissa by early November and are thought to spend nearly six months before leaving, evidently returning to their feeding areas. So far, little is known about the feeding areas of the ridleys using the Orissa coast for nesting. However, we still have no definite answer about the non breeding area of this olive ridley population that migrate every winter to nest in Orissa, much less the routes used by the turtles to travel from the nesting beaches.

The results presented here include reviews of tagging and molecular genetic studies and a recent exercise on satellite telemetry of olive ridleys in Orissa.

METHODS

Satellite telemetry. Four Kiwisat 101 transmitters (Sirtracks Ltd, New Zealand) were employed for this study. The specifications selected were: 1 Watt transmissions, 30 second repetition rates, 2 lithium D cells, 8-bit temperature sensor, two, 8-bit "surface-time" counter, "surface-time" data to be reported in four 6-hour categories, duty cycle to be 24 hours on for first two weeks, followed by a 72-hour cycle of 24 hours on/48 hours off until the end of the transmission. The transmitters were attached at the end of April to minimize the chance of turtle mortality due to trawling. Between 18 and 21 April 2001 four satellite transmitters were attached to each of four female, post-nesting olive ridley sea turtles from the nesting beach south of Devi River mouth, Orissa. The transmitters were attached to the carapace of the turtles using Epoxy.

Tagging. Over three years, 10,000 nesting females were tagged at the three mass nesting sites in Orissa, Gahirmatha, Rushikulya and Devi mouth. At Gahirmatha, 1,500 mating pairs were captured using a locally designed fishing net and tagged. All animals were double tagged using monel tags (for details, see Pandav et al. 2001).

Molecular studies. Tissues were collected from mating pairs and nesting females in Orissa and from hatchlings at Madras, further south on the east coast of India. Mitochondrial DNA sequencing and microsatellite analysis was carried out on samples from Orissa and Madras (for details, see Shanker et al. 2000).

RESULTS

Satellite telemetry. We received 48 to 114 days of data on the 4 turtles, with 25 to 88 high quality location points. Initially, the turtles moved into offshore waters and seemed to be moving randomly. It then became clear that 3 of the turtles were moving in large circles off the coast of Orissa and northern Andhra Pradesh. After that, one of the turtles began to move south towards Sri Lanka. This turtle then swam 1000 km in 18 days to reach the coast of Sri Lanka (Fig. 1). The turtles swam a total of 1300 to 2900 km, but they all averaged about 25 to 30 km per day despite differences in daily and monthly travel rates. The turtle that swam to Sri Lanka achieved rates of about 150 km per day during her migration south. In July and August, the transmissions ceased suddenly for each of the 4 transmitters. Though there are several possible causes -failure of transmitter, failure of battery, method of attachment, and damage to antenna - it seems likely that the high fishery related mortality of turtles on the coast of Orissa may be the cause.

Tagging. There were 20 long distance tag returns from Sri Lanka and the Gulf of Mannar region in southern Tamil Nadu. 80% of these tag returns were from Sri Lanka and most of them, interestingly, were during the breeding season.

Molecular Genetics. Both mitochondrial DNA sequencing analysis and microsatellite analysis has shown that ridley turtles do not exhibit strong population structure on the east coast of India (Shanker et al. 2000). However, the sequencing analysis suggests that Indian ridleys may have served as an evolutionary source for global populations of olive ridleys (ibid.). Current projects are examining ridleys from a wide variety of sources in the Bay of Bengal and Indian ocean.

DISCUSSION

The tagging data demonstrates that ridley turtles that nest in Orissa migrate to southern Tamil Nadu and Sri Lanka during the non-breeding season. The occurrence of tagged turtles in these waters during the breeding season and the absence of population genetic structure raises questions about the precision of natal homing in these turtles. However, it is the satellite telemetry study that provides evidence about the exact migratory route taken by turtles, including important data such as travel rates and offshore distance from the coast. Another important finding is that ridley turtles occur in Orissa and northern Andhra Pradesh waters during the post nesting period. During their post nesting movement, they may come into nearshore waters (within 30 km) and are thus vulnerable to trawling related mortality. Considering that all four turtles are believed to have fallen prey to trawling related mortality, the results also highlight the threats to this population. More than 75,000 turtles have been counted dead in the last years on the Orissa coast (Pandav and Choudhury 1999, Kar 2001), and this situation needs to be remedied at the earliest.

In evaluating this and future projects, one has to evaluate the relative merits and demerits of satellite telemetry and other tools for studying sea turtles. Ideally, a combination of methods would help to answer questions about the biology and conservation of sea turtles. However, one additional factor that needs to be considered is the conservation importance of scientific studies. These studies cannot be judged on the success of scientific aspects alone. In this study, much was gained from the awareness and training programs associated with the telemetry exercise. Local communities, local governmental agencies and biologists were addressed during the course of the exercise. In addition, a lot of publicity and awareness was generated through coverage in national newspapers and TV channels. TV channels carried updates on the telemetry over a few months. A website was set up giving the movements of the turtles and this was also frequently visited.

In summary, we learnt some very important lessons from this small data set and also achieved some good results with regard to the awareness and publicity associated with the telemetry exercise.

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LITERATURE CITED

Kar, C.S. 2001. Review of threats to sea turtles in Orissa. In: K. Shanker and B.C. Choudhury, eds. Proceedings of the National Workshop for the Development of a National Sea Turtle Conservation Action Plan, Bhubaneshwar, Orissa. Wildlife Institute of India, Dehradun, India, p. 15-19.

Pandav, B., B.C. Choudhury, and C.S. Kar. 1994. A status survey of the olive ridley sea turtle (*Lepidochelys olivacea*) and their nesting beaches along the Orissa coast, India. Wildlife Institute of India, Dehradun.

Pandav, B. and B.C. Choudhury. 1999. An update on mortality of olive ridley sea turtle in Orissa, India. Marine Turtle Newsletter 83:10-12.

Pandav, B. 2001. Conservation and management of olive ridley sea turtles on the Orissa coast. Ph.D. Thesis, Utkal University, Bhubaneshwar India.

Shanker, K., R.K. Aggarwal, B.C. Choudhury, and L. Singh. 2000. Conservation genetics of the olive ridley (*Lepidochelys olivacea*) on the Orissa coast: A Report. Wildlife Institute of India, Dehradun, India.

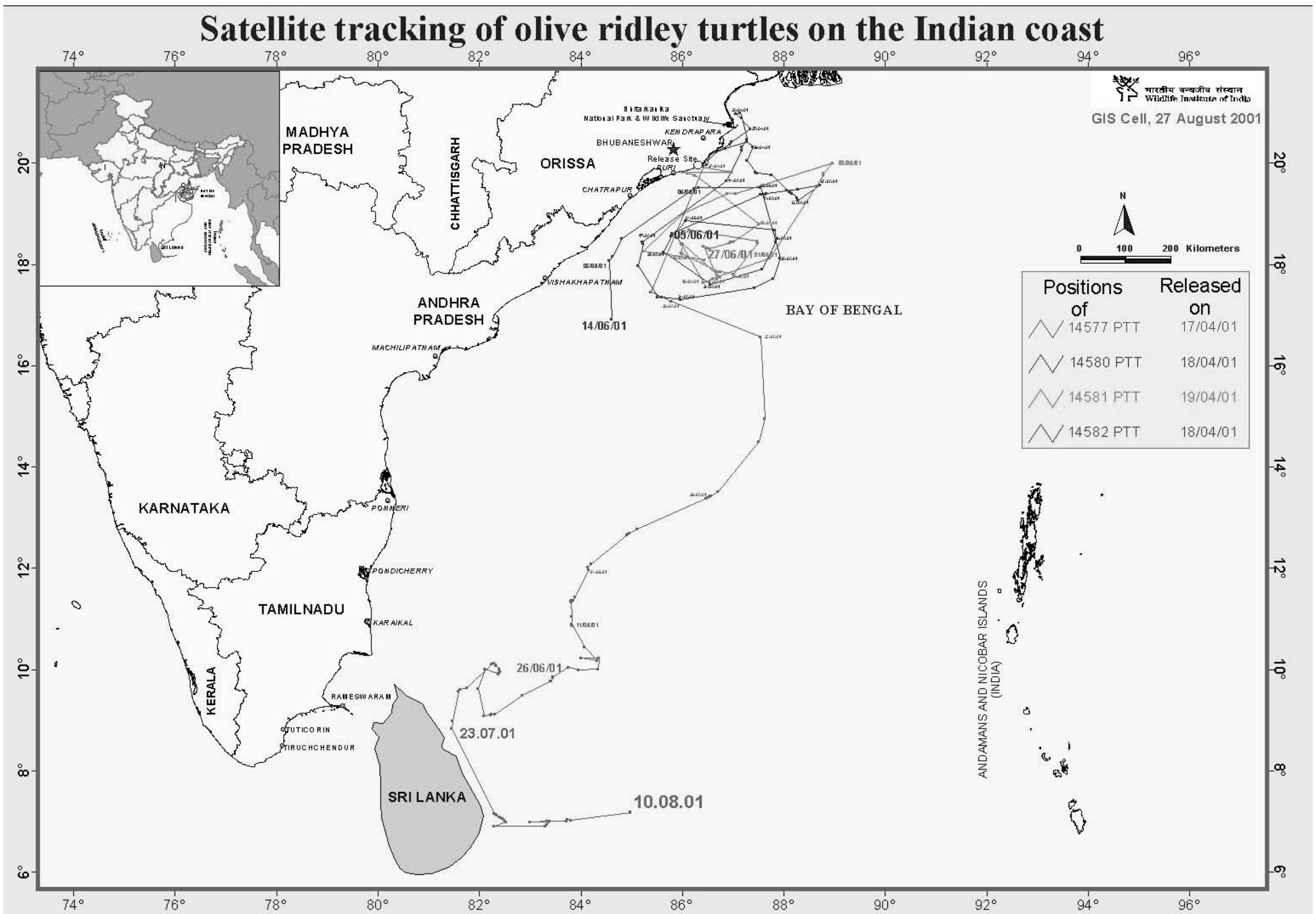

Fig. 1. Satellite tracking of four olive ridley turtles along the east coast of India from April to August, 2001.

Overwintering behavior of green turtles in the Mediterranean

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On the east and west coasts of America, green and loggerhead turtles have been observed performing long benthic resting dives as part of their overwintering strategy. However seasonal movement to warmer waters is also seen in these areas showing that these turtles display a variation in overwintering strategies. In the Mediterranean, turtles cannot migrate southwards indefinitely to avoid colder conditions since this is an enclosed sea. Hence if cold-water conditions persist in winter even in the southern Mediterranean, then we would predict that long dives to the seabed may be a fundamental component of the turtles' overwintering strategy. Satellite transmitters attached to 3 green turtles in the Mediterranean recorded dive data and water temperature during the post-nesting migration, and then for periods of between 197 and 282 days at the foraging grounds. For the 3 turtles, 626, 440 and 653 dive data histograms were received whilst at their foraging grounds. All 3 turtles had specific home ranges once they reached the foraging grounds, but then showed a distinct change in behaviour during winter: moving either into deeper water or a different area along the same coastline and conducting very long (at times >90 min) dives. Dive duration is expected to vary with respect to dive depth, activity and water temperature, and the relative roles of these factors were explored. Long-term temperature records (1855-present) were used to examine whether the environmental conditions were typical in this study year and if long-deep dives are routine for overwintering green turtles in the Mediterranean.

Insights into migration and foraging behavior of Mediterranean loggerhead turtles using satellite telemetry

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Knowledge of the biology of loggerhead turtles (*Caretta caretta*) in the Mediterranean other than on nesting beaches is severely lacking. Satellite telemetry offers the opportunity to define migratory corridors and identify foraging grounds but to date, beyond a very early tracking of a female loggerhead in the interesting interval (Hays et al. 1991), tracking studies have been limited to post-nesting green turtles (Godley et al., in press) and loggerhead turtles released from a rehabilitation facility (Bentivegna 1998). In this study, two nesting females were equipped with Argos linked tracking units (Telonics ST 6) allowing the derivation of both positional information, surfacing patterns and environmental temperature. The turtles were tracked for 60 and 81 days giving 258 and 80 positional fixes, respectively. These data allowed reconstruction of post-nesting migratory routes, location of foraging grounds and confirmed that females demonstrated foraging site fidelity, at least within the time frame of transmitter life. Surfacing patterns were described during migration and at the foraging sites and related to environmental parameters and current knowledge of loggerhead physiology.

Initial realities in the analysis of ARGOS satellite telemetry data

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As the world of sea turtle biology becomes increasingly aware of the limitations in concentrating efforts on nesting beaches alone, the application of Argos satellite telemetry to biology and conservation efforts has become a popular albeit expensive tool. Satellite telemetry allows sea turtle biologists to better assess and understand ecological requirements and conservation concerns of the each species or population of study that would not otherwise be possible. Assessing where turtles go when they leave the nesting beaches and their ecological needs both en route and at the foraging grounds are crucial gaps in our collective understanding of these species. While the development of satellite telemetry as a critical tool of sea turtle biology is important, so is an understanding that analysis of telemetry data received from Argos is not straightforward.

Currently, we are performing an analysis of home range within foraging grounds of seven hawksbill sea turtles, *Eretmochelys imbricata*, originating from nesting beaches in Antigua and Jamaica. During the process of data analysis and literature review, several factors of importance surfaced. The following is an account of initial concerns encountered during investigation.

Data received by Argos is based on "hits" or 'verified' locations of the animal and contain multiple parameters that relate to the quality of the location estimation. The significance of these quality parameters are often only taken into mild consideration in analyses due to either a lack of understanding of parameter implications or the necessity to retain a sufficient sample size. Quality parameters are derived according to the number of satellites used in achieving a location estimation and the angular positioning of those satellites (Argos 1999). Ultimately, the quality of location estimations is beyond the control of the researcher and dependent upon the behavior of individual animals. Turtles display among and with-in individual variation in the manner and duration of surfacing events. This surfacing behavior determines the amount of time that the satellites have to receive transmissions. (Plotkin 1998). Generally, using a greater number of satellites increases the accuracy of the estimation. Additionally, the effect of the actual transmitter on the animal must be considered (satellite, Frazier 1998; radio, White and Garrott 1990).

Important to consider are the objectives of the study and the scale of the investigation. In other words, how much precision is necessary to answer the question? With our study of foraging ground behavior, a higher level of precision is required compared to what a study focusing only on overall migratory routes would require. The researcher must determine the level of accuracy necessary to appropriately answer the research question. The primary indicator of location accuracy is the "confidence level." There are four levels of confidence (LCs 3,2,1,and 0) with associated accuracy estimates ranging from a radius of <150 m up to >1000 m. Additionally, two location classes (LCs A and B) provide "no estimate of location" and one (LCZ) yields "invalid locations." (Argos 1999) The methods for rejecting 'quality' hits of insufficient accuracy become problematic as the bulk of hits received often fall under this classification due to the fact that turtles spend only small amounts of time at the surface. Here, the term quality hit is used to refer to all hits that are not duplicates, obviously outside the possible range of the animal in question- like on land, or hits where the speed of travel was not biologically possible.

When trying to perform analyses such as the determination of foraging ground home ranges, acceptance of hits becomes particularly problematic due to the accuracy deemed necessary by the scale and nature of the question. Discarding entire sets of points is often not an option. Therefore, to maximize the level of precision of analysis while minimizing the number of rejected points, a balance is needed that is not pre-determined by similar studies. Thus, researchers must look to other parameters for an understanding of the hit quality. Additional indicators to assess include the quality index, the number of messages received by the satellite, the pass duration, and best level. The IQ, or quality index, is a two-digit response in which the first digit represents the residual error on frequency calculation and the second digit pertains to the oscillator drift between satellite passes. In both instances, the higher the number, the higher the level of accuracy of the transmissions. Next, the number of messages received by the satellite is followed by the number of these passes having a strength >-120 decibels and can be useful as secondary indicators of transmission quality. Also "best level", which represents the strongest signal strength received for the transmissions and "pass duration", the time elapsed between the first and last message received by the satellite, can be used as indicators (Jennifer Sparks, Argos, pers. comm.)

The last aspect of consideration in analysis is the accuracy of the maps and other data layers used when plotting the location data. This obviously becomes more importation as the scale of the question decreases and a more detailed level of analysis is required. For example, the accuracy of available bathymetric maps throughout the Caribbean region has put constraints upon foraging ground analysis. This is likely a similar problem in many other parts of the world particularly around oceanic islands. Data that is included in analysis, like bathymetry, needs to be thoroughly analyzed to ensure accuracy and reduce the propagation of error.

It would be overly exhaustive to attend to each and every of these parameters for each hit of every study. Therefore, taking the requirements of the experimental objective into consideration, the researcher can determine which indicators will be the most useful in allowing for maximum precision of the data at the level of detail appropriate for analysis. While the accuracy of technology increases with further development, it should be recognized that, as scientists, there must be an awareness of the constraints of the tools that are being used to draw 'conclusive' results. In the absence of such awareness, many resources could be wasted and information that does not adequately portray the ecology of these species could to be used by policy-makers worldwide in drafting management strategies of these international migrators. With the present day concerns about potential sea turtle declines at population, regional, or global levels, the sea turtle community can not afford data misinterpretation. Satellite telemetry is a tool that is revolutionizing what can be learned about the marine stages of adult turtles. However, in light of this revolution, discretion and care must be taken. It is through the retention of this discretion that biological information will be produced that can successfully contribute to the conservation of these species.

Acknowledgements. We would like to thank first and foremost George Balazs and Barbara Schroeder for making possible the Caribbean Hawksbill Research Tracking Project (1998-1999); Jim Richardson for the collection of Antigun hawksbill telemetry data and also for the application of the transmitters to four hawksbills on Jumby Bay, Antigua; Andrea Donaldson for the application of transmitters to four hawksbills in Jamaica; Thelma Richardson for the organization of a database; and Kevin Samples for GIS technical support in the face of these encountered difficulties.

LITERATURE CITED

Argos. 1999. User's Manual. Toulouse: CLS/Service Argos.

Britten, M.W., P. Kennedy, and S. Ambrose. 1999. Performance and accuracy evaluation of small satellite transmitters. J. Wildlife Management 63:1349-1358.

Frazier, J.A. 1998. Chelo-telemetry: more on great Chelonian taboos. In: Proceedings of the 18th Annual Symposium on Sea Turtle Biology and Conservation. NOAA Tech. Memo. NMFS-SEFSC-436. p. 97-99

Hays, G., S. Akessont, B.J. Godley, P. Luschi, and P. Santidrian. 2001.The implications of location accuracy for the interprettation of satellite-tracking data. Animal Behavior 61:1035-1040.

Plotkin, P.T. 1998. Interaction between behavior of marine organisms and the performance of satellite transmitters: a marine turtle case study. Marine Technology Society Journal 32:5-10.

Vincent, C., B.J. McConnell, V. Ridoux, and M.A. Fedak. 2002. Assessment of Argos location accuracy from satellite tags deployed on captive gray seals. Marine Mammal Science 18:156-166.

White, G.C. and R.A. Garrott. 1990. Analysis of Wildlife Radio-Tracking Data. Academic Press, Inc. Boston.

Migration routes and dive patterns of post-nesting hawksbills from the Pearl Cays, Nicaragua

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Four post-nesting hawksbills were satellite tracked from the Pearl Cays, Nicaragua in 2000 and 2001. In addition to identifying resident foraging sites and migration routes we were also interested in characterizing dive patterns and using the opportunity to raise awareness and educate Nicaraguans about sea turtles. More than 80 local, regional, and central government personnel, coastal community leaders and local fishers; and students and teachers from a nearby school participated in the two satellite deployment events. Prior to the release of each turtle, participants named the female and a small paper flag of Nicaragua was attached to the shell. We found this to be an excellent opportunity to increase the public's awareness and interest in sea turtle biology and conservation issues.

All four turtles traveled in a northeasterly direction from the Pearl Cays. Three of the turtles settled in the same general vicinity in the offshore waters of central Nicaragua. The forth turtle migrated farther to the northeast and settled on the edge of the continental shelf, east of the Nicaragua/Honduras border. Distances and average daily speeds traveled were presented, as well as comparisons between dive durations in-transit versus at the resident foraging site, and diurnal versus nocturnal dive durations at the resident foraging site.

Results from these satellite tracked hawksbills show that Nicaragua's Caribbean coastal waters harbor critical foraging habitat for the Pearl Cays rookery, and possibly for other rookeries in the region. In addition, there is a distinct migratory route used by at least part of this population. Thus, disturbance or destruction of foraging habitat from activities such as oil exploration and extraction, and lobster divers could have detrimental affects to the Pearl Cays population, probably the largest remaining hawksbill rookery in the central-western Caribbean.

Acknowledgments. We would like to thank Jefferson Arteta for his hospitality, and Liza González and the Ministerio de Ambiente y los Recursos Naturales for their support and providing us with the necessary permits to conduct this study. Logistical support was provided by DIPAL (a Dutch government aid project), CAMP-LAB, and Acciones Medicas Cristianas. William McCoy would like to thank the David and Lucile Packard Foundation, National Fish and Wildlife Foundation, the Sea Turtle Symposium International Travel Grant Committee, and the Wildlife Conservation Society for their financial assistance for him to attend this year's symposium.

Caribbean round-trip ticket: the migration behavior of female hawksbill turtles recorded using data loggers

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This study was conducted between 1999 and 2001 at Buck Island Reef National Monument, a small protected island off St. Croix, US Virgin Islands. In August and September 1999, shortly before the end of the peak nesting season, six nesting Hawksbill Turtles were equipped with time-depth recorders (Mk7, Wildlife Computers). Data on light intensity and depth were recorded at intervals of 30 sec. while the temperature was measured every 900 sec. Recording was duty cycled (two days on, four days off), so that the memory lasted from the end of the 1999 nesting season to the approximate beginning of the 2001 nesting season. The TDRs were fixed to the protruding keratinous serrations of the posterior marginal scutes (No. 10 and 11) using stainless steel bolts and epoxy. Based on the long term tagging and monitoring data of the National Park Service, four of the six turtles in this study were expected to remigrate after a 2-year interval. Lacking 2-year candidates, we equipped two additional females that showed a 3-year pattern.

Between July and September 2001, the four turtles scheduled to return were observed nesting at Buck Island, three of them still carrying devices that were immediately removed. GLS-analysis (Global Location System) using the light data of turtle QQD 280 revealed that most of the positional readings during the 2 year remigration interval were off the south-eastern coast of Puerto Rico. The turtle thus traveled a minimum distance of 260 km between the two successive nesting seasons at Buck Island. First analysis of the depth data of QQD 280 revealed patterns in dive activities during different phases of the remigration interval (Fig. 1). The shape of the dives (Fig. 2) as well as the time spent at depths (Fig. 3) were taken into account. U-dives were characterized by a distinct bottom phase between descent and ascent, during which resting may occur, while V-dives lacked any prolonged stay at any depth level. S-dives were defined as dives where a plateau in time at depth gave the ascent an s-shape, whereas several plateaus at different depth levels occurred in P-('Plateau-')dives. All dives that could not be classified through the described definitions were grouped together as D-('Diverse'-)dives. The latter are mostly shallow (5 m or less) and of short duration. V-, S-, P- and D-dives are considered active dives.

Fourteen days after deployment of the device on QQD 280 the turtle was seen nesting again. The depth data for this period represent the inter-nesting dive behavior, characterized by a high percentage of similar U-shaped dives to medium depths of 10 to 15 m. Irregularities in this patterns occurred after reentering the water as well as during the two nights prior nesting, when very shallow and short dives of the active V-, P- and D-type were recorded (Fig. 1a and 2a). The same overall patterns were apparent during the Pre-Nesting phase (Fig. 1e and 2e) after the turtle had returned to the waters proximate to the nesting beach. During the two migratory phases the percentage of U-dives decreased and during the day as well as at night the turtle performed active dives represented by the types V, S and P (Figs. 2b and d). P-dives appear to be primarily traveling behavior and seem connected to deep-diving to depths of up to

103 m. The time spent at greater depth is balanced by the enlarged proportion of time spent at the surface (Fig. 3; 14-20 Sep 1999 and 22-28 Jun 2001). The additional increase in surface-time (maximum surface interval >2 hours) visible during the breeding migration is probably due to mating behavior. The key characteristics of the stationary foraging phase were a very high percentage of U-dives (Fig. 2c) and a bimodal distribution in preferred depth levels (Fig. 3; 20. Sep 1999-22 Jun 2001). The two levels (17 and 29 m) result from the diurnal dive pattern of the turtle with shallower dives occurring at night and deeper dives during day (Fig. 4). Furthermore, the dive duration was found to be shorter in day- than in night-dives. Fig. 4 shows the two distinct scatters of data points do not share a single regression line but rather describe two different ratios between dive duration and maximum depth of the dive. The energy expenditure for routinely repeated U-dives are obviously not the same during the day and at night, indicating that the turtle performed a behavioral pattern of diel (feeding) activity and nocturnal resting. The decreased rate of oxygen consumption during resting in the reef facilitates prolonged submergence times at night. The narrow scatter of bottom depth levels of these dives show a much stronger depth preference, probably due to resting site fidelity than during the feeding dives, where the depth of the bottom of the dive depends on food distribution. The described dimorphism between day and night was found only during the stationary foraging phase.

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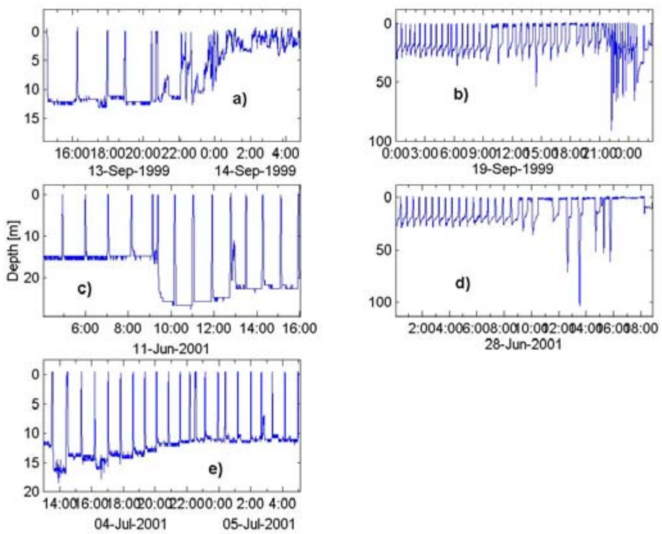

Fig. 1. a-e) Sections of the TDR-data of turtle QQD 280 representing the typical dive profile of the five successive phases within the 2-year remigration interval. a) Inter-Nesting Interval, b) Foraging Migration, c) Stationary Foraging, d) Breeding Migration, e) Pre-Nesting.

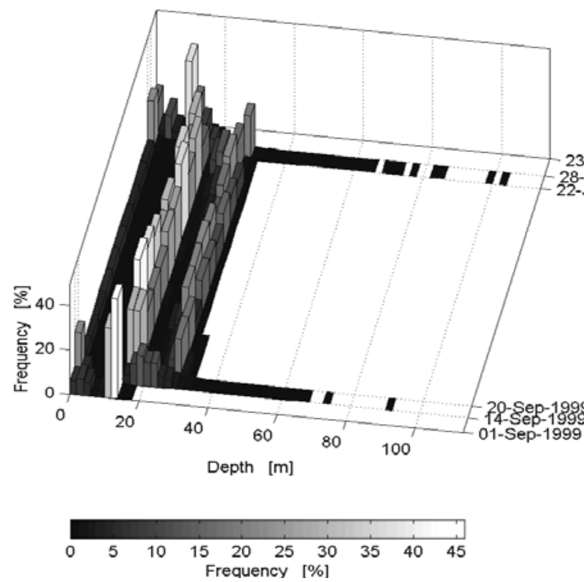

Fig. 3. The frequency of recordings at different depth levels (time at depth) in the course of the remigration interval. 1.-14.Sep.1999: Inter-Nesting Interval, 14.-20.Sep1999: Foraging Migration, 20.Sep.1999-22.Jun.2001: Stationary Foraging (639 days), 22.-28 Jun.2001: Breeding Migration, 28.Jun.-23.Jul.2001: Pre-Nesting.

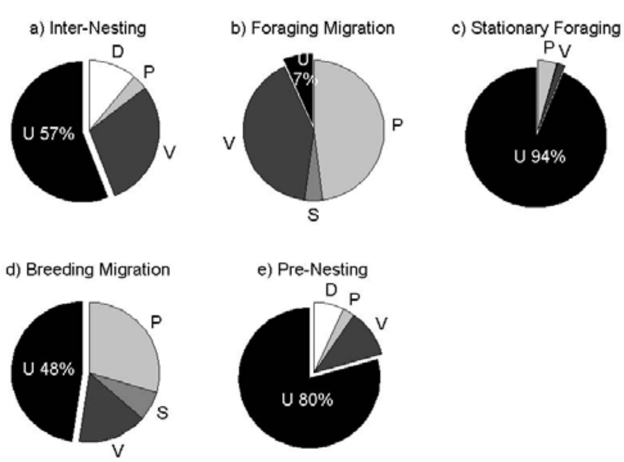

Fig. 2. a-e) Percentage of different dive types during the five discrete phases of the remigration interval. Description of dive types see text.

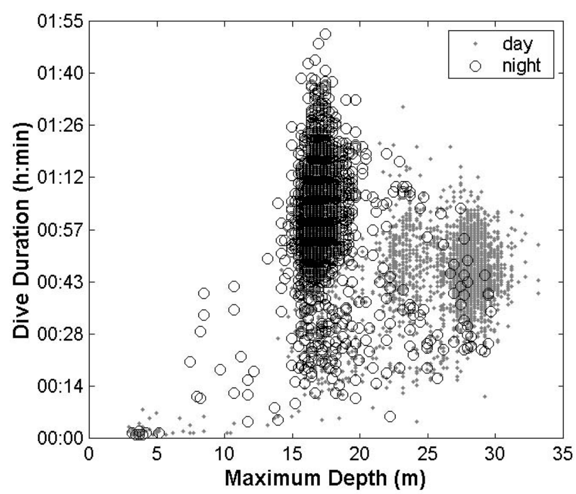

Fig. 4. Dive duration vs. maximum depth of each dive during the stationary foraging phase (n=5579).

Movements of adult male Kemp's ridley sea turtles (*Lepidochelys kempii*) in the Gulf of Mexico investigated by satellite telemetry

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INTRODUCTION

The endangered Kemp's ridley turtle nests almost exclusively along the Gulf of Mexico coast, with the largest concentration near Rancho Nuevo, Tamaulipas, Mexico. Satellite telemetry studies have shown that post-nesting, adult female Kemp's ridleys are primarily near-shore, shallow water inhabitants, capable of swimming rather long distances in a directed manner (Byles 1989, Mysing and Vanselous 1989, Shaver 2001). The waters off the western and northern Yucatan Peninsula, southern Texas coast, and northern Gulf of Mexico are important foraging areas where adult female residency is established (Byles 1989, Shaver 2001).

In contrast, knowledge of movements and habitat utilization by adult males is limited. Such information is important to develop and implement recovery actions for this species. This study was undertaken to gain information on movements, migratory paths, feeding grounds, and home range of adult male Kemp's ridley turtles through satellite tracking of 11 individuals.

MATERIALS AND METHODS

Eleven adult male Kemp's ridley turtles were outfitted with model ST-14 satellite (UHF) platform transmitter terminals (PTTs) manufactured by Telonics, Inc., of Mesa, Arizona, USA. PTTs were configured in a backpack style and were attached to the second neural scute of the carapace (Plotkin 1994, 1998), on a base of fiberglass insulation, using three layers of polyester resin and fiberglass cloth.

The PTTs were attached to turtles that local fishermen incidentally captured by net at Barra Carrizo and Barra del Tordo, in the vicinity of Rancho Nuevo, Tamaulipas, Mexico, between 11 August 1999 and 25 May 2000. From the turtles that fishermen captured, we selected males for this study based on the presence of a long tail and soft plastron. Curved carapace length (CCL), measured from the nuchal tip to the post-central tip on the opposite side of the carapace, ranged from 60.0 to 69.5 cm (mean=65.5 cm, S.D.=2.9 cm, n=11). Straight carapace length (SCL), from the nuchal notch to the post-central tip, calculated using the length conversion equation in Schmid and Witzell (1997), ranged from 56.0 to 64.3 cm (mean=60.8 cm, S.D.=2.5 cm, n=11). After PTT attachment, each turtle was marked with a metal flipper tag and passive integrated transponder (PIT) tag, and was released near their capture site.

Turtle movements were monitored via the Argos, Inc. Data Collection and Location System until transmitters were removed or transmissions ceased. The calculation and accuracy of latitude and longitude was dependent on the number of messages received from a PTT during a satellite pass and the angle of the satellite relative to the PTT. Argos supplied location classes (LC) for each calculated latitude and longitude; these included LC 3, 2, 1, 0, A, B, or Z (Argos 1996).

Location data were reviewed and either accepted or rejected based on criteria established by Plotkin (1994, 1998). Locations were rejected if they met one or more of the following criteria: (1) only two transmissions were received for a transmitter during a satellite pass and both were identical; (2) the location calculated for a transmitter was on land; (3) the rate of movement of a turtle between two consecutive locations exceeded 6 km/hr; and (4) the movements among consecutive locations were deemed unlikely (Plotkin 1994, 1998). For each turtle, accepted locations were plotted sequentially to depict sequence of movement.

Using the Geographic Information Systems program ArcView with Tracking Analyst Extension and Animal Movement Analyst Extension (AMAE) (Hooge et al. 2001), home range was calculated for those PTTs for which the assumptions of the individual home range models used were met. All PTTs were analyzed for site fidelity (i.e., the animal's locations did not exhibit significant dispersion or significant linearity) and those that failed to meet this assumption were eliminated from all home range analyses (Hooge et al. 2001). For those with adequate sample size, minimum convex polygon (MCP) home range was calculated; for those without serial autocorrelation, kernel home range with 95% and 50% probabilities were calculated, with the 95% contour considered as the area that the animal actually used and the 50% contour as the core of activity (Hooge et al. 2001).

RESULTS AND DISCUSSION

For the 11 turtles monitored, locations were yielded from 73 to 233 days after the transmitters were deployed (mean=131 days, S.D.=52 days). Overall, 64 locations [LC 1 (n=2), LC 0 (n=4), LC A (n=11), and LC B (n=47)] were rejected and 297 locations [LC 3 (n=10), LC 2 (n=17), LC 1 (n=15), LC 0 (n=18), LC A (n=82), and LC B (n=155)] were accepted and mapped. Most of the locations accepted for the 11 turtles were in near-shore waters 0-37 m (0-20 fm) deep.

Eight turtles (7660, 7661, 7662, 7669, 7671, 7672, 7682, 7683) exhibited multi-directional movements within localized core areas, which differed slightly for each turtle (Fig. 1). The core areas for seven of the eight (7660, 7661, 7662, 7671, 7672, 7682, 7683) were in a region between 23 km south and 42 km north of Rancho Nuevo. The core area for the eighth (7669) was about 100 km north of Rancho Nuevo. Movements for seven of the eight (all but 7671) met the assumptions of the home range models used; for these seven, the mean kernel home range with 50% probability was 95 km^2 (range=19-184 km^2) (Fig.1).

Three turtles (7670, 7674, 7674B) moved primarily in one direction and their last identified location was their most distant from Rancho Nuevo. One turtle (7674) moved southward after release and was last located washed ashore dead about 92 km south of Rancho Nuevo, while another (7670) moved northward after release and was last located about 29 km north of Rancho Nuevo. Only one turtle (7674B) left Mexican waters during the tracking period. This turtle moved northward after release, generally traveled parallel to the Gulf of Mexico coastline, and was last located just south of Galveston, Texas, USA, about 565 km north of Rancho Nuevo.

Adult male Kemp's ridley turtles in this study appeared to be mostly year-round residents in the vicinity of the nesting beach. In contrast, most adult female Kemp's ridleys outfitted with satellite transmitters after nesting left waters offshore from their nesting beaches in Tamaulipas and Texas between May and July, traveled within near-shore Gulf of Mexico waters, and swam directly to distant feeding areas, where they established relatively circumscribed ranges (Byles 1989, Mysing and Vanselous 1989, Shaver 2001). The opportunity for mating and year-round prey availability off the coast of Tamaulipas, Mexico are primary factors that may contribute to non-migratory behavior in adult male Kemp's ridley turtles. Females may migrate more frequently in search of optimum foraging sites, thought to be located off the mouth of the Mississippi River, USA and Campeche Banks, Mexico, since the energetic costs of producing eggs are greater than for producing sperm.

A resident population of adult males underscores the need for protection of the marine habitat adjacent to the Rancho Nuevo nesting beach year-round. Currently, under Mexican law, the Natural Reserve of Rancho Nuevo incorporates 15 km of coastline and a 4 km offshore zone that is closed to commercial fisheries during the sea turtle breeding season. These data support an expansion of the offshore zone to the north and south, especially to encompass the region where the core areas were located. Additional satellite transmitters should be deployed on adult males to gather more information on habitat use and movements. It would be useful to monitor adult males captured far away from the nesting beach and adult males captured during actual mating activity near the nesting beaches in Tamaulipas and Veracruz, Mexico and Texas, USA, and each should be examined via laparoscopy to verify that they are reproductively active.

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LITERATURE CITED

Argos. 1996. User's manual. Service Argos France, 176 p.

Byles, R.A. 1989. Satellite telemetry of Kemp's ridley sea turtle, *Lepidochelys kempi*, in the Gulf of Mexico. In: S.A. Eckert, K.L. Eckert, and T.H. Richardson, comps. Proceedings of the Ninth Annual Workshop on Sea Turtle Conservation and Biology. NOAA Tech. Memo. NMFS-SEFC-232, p. 25-26.

Hooge, P.N., W.M. Eichenlaub, and E.K. Solomon. 2001. Using GIS to analyze animal movements in the marine environment. www.absc.usgs.gov/glba/gistools/,20 p.

Mysing, J.O. and T.M. Vanselous. 1989. Status of satellite tracking of Kemp's ridley sea turtles. In: C.W. Caillouet, Jr. and A.M. Landry, Jr., eds. Proceedings of the First International Symposium on Kemp's Ridley Sea Turtle Biology, Conservation, and Management. Texas A&M University Sea Grant College Publication TAMU-SG-89-105, p. 112-115.

Plotkin, P.T. 1994. The migratory and reproductive behavior of the olive ridley, *Lepidochelys olivacea* (Eschscholtz 1829), in the eastern Pacific Ocean. Ph.D. Thesis, Texas A&M Univ., College Station.

Plotkin, P.T. 1998. Interaction between behavior of marine organisms and the performance of satellite transmitters: A marine turtle case study. Mar. Tech. Soc. J. 32:5-10.

Schmid, J.R. and W.N. Witzell. 1997. Age and growth of wild Kemp's ridley turtles (*Lepidochelys kempi*): Cumulative results of tagging studies in Florida. Chelonian Conservation and Biology 2:532-537.

Shaver, D.J. 2001. U.S. Geological Survey/National Park Service Kemp's ridley sea turtle research and monitoring programs in Texas. In: M. McKay, J. Nides, W. Lang, and D. Vigil, eds. Proceedings of the Gulf of Mexico Marine Protected Species Workshop. U.S. Department of the Interior, Minerals Management Service, Gulf of Mexico OCS Region, MMS-2001-039, p. 121-124.

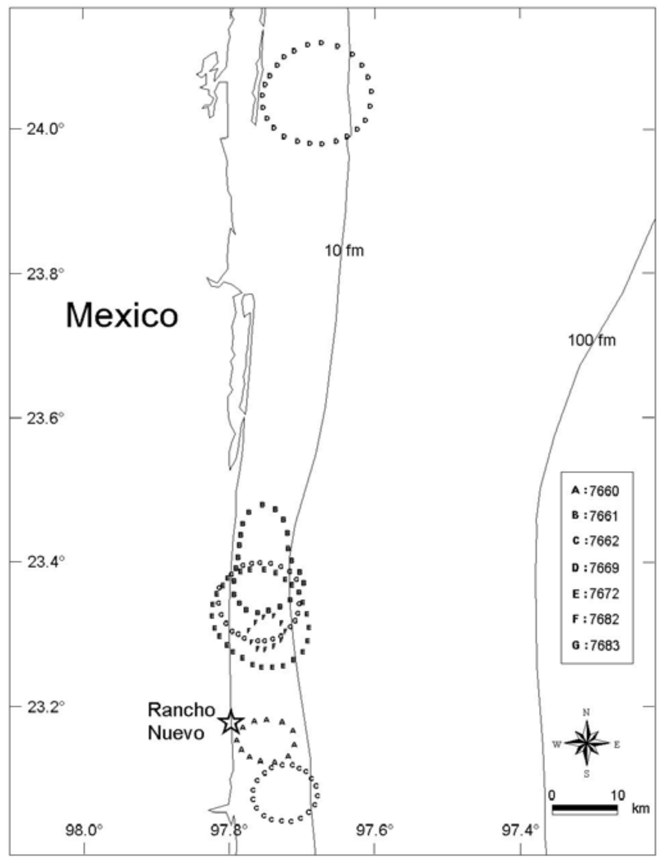

Fig. 1. Kernel home range with 50% probability for seven adult male Kemp's ridley turtles in Gulf of Mexico waters off Tamaulipas, Mexico.

Satellite telemetry of green turtles nesting at Taipin Tao, Nan-Sha Archipelago

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Nan-sha Archipelago has long been recognized as one of the major sea turtle nesting area in the South China Sea. However, the hostile attitude by the military forces from claimant nations that occupy most of the islands in the region prevents surveys on sea turtles. Previous surveys and questionnaire interviews on Taipin Tao, Nan-sha Archipelago in 1995 have reviewed that both green and hawksbill turtles are nest on the island and the green turtle is the major species. The nesting population was estimated between 25 to 40 turtles. The nesting season lasts all year around and peak from July till November. In order to further understanding the nesting ecology of the green turtles on Taipin Tao, the satellite telemetry was conducted. Four PTT ST-14s were deployed in the April of 2000 and 2001. The post-nesting migration period were found lasted from 10 to 40 days, the migration distance ranged from 351 to 1569 miles. The migration speed was calculated from 1.27 to 1.63 km per hour. The turtles spent 95 to 97% time per day submerge during the migration period. The marine habitats include Pala-wan and northeast Luzon Islands of Philippine, and eastern mainland Malaysia that face the Sulu Archipelago, Philippine of Celebes Sea. The widespread distribution of the marine habitats of nesting green turtles on Taipin Tao suggests the importance of regional and international cooperation on sea turtle conservation in the South China Sea.

Post-nesting movements of leatherback turtles tracked from Culebra and Fajardo, Puerto Rico with pop-up archival and TDR satellite tags

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Movements of eleven leatherback sea turtles nesting in Culebra and Fajardo, Puerto Rico were determined with directly attached time depth recorders (TDR, 6 turtles) and pop-up archival satellite tags (5 turtles). Our main objective was to test the feasibility of using implanted titanium bone anchors (used in humans) to secure both tag types directly to the turtles carapace. Most TDR duty cycles were set on nearly continuous transmission to maximize early data return. Attachment periods ranged from four days to over five months (and counting), the latter exceeding the expected life span of the TDRs battery. Some turtles headed directly offshore, five bearing NW, and three to the E/NE. One of these turtles was located off North Carolina when transmissions ceased. One turtle moved directly NE, traveling over 4500 km via the to the Azores front via the mid-Atlantic ridge. At least four turtles returned to nest, but their tags were the earliest shed, suggesting that they may have been dislodged by mating activities. Daily geolocation estimates were obtained from popup archival tags while they remained on the turtles. Our results indicate that this nesting assemblage disperses to widely separated Atlantic regions. Simple modifications of our direct attachment methodology should allow us to greatly extend tracking duration.

Comparison of resident foraging areas utilized by loggerhead turtles (*Caretta caretta*) from a South Carolina nesting beach using GIS and remote sensing application

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Five adult female loggerhead turtles were instrumented with Telonics ST-14 satellite transmitters on Cape Island, Cape Romain National Wildlife Refuge, South Carolina in 1998. Resident foraging areas were located on the Continental Shelf, both north and south of the nesting beach, at distances of approximately 285 - 871 km. Four turtles provided useful data from which to characterize and compare these habitats. We used the Minimum Convex Polygon (MCP) and Kernel Density Estimates (KDE) to determine core (50%) and home ranges (95%). MCP resident foraging area sizes ranged from 204 – 1,342 km^2. KDE core area sizes ranged from 17 - 201 km^2 with home ranges varying from 87 - 1,468 km^2. The size of the home range and core area may be related to habitat quality. Mean water depth was between 25.5 and 81.0 m. Sea surface temperatures in which the loggerheads were found ranged from 18.2ºC to 30.2ºC; the transmitter temperatures ranged from 14.4ºC to 31.1ºC. Mean temperature in which the loggerheads were found varied by 4.9ºC. One turtle had a northern (fall) and a southern (winter/spring) resident foraging area. This turtle remained in its northern resident foraging area until seasonal temperatures began to decrease in late October. This fairly constant temperature regime seems to be a combination of latitude, distance to the Gulf Stream, and seasonal turtle behavior.

Culture and conservation / Cultures of conservation

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Human use of marine turtles takes on many forms, and varies across time and place. Culture is a mediating concept often used to understand, explain, and/or justify human interactions with various species of wildlife, including marine turtles. Culture is a problematic concept, however, often misused and oversimplified. While we may identify and isolate cultural values held by others as they relate to conservation, we may take our own cultural values for granted. In the search for conservation policy, oversimplified notions of culture can be divisive, creating an us vs. them scenario. In this paper, we identify key concepts central to understanding culture, explore a variety of cultural values related to marine turtles across time and place, and discuss how culture, in all of its complexity, can play a role in conservation policy.

Beyond trends: reconciling the concepts of absolute protectionism and sustainable extractive use to achieve "best use" of sea turtles

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INTRODUCTION

In recent years there has been considerable discussion in the sea turtle conservation community regarding the status of sea turtle species and the most appropriate methods to conserve sea turtles. The debate has become increasingly polarized with diametrically opposed positions being proposed by two schools of thought. One school calls for the complete protection of sea turtles and the other proposes sustainable extractive use of sea turtles as the preferable policy to achieve successful conservation. The two main battlegrounds in this controversy have been the classification of the status of sea turtle species in the IUCN Red List of Threatened Species and the proposals presented at CITES to downlist a hawksbill turtle population to Appendix 2.

Representatives of the two schools of thought have hotly contested the classification of sea turtles in the IUCN Red List of Threatened Species. Pro-protection groups have suggested that many species of sea turtles show negative population trends and therefore fulfill the criteria of population declines during the last three generations and hence should be listed as endangered and that some species should even be considered critically endangered. Pro-use groups have stated that there are plenty of sea turtles in the ocean and that there is little probability of any species going extinct in the near future.

Officially, there is no connection between the results of the IUCN assessments and the most appropriate strategy for sea turtle conservation. However, those in favor of absolute protection have seen the classification of the sea turtle species as endangered as support for their position. On the other hand, pro-use advocates suggest that if the sea turtle species do not fulfill the criteria of being endangered, then extractive use of sea turtles should be promoted.

In the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), there is a similar conflict. In the two latest Conferences of the Parties of CITES, Cuba has repeatedly requested a downlisting of the hawksbill population in Cuba from Appendix 1 to Appendix 2 in order to allow export of stockpiled tortoiseshell to Japan. The Cuban proposals have been vehemently defended by pro-use scientists, groups and countries and opposed with equal dedication by conservation organizations, pro-protection researchers and countries.

It can be concluded that proponents of both schools of thought have been unable to agree on the issues of status evaluation and conservation action. But does there exist an objective way to determine which of the two schools of thought is right?

The objectives of this paper are firstly, to analyze the value of population trends in identifying the most appropriate sea turtle management regime; and secondly, to suggest reconciliation between the two schools of thought that may help to forward sea turtle conservation through cooperation between proponents of the two conservation strategies.

What are trends? Population trends in sea turtles are most commonly recorded as the change over time in the number of nests deposited on a particular beach or the number of females arriving at the nesting beach each year. A trend in nesting is the result of interactions between many variables and processes. There are many important factors to consider. Biological factors comprise for example; density dependent effects on growth in feeding grounds and density dependent effects on hatching success at nesting grounds. Among environmental factors there are sand temperature that influence sex ratios, freshwater inflow and sediment load on feeding grounds (dependent on rainfall) that may be related to ocean climate cycles such as ENSO and climate cycles in the North Atlantic. Human use factors include management regimes and use patterns. A common trait of all these factors is that they may vary in time and in space.

Example of a trend – green turtles at Tortuguero. As an example of a trend we can look at the Tortuguero, Costa Rica, green turtle nesting trend. We used data from approximately weekly track surveys conducted along the entire Tortuguero beach (22 miles until 1994, when Jalova lagoon opened up and most nesting was confined to 18 miles of beach). We set end dates with 0 nests at June 15 and November 1 and then fitted a cubic polynomial function to each year's track survey results. The resulting functions for each year were used to calculate daily (or rather nightly) numbers of nests and the daily totals were added up to yearly estimates of the total number of nests deposited. Regression of the ln of the estimated yearly totals was used to determine the nesting trend. The overall trend is a mean annual increase in the number of green turtle nests of 3.3% for the time period between 1986 and 2001.

So, is this positive trend due to successful protectionism? We do not think that can be stated with confidence. The trend is the result of the many factors mentioned above and others, acting over the past 25 years or more and throughout the Caribbean and beyond. Climate cycles, changes in management regimes, human use patterns and even the Nicaraguan civil war in the 1980's may have influenced the Tortuguero nesting trend. It would be naïve to pretend that we know enough about sea turtle biology, human use and global climate to say that the apparent increase in green turtle nesting has been due exclusively to successful protectionism.

It would be equally naïve to pretend that our knowledge of sea turtle population dynamics is sufficient to use the trend to set an annual quota of green turtles that can be harvested/killed by Costa Rican fishermen and be sure that the fishery will not cause a population decline. This becomes even more apparent when we consider that there is a large capture of Tortuguero green turtles in Nicaraguan waters (Lagueux 1998).

Usefulness of trends in identifying successful management regimes. We have to acknowledge that trends in nesting populations are the results of a combination of many variables, some that we have more detailed information about than others. Our knowledge is currently insufficient to look at trends, which are the results of variables interacting over time spans of 25+ years and over large areas, and confidently determine the impact of specific management methods which may have been employed during only limited time and in only limited areas. Our ability to predict how the variables will interact in the future is even more limited, especially when we throw in global warming, climate change and rising sea levels into the already complex equation. Due to our incomplete understanding of the processes affecting population trends, there is enough room for the proponents of the two schools of thought to interpret trends at their own convenience so that the interpretation supports their position regarding sea turtle management.

Therefore, we have to conclude that the usefulness of trends is currently limited when it comes to deciding what management approach – absolute protectionism or sustainable extractive use - should be preferred.

If trends are currently of limited usefulness then what ways forward are there whilst we wait for the necessary knowledge to develop that will allow us to perfectly understand and predict the complex equations that control population trends?

Reconciling the two schools. If we can reconcile the two schools of thought and develop a synthesis that satisfies both schools then at least we can put behind us the controversies of the IUCN Red List classifications and CITES and work together towards a common goal. This would prevent us from spending energy, time and funds on arguing over issues that we know we will not be able to resolve through currently existing mechanisms. We are sure that there are many excellent ideas for how reconciliation can be achieved so we will limit this paper to two possible options.

The goal of a protectionist conservationist, we would suggest, is to stop population decline by prohibiting extractive use of sea turtles. The goal of the proponents of sustainable extractive use, we think is to ensure that sea turtles like any natural resource will benefit people. A synthesis of these two goals could be what we would like to present as "Best Use." The goal of "Best Use" is to develop non-extractive use of sea turtles as a means of providing benefits to people and at the same time protect sea turtles to ensure that there are no population declines.

Non-extractive "Best Use" includes using sea turtles as an eco-tourism attraction. An example is Tortuguero, where in 1999 a total of 20,885 visitors got permits to go on guided turtle walks (Troëng et al. 2000). The tourists spent on average US$57.6 per day for an average 4.1 days in Tortuguero (ICT 2000). The value of turtle related tourism is approximately US$4.9 million per year and local tour guides proudly state that a turtle is worth more to them live than dead.

We can contrast this value with the income from the turtle fishery that operated along the Caribbean coast of Costa Rica until 1999 and that permitted an annual take of 1,800 green turtles. The income from the sale of meat and eggs from one green turtle is estimated at US$198.7 (Troëng et al., in press). The total value of the fishery can therefore be estimated at approx. US$360,000 per year. In 1999, the fishery was stopped due to a lawsuit presented by several individuals and conservation organizations. The economic considerations and the concern about the impact of the rampant illegal fishing masked by the quota system, were important reasons for the court ruling that lead to the ban.

Another "Best Use" option could be using sea turtles as symbols, for example on T-shirts or in local artwork, as is the case in many sea turtle conservation projects around the world.

The joint challenge for the future would be to cooperatively develop more non-extractive uses, for fishermen and others that are involved in extractive use of sea turtles. This is particularly important in feeding grounds and along migratory corridors, where to date there have been few non-extractive uses of sea turtles.

Future of sea turtle conservation. It still remains to be seen if there is enough interest and goodwill to reach reconciliation between proponents of the two dominant schools of thought. It is also too early to predict if the "Best Use" concept will be successfully applied in sea turtle conservation on a broad scale. However, we make the prediction that the sea turtle populations for which "Best Use" is implemented and the people depending on those turtle populations for their livelihood will fare best in the future.

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LITERATURE CITED

ICT. 2000. Plan de desarrollo turístico de Limón. Unpublished report to Instituto Costarricense de Turismo. 46 p.

Lagueux, C.J. 1998. Marine turtle fishery of Caribbean Nicaragua: human use patterns and harvest trends. PhD Dissertation. University of Florida, Gainesville. 215 p.

Troëng, SJ. Mangel, S. Kélez, A. Myers, J. Kashner, L. Bell Chambers, D. Vizcaino, A. Rees, B. Amiteye, E. López, T. Moorman, Y. Rojas, L. Taylor, P. Angeloni, A. Morales, D. Quevedo, J.C. Melendez, J. Castro, and E. Rankin. 2000. Report on the 1999 Green Turtle Program at Tortuguero, Costa Rica. Unpublished report presented to Caribbean Conservation Corporation and the Ministry of Environment and Energy of Costa Rica. 46 p.

Troëng, S., C. Castro, L. Monterrosa, D. Campbell, and E. Hamorro. In press. Contingent valuation of green turtles *Chelonia mydas* in Caribbean Costa Rica. In: M. Coyne, comp. Proceedings of the 21st Annual Symposium on Sea Turtle Biology and Conservation. Philadelphia, PA, USA.

Proyeto TAMAR: a community-based conservation program

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The initial objectives of TAMAR were to quantify the number of species, distribution and abundance of sea turtles, the seasonality and geographic range of egg laying, and the primary threats to turtle survival. A comprehensive two-year survey of the coastline was carried out in 1980-1981 This survey was conducted by a four person team and comprised with on site observations and interviews with fishermen. One of the results of the survey was the identification of different uses of turtles in different communities. The need of dealing with cultural aspects was clear to be essential to achieve long term conservation goals. It's necessary to change the paradigm that conservation is a barrier to human survival or to socio-economic development. Local people who depend on sea turtles for their livelihood must be part of the conservation program and consequently be benefited by its actions direct and indirect. Despite the fact that exploitation had occurred at a subsistence level (we found no formal markets for turtle products), the survey revealed that a substantial annual harvest had taken place for generations with little regard for population size or rates of recruitment. The primary commodities were eggs, meat and shell, but there was no evidence of the use of oil or skins. Patterns of harvest and use differed only slightly among villages. Generally, feeding or nesting turtles were captured opportunistically. A few artisans earned income from the sale of hawksbill shell jewelry to urban retail buyers. There was a small and informal market in some cities for whole turtle shells displayed for decoration. Egg poaching was widespread all along the coast, often approaching 100% of all eggs laid. In no case did turtles provide a primary source of either income or protein.

"When beginning a program with endangered species, there is not always the luxury of conceiving long term goals and elaborate educational strategies." As a result, it was essential to find out practical solutions to stop female killing and egg poaching. Direct hiring of ex-poachers to patrol the beaches come out as the first TAMAR action towards sea turtle conservation in the country as well as the primary community benefit. The decision to spend virtually all the project budget within the communities was based on the simple reality that sea turtles in Brazil were disappearing.

"One of the greatest and most complex challenges to long term conservation is to understand that conservation of endangered species has traditionally implied in interfering with human survival in local communities"

Therefore the Tamar's vision became "To protect sea turtle through applied research environmental education and conservation actions based on social inclusion of the coastal communities."

Although Brazil is a country with one single language and no dialects, there was a need to adequate conservation strategies and create economic alternatives for the different realities and cultural habits found along the coast. Each TAMAR station makes its best to respect the trends and development plan of each region. In a developing country the concept of sustainability must consider the promotion and conciliation of: (1) Social equality, (2) Environmental conservation, (3) Economic efficiency, and (4) Sustainable development.

COMMUNITY PARTICIPATION AND ENVIRONMENTAL EDUCATION

Tamar's philosophy is that participation of local communities is essential for the success of any project of nature conservation. By creating new means of subsistence it helped to preserve local culture, especially by offering jobs. Programs, which offer alternative sources of income, include t-shirt factories, craft making, ecotourism initiatives, and oyster culture, among others. At grassroots level, integrating the program into daily life can ensure that new generations are raised with a more conservationist outlook. Applied methods of environmental education include specific courses and activities (paper recycling, selective garbage collection, junior ecological tour guiding) that involve members of the communities. Today, the livelihoods of about 500 people throughout the country depend on the conservation program developed by Tamar. The majority of these people are fishermen and their families who live in areas where Tamar has established its stations. Environmental education programs for the coastal populations were developed, transforming local people into active partners and allies in saving and protecting the sea turtles in Brazil. This is done both in a formal manner together with schools and other educational institutions, and in an informal manner, directed at the general public, such as the tourists which visit the different Tamar stations spread throughout the country. The message of sea turtle conservation is also spread through media campaigns, expositions, conferences, video presentations, and the distribution of posters and pamphlets.

· No. SCHOOLS ATTENDED/YEAR: 534
· No. STUDENTS ATTENDED /YEAR: 29,162

As biological benchmarks, thanks to these efforts in promoting social welfare and public awareness it is possible for over 1.000 million hatchlings of 5 different sea turtle species to safely run into the sea. Nowadays 77.8% of the total nests monitored are safe to be kept in-situ and also 3,646 sea turtles have been saved from fishing nets and other fishing devices

EDUCATION AND ECOTOURISM

Visitor Centers were created at some of the Tamar bases, and continually offer new attractions and features for tourists, schools, and local community members. By contributing to the development of ecotourism in the regions where it is based, Tamar gains yet another means to spread its message of community based conservation and generate funds to finance its conservation and research. At the same time, it helps create more employment opportunities for community members, not only in Projeto Tamar itself, but also in other businesses , which are built in these areas to support the increasing number of ecotourists.

MINIGUIDES

It consists of a summer training course in which local children between 8 and 13 years old learn basic information about Marine Ecosystems, sea turtles, strategies to promote their conservation and stalls to interact effectively with tourists. After the course groups of 6 children are selected as trainees to work at TAMAR visitor center to complete their training. The miniguides interact with the tourists giving information about sea turtles' basic biology and Tamar's work. They also have an opportunity to take part in the field activities with the technical staff. After this training, the best guides are selected to spend one year helping to assist people at the visitor's center. During this period each children has to attend school, and in order to avoid overlapping with school hours each child works only during weekends or part time during the week. An educator hired as a consultant specifically for this program assists them.

Main Goals. (1) training children in tourist guiding activities; (2) enhance local community concern about environmental conservation through the children; (3) increase pride for the local environment, mostly marine ecosystem; and (4) create new opportunities and sources of income for the children involved in the program, without jeopardizing their regular study at school, thus helping them and their families.

The creation of protected areas is one of the most efficient measures for endangered wildlife protection. This procedure has been used in Brazil in several situations since the 1970's. Two Federal Biological Reserves were created specifically to protect important sea turtle nesting sites on the Brazilian coast: Comboios, in the State of Espírito Santo, and Santa Isabel, in the state of Sergipe. This category of protected area is the most restrictive not allowing human populations or activities within its boundaries. Since this measure blocks the access to natural resources that were used before it usually faces resistance from local communities. Integration of these populations on the management of protected areas is a key to obtain long-term conservation success. Tamar's strategy to achieve sea turtle conservation in these two particular areas is to develop social and ecological sustainable economical alternatives.

The t-shirt factories: Regência and Pirambu. The first t-shirt factory was created in Regência in 1990, and a second one started its activities in 1995 in Pirambu, both as an alternative for jobs and income for the fishermen wives. These two factories produce most of the Tamar t-shirts. Nowadays both factories hire around 60 people and more may join the regular staff during high production seasons. Together they can produce from 300 up to 800 t-shirts per day. Peak production coincidently happens during the nesting season, between September and March, and more people are hired temporarily. For many families fishing is this the main source of income, which is also a traditional activity in these areas, has become scarce and not as productive as before. Besides the financial benefits, the factories also contributed for a social change in the villages. Traditionally patriarchal, the villagers now had the leadership of women at home bringing together their will for professional and personal growth. The leader and manager of the Regência unit, belongs to the community and through regular meetings tries to stimulate and gather her team. Thanks to this the major part of the workers went back to school. She tells that some children in the village dream of working in the factory when they grow up, a sign that this work shall have a continuity as its results and benefits. Started Collaborators T-Shirts (per day) / Regência 1990 27 300 to 700 / Pirambu 1995 18 to 25 200.

Paper recycling workshop. Boys and Girls between 9 and 17 years old from the costal community of Ubatuba São Paulo and Regência Espírito Santo, have a chance to a better life through the participation on the paper recycling workshop supported by Tamar. To be accepted in this training on professional skills program each child has to attend the school. After they become 18 years old, Tamar tries to fit them in other jobs. The paper recycling factory in Ubatuba was created in 1997, with Bid (Inter American Bank for Development) support. Last year it moved to a new place that gave them the opportunity to improve the production. The 12 children involved in the program work part time. The paper recycling in Regência was created in 1990 and it involves 11 kids producing paper bags to used in Tamar's shops. The profit is shared among the kids and re-invested to buy raw material.

Oyster culture. The increasing number of incidental capture of sea turtles observed each year, mainly due to the shrimp fishery, resulted in a strategic plan to create an alternative form of local fishery that did not threaten sea turtles. In December 1997 a study in the north of the SIBR was carried out to implement a culture of native oyster (*Crassostrea rhizophorae*) as a viable economic alternative for the community. In the past this mollusk was exploited without any investment into maintaining the resource, causing this oyster bank to become economically unviable due to overexploitation. The oyster culture is an alternative activity parallel to fishing, and is of low cost and with great family participation. It was successfully introduced in the Ponta dos Mangues region (municipality of Pacatuba-SE) in December 1997, acting as an essential factor for conservation, creating perspectives for a better future for the community, and consequently for the environment. With the arrival of new technicians working full time, new activities were developed aimed at the organization and professionalism of the program. Currently the spats are sent to several institutions with high degree of quality and selection, and are offered in 3 sizes of 10, 15, and 20mm. With this increment it is possible to keep a monthly floating stock of 350,000 spats. By the end of 1999 and during the year 2000, 70% of the spat production was commercialized to several Brazilian states. This activity contributed to covering the costs of all the personnel involved. Furthermore, researchers, producers, and students, from Brazil and overseas, received training through visits, internships, and courses. Their training contributed significantly to the development of oyster culture in other regions. Currently the oyster growth areas at Ponta dos Mangues and Pirambu are absorbing 60% of the spat production. A free supply is offered to institutions and community groups aiming at stimulating this activity as a viable economic alternative for several areas. Issues such as minimization of human impacts on coastal environments, study of the oyster under different environmental conditions and the recognition and mass-broadcast of the activities carried out at Ponta dos Mangues, are important for oyster culture.

Tamar´s experience has been an evolving process, with several benchmarks at each step of the way. Given that it have taken different strategies and a process of trial and error for each community. It is our understanding, based on this experience that there are no model approach or methodology for conservation programs, since they need to be adjusted to the local circumstances, respecting each different culture and diversity. Tamar found its only path, and will continue to seek creative and realistic solutions.

Community-based marine turtle conservation in Nuichua Nature Reserve, Ninhthuan Province, Vietnam

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There has never been a country-wide study of marine turtles in Vietnam and thus, information on Vietnamese marine turtles is insufficient. However, it is certain that populations have sharply declined. Marine turtles had traditional nesting sites along the coast of Vietnam. Today, however, marine turtles nest at only a few sites, mainly on the islands such as Con Dao archipelago in Ba Ria – Vung Tau province and Phu Quoc archipelago in Kien Giang province. Ninh Thuan may be the only nesting ground with significant numbers of nesting marine turtles. The project was designed and conducted on a community based approach.

Project objectives. (1) Conserve the only coastal area in Viet Nam where turtles lay eggs by reducing marine turtle mortality during hatching periods from such factors as predator, wind, beach erosion and human; and conserve adult and young turtle from catching; (2) conserve marine turtles whose numbers are thought to be seriously declined in Vietnam; (3) strengthen the capacity of local authorities on turtle conservation; and (4) educate and involve local people to the work on turtle conservation.

Integrating local knowledge and outside science in sea turtle conservation: a case study from Baja California, Mexico

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Local fishers often possess an intimate knowledge of their environment. Based on years of daily observations, fishers' knowledge may provide greater scientific detail than some studies conducted by outside researchers. However, because fishers have historically been blamed for declining sea turtle populations, this body of knowledge has often been overlooked in conservation initiatives. Outside "experts" typically organize community work by providing direct, controlled guidance regarding appropriate conservation techniques. In order for fishers to actively share their knowledge, they must first be viewed – and view themselves – as an integral part of the conservation team contributing valuable information and ideas, not just acting as boat drivers and guides for outside researchers. In a case study of sea turtle conservation efforts in the Californias , the process of integrating local and outside science will be discussed. Through a partnership-based research approach, mutual respect has enabled open communication and collaboration between outside researchers and members of local host communities. As a result, fishers have been more willing to share their intimate knowledge of their environment – often providing baseline data crucial to the regional sea turtle recovery efforts that they themselves have actively participated in.

UNDERSTANDING SCIENCE AND KNOWLEDGE

At last year's Symposium in Philadelphia, Jack Frazier (in press) posed the question: "Is increased scientific production saving turtles?" The follow-up question to this would be: "Whose science?" Within what has been referred to as the dominant western worldview an arbitrary demarcation often exists between outside "expert" science and local knowledge, with a greater value placed on the former (Bird 2002, Nader 1996). In some cases, however, local knowledge based on long-term observations – similar to the repetition used in western scientific approaches to hypothesis testing – has demonstrated a greater breadth and depth of knowledge than research conducted by outside "scientists" (Johannes, in press). Although outside researchers may enter a community with a textbook knowledge of ecosystem functions and indicators, the local fishing populations often possess the most detailed knowledge of their coastal region. When their livelihood is directly related to their ability to effectively and reliably locate desired resources in order to earn their income and feed their family, an intimate understanding of the environment, and the resources they harvest, is necessarily acquired over time. Such knowledge needs to be harnessed and integrated into conservation. Espousing an interdisciplinary approach to sea turtle conservation relies on the utilization of many "sciences" to provide a more holistic view of natural and cultural ecology, which greatly impacts the success of conservation initiatives.

LOCAL KNOWLEDGE FOR SEA TURTLE CONSERVATION IN THE CALIFORNIAS

Ongoing projects in several Californian communities have shown that local knowledge can greatly enhance sea turtle recovery efforts. Here, two main tools – conservation research and active community involvement – are being used to combat the primary threat sea turtles are facing in the region: direct harvest. The research consists of community-based work and socioeconomic studies of current and historic sea turtle utilization in the Californias, particularly in the Bahía Magdalena, Baja California Sur, region (Bird 2002, Nichols et al. 2000a, Marsh et al., this symposium), as well as ongoing biological monitoring and ecological studies. A variety of data have been collected, including mortality information (Koch et al., this symposium), diet analyses (Lopez et al., this symposium), and tissue samples for genetic analysis. Radio and satellite transmitters have been deployed in order to monitor the distribution, movements and long-distance migratory patterns of sea turtles (Nichols et al. 1998, Nichols et al. 2000b).

Local fishers from communities in the region have been involved in all aspects of data collection, identifying optimal locations and times to set nets, assisting in captures, measurements and marking, as well as informally monitoring turtle movements while fishing on the bay (Nichols et al. 2000a). Several fishermen have also assisted in the mapping of locations where sea turtles are observed and/or captured most frequently. Locals have also helped to identify seasonal movements and behaviors relative to tidal, lunar and diel cycles (Brooks et al., this symposium). Members of the local community have generated ideas and provided assistance in the creation of survey and interview questions used to gather public opinion related to sea turtle conservation initiatives. Their sharing of detailed knowledge about the ecology and social systems of the bay as a whole has contributed immensely to our work – improving the accuracy of the information collected and providing a more complete picture of the sea turtle's natural and cultural history.

RESEARCH APPROACH: INTEGRATING LOCAL KNOWLEDGE AND OUTSIDE SCIENCE

Our research approach seeks to utilize local knowledge and foster partnerships, facilitating the exchange of information and active community participation. By avoiding a purely biological "turtle-centric" approach, instead investigating the overall turtle habitat – including the cultural and socioeconomic background of which turtles are an integral part – our understanding has been greatly enhanced. The following stepwise approach outlines the process by which local science has been integrated into conservation initiatives in the Californias: (1) The first step involved getting to know who we were working with, while allowing them to know us as more than just outside researchers: We built trust through friendships and partnerships within the local community – through frequent visits, open discussions, joint activities, and shared leadership. (2) Since initial entrance into the community, we have used informal conversation, surveys and semi-structured interviews to learn about the community issues relevant to local conservation initiatives. We worked within the existing socioeconomic framework by giving attention to cultural norms and beliefs, personal needs, and politics. (3) While it may be appropriate to share the knowledge we possess with local fishers, (particularly when it is specifically requested), we do not do all the talking: We spent an equal amount of time asking questions. Both "outsiders" and "insiders" were engaged in participant observation, sharing with and learning from each other. (4) We integrated local knowledge and information, alongside the outside science, into general and/or specific action plans and implemented them with the support, knowledge and active participation of the local population. (5) Lastly, we continue to monitor progress, through surveys and mark-recapture studies, and maintain flexibility, following adaptive management strategies.

Over the course of six years of involvement, local and regional meetings have been held to identify community issues and generate conservation strategies related to sea turtle recovery efforts. Recently, an organized network of sea turtle conservation and monitoring spanning the Baja California peninsula from the Pacific coast to the Gulf of California has been created. Through the annual meeting of the Sea Turtle Conservation Network of the Californias (STCNC), several fishing communities have publicly shown their interest in contributing more towards sea turtle conservation efforts through systematic monitoring (Pesenti 2002). For example, in the past, fishers have known the general movements and distribution of turtles, but have lacked the support of numbers. Now, through the coordinated joint efforts of seven dedicated communities and outside research groups, monthly monitoring is enabling fishers to attach quantitative weight to their observations. The results of these studies will be shared between communities year round, with additional reporting at the annual STCNC meetings in Loreto.

OUTCOMES AND LESSONS LEARNED

Because our research approach is culturally sensitive and we recognize the economic and cultural values associated with sea turtle use within the community, respect is shared between fishers and researchers. This mutual respect is paramount to collaborative research efforts, positively impacting the success of conservation activities. Utilizing local knowledge broadens our biological studies, often providing additional baseline data and ideas to work with. It also augments the potential for success in our community-based research efforts, and eventually regional conservation.

If the sea turtle community is concerned about the fate of turtles, local knowledge must be valued, utilized and finally integrated alongside the knowledge that outside researchers bring into the community. Aside from any moral or ethical arguments about community participation and respecting the local host communities we live and work in – of which there are several – working with the community is just good conservation sense. When dealing with any threatened or endangered species or habitat it is imperative that we draw upon all the available tools and all the existing knowledge which is readily accessible in order to create conservation strategies in a timely fashion. If we utilize the body of knowledge that already exists within a local community we may eliminate this need to "produce" more "science" and in the meantime save valuable time, money and resources, which could be directed towards other conservation efforts.

Acknowledgements. We wish to thank the following communities: Puerto San Carlos, Puerto Magdalena, Lopez Mateos, and Punta Abreojos for their immense contributions to our work. Thanks to the staff and students at the SFS Centro para Estudios Costeros, especially Salvador García-Martinez, Pamela Kylstra, and Volker Koch for their ongoing support. Bob Johannes, Peter List and John Young provided valuable comments on portions of this manuscript. We are grateful for the support shown by all of the individuals who have contributed their knowledge towards conservation efforts in the Californias, particularly Adan Hernandez, Miguel Lizzaraga, and Isidro Arce. We also thank members of other communities from different countries who have shared their knowledge and enriched our collaborations. K. Bird's participation in the Symposium was made possible through grants from The Sea Turtle Symposium, the David and Lucile Packard Foundation, and the Oregon State University Department of Philosophy. C. Tambiah wishes to thank the David and Lucile Packard Foundation, the Sea Turtle Symposium, the "Art for Conservation" Initiative, and the Community Participation and Integrated Sea Turtle Conservation Initiative for travel and logistical support. The David and Lucile Packard Foundation, Homeland Foundation, Wallace Research Foundation, U.S. Fish and Wildlife Service, and U.S. National Marine Fisheries Service have provided major funding for the project described here to WiLDCOAST.

LITERATURE CITED

Bird, K.E. 2002. In press. Community-based sea turtle conservation in Baja, Mexico: Integrating Science and Culture. MS Thesis. Departments of Anthropology, Fisheries and Wildlife, and Philosophy. Oregon State University, Corvallis.

Brooks, L.B., W.J. Nichols and J.T. Harvey. This symposium. Estero Banderitas marine protected area: A critical component to the recovery of the East Pacific Green Turtle (*Che lonia mydas*).

Frazier, J.G. In press. Science, conservation, and sea turtles: What is the connection? Proceedings of the 21st Annual Symposium on Sea Turtle Biology and Conservation. February 2001. NOAA Tech. Memo.

Johannes, R.E. In press. Integrating traditional fishing knowledge with western scientific knowledge for better marine resource management. In: Nakashima et al., eds. Local and indigenous knowledge systems. UNESCO: Paris.

Koch, V., W.J. Nichols, L. Brooks, and S. Gardner. This symposium. Black turtle (*Chelonia mydas*) mortality in Bahía Magdalena, Baja California Sur, Mexico.

Lopez-Mendilaharsu, M., S.C. Gardner, J.A. Seminoff. This symposium. Feeding ecology of the East Pacific Green Turtle (*Chelonia mydas agassizii*) in Bahía Magdalena, B.C.S., Mexico.

Marsh, J.C., W.J. Nichols, E. Palacios-Castro, S. Garcia-Martinez and K.E. Bird. This symposium. Community-based coastal resource management: Success factors and the sea turtle reserve in Estero Banderitas, BCS, Mexico.

Nader, L., ed. 1996. Naked Science: Anthropological inquiry into boundaries, power and knowledge. Routlege Press: New York.

Nichols, W.J., K.E. Bird, and S. Garcia-Martinez. 2000a. Community-based research and its application to sea turtle conservation in Bahía Magdalena, BCS, México. Marine Turtle Newsletter 89:4-7.

Nichols, W.J., A. Resendiz, J.A. Seminoff and B. Resendiz. 2000b. Transpacific migration of the loggerhead turtle monitored by satellite telemetry. Bull. of Marine Science.

Nichols, W.J., J.A. Seminoff, A. Resendiz, P.H. Dutton and A. Abreu-Grobois. 1998. Using molecular genetics and biotelemetry to study life history and long distance movement: A tale of two turtles. In: S.P. Epperly and J. Braun, comps. Proceedings of the 17th Annual Symposium on Sea Turtle Biology and Conservation. NOAA Technical Memorandum. NMFS-SEFSC-415.

Pesenti, C. 2002. Conference report: The 4th annual meeting of the Sea Turtle Conservation Network of the Californias. Journal of Environment and Development. Vol. 11, no. 2.

Sea turtle health assessment program in the Caribbean and Atlantic

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INTRODUCTION

Although sea turtles have survived on this planet for over 150 million years, recent anthropogenic influences have resulted in the classification of all seven species as either threatened or endangered. Over the past century, habitat destruction, incidental and intentional harvesting and temperature change have caused the accelerated decline of sea turtle populations worldwide. Currently, sea turtles are facing an additional challenge to their survival; an increasing incidence of diseases and health related problems in the wild (Herbst 1994, George 1997, Lutcavage et al. 1997). As populations continue to dwindle, the more critical it becomes for scientists to ascertain the health status of free-ranging sea turtles and to address the health–related problems that could decimate already fragile populations.

One obstacle to conducting health evaluations of sea turtles is a lack of standardized and accepted field sample collection techniques and laboratory diagnostic tests. Additionally, to the authors' knowledge no studies have attempted to look simultaneously at a variety of sites utilizing the same field and laboratory techniques. It is necessary to obtain baseline data to establish "normal" health parameters, in addition to determining what infectious / parasitic agents and toxins are prevalent in these populations. The Sea Turtle Health Assessment Program in the Caribbean and Atlantic takes these factors into consideration, providing a comprehensive model for investigating sea turtle health. The specific objectives of this program are: (1) to establish baseline blood values, and to determine the prevalence of select parasitic and infectious agents, fibropapillomatosis, and toxins, in free-ranging loggerhead (*Caretta caretta*), green (*Chelonia mydas*), leatherback (*Dermochelys coriacea*), hawksbill (*Eretmochelys imbricata*), Kemp's ridley (*Lepidochelys kempii*), and olive ridley (*Lepidochelys olivacea*) sea turtles at study sites; and (2) to provide training to biologists, NGO staff, local veterinarians and students in sea turtle health-monitoring techniques.

METHODS

Veterinarians with the Field Veterinary Program of the Wildlife Conservation Society work at five key foraging and/or nesting sites in the Caribbean and Atlantic. Physical examinations, and in select cases ultrasonography and laparoscopy, are conducted and biomaterials including blood, epibiota, feces, surgical biopsies, and, if appropriate, necropsy tissues, are collected in a standardized manner. Physical examination and necropsy forms are used by the veterinarians at all sites and local biologists are being trained to conduct both physical examinations and necropsies for long-term monitoring when FVP veterinarians are not present. Field sample collection methods are available from the first author upon request.

A number of laboratory personnel, with experience in sea turtle diagnostics, are collaborating with us. This ensures that all samples are processed in the same manner. At this time, collaborators include: Dr. Ellis Greiner of the University of Florida for fecal, spleen, and heart parasitic evaluation; Dr. Rick Alleman of the University of Florida for clinical pathology; Dr. Carolyn Cray of the University of Miami for plasma chemistries, protein electrophoresis (EPH), corticosterone and aspergillosis assays; Dr. Larry Herbst of Albert Einstein Hospital for herpes ELISA, spirorchid ELISA, and vitellogenin; Dr. Michael Linn of the Wildlife Conservation Society for histopathology; and Dr. Bob Poppenga of the University of Pennsylvania for toxins. We are currently talking with additional researchers that have an interest in genetic, hormonal, and/or infectious serology evaluation of these populations.

RESULTS

We have developed standard physical examination and necropsy forms to ensure consistent data collection by field researchers at the different field sites. Diagnosticians with expertise in different aspects of sea turtle health have been / will process, in a standard manner, the samples from the different species and sites. We are working closely with sea turtle biologists at the sites (Nicaragua, Costa Rica, Georgia, Congo, Gabon) to the benefit of both biologists and veterinarians for a multidisciplinary approach to sea turtle conservation.

We have collected biomaterials from 5 hawksbill, 46 green, 29 loggerhead, 1 Kemp's ridley, and 35 leatherback adult turtles, as well as a number of hawksbill and loggerhead embryos and hatchlings. As an example, preliminary data from our work in the southeastern USA are presented here. We have data from one season (2001) during which we sampled nesting loggerhead turtles (n=8), foraging loggerhead turtles (n=16), loggerhead nest excavations (n=52), and stranded turtles (3 loggerhead, 1 Kemp's ridley, and 1 green turtle). Complete blood counts, plasma chemistries, and EPH results for the nesting females and foraging loggerhead turtles are presented in Table 1. All 8 nesting and 16 foraging loggerheads were negative for toxins (alpha-BHC , beta-BHC, Lindane, Heptachlor, Heptachlor expoxide, Aldrin, Dieldrin, alpha-Chlordane, Endrin, Methoxychlor, pp-DDT, pp-DDE, pp-DDD). Serologic assays for *Aspergillus* sp. antibody and antigen (commonly used with avian species) were also negative. No external Fibropapillomas were observed on any of the turtles. The barnacle loads were high on the adult nesting and foraging turtles with 4 turtles graded as 4+, 13 graded as 2+, and 6 graded as <=1+ (1 not graded). Herpes and spirorchid serology are pending. Once we have all data collected, it will be analyzed for correlation of blood parameter findings with infectious agents, toxin levels, and clinical findings. Of the eggs that did not hatch, embryos were evaluated for age of death, deformities were noted (i.e., albinism, ocular/facial malformations, missing flippers), and yolk and embryos were either frozen or placed in 10% buffered formalin for future toxin and histologic evaluation, respectively. We provided veterinary care to five stranded turtles; a 35 kg Kemp's ridley and 4 kg green turtles with hypothermic stunning, 100 kg female loggerhead with egg yolk peritonitis, focal pneumonia, and spindle cell carcinoma, 105 kg female loggerhead with a deep carapace propeller wound, and a 35 kg loggerhead turtle with recent shark bite amputation of its right front flipper. All turtles were triaged by our team, health assessment samples were collected, and the turtles were then sent to Sea World of Orlando or Disney's Living Seas for long term care and if appropriate, release.

CONCLUSIONS

As we continue to develop this program, we will maintain collaborative ties with field and laboratory personnel. Now that we have succeeded in establishing standardized field sampling techniques we will be able to determine baseline blood parameter values and prevalence of infectious and parasitic agents, and noninfectious causes of disease in the populations at our five sites. Even though in much of the world the most significant threats to sea turtle conservation remain the poaching of eggs and killing of adults for meat, disease (much of it due to anthropogenic changes) has begun to hamper long-term conservation efforts as evidenced by fibropapillomatosis and recent mass strandings. The importance of this study warrants continued fund raising efforts. Our ability to incorporate health studies within on-going ecological studies, which provides access to large sample sizes and fosters collaboration between conservation biologists and veterinarians, is imperative as we tackle conservation issues of the 21st century (Deem et al. 2001).

LITERATURE CITED

Deem, S.L., W.B. Karesh, and W.Weisman. 2001. Putting theory into practice: wildlife health in conservation. Conservation Biology 15:1224-1233.

George, R.H. 1997. Health problems and diseases of sea turtles. In: P.L. Lutz and J.A. Musick, eds. The Biology of Sea Turtles. CRC Press. New York. p. 363-385.

Herbst, L.H. 1994. Fibropapillomatosis of marine turtles. Annual Review of Fish Diseases 4:389-425.

Lutcavage, M., P. Plotkin, B. Witherington, and P. Lutz. 1997. Human impacts on sea turtle survival. In: P.L. Lutz and J.A. Musick, eds. The Biology of Sea Turtles. CRC Press. New York. p. 389-411.

Table 1. Mean ∀SD of body weight, straight line carapace length (n-n), over the curve carapace length (n-n), complete blood counts, plasma chemistries, and EPH results for the Georgia nesting and foraging females and foraging male loggerhead turtles (*Caretta caretta*).

Category	Nesting female (n=8)	Foraging female (n=12)	Foraging male (n=4)
Body weight (kg)	n/a	44.3 " 18.3	70.3 " 26.1
CL (n-n) OTC (cm)	100.6 " 8.1	68.7 " 10.8	81.5 "10.0
CL (n-n) straight line (cm)	n/a	64.6 " 10.7	76.1" 9.9
PCV (%)	38.7 " 2.8	32.3 " 6.6	34.3 " 4.3
TS (g/dl)	n/a	3.5 " 1.3	5.1 " 0.6
RBC	65.8 " 13.8	63.5 " 21.7	79.0 " 34.0
Glucose (mg/dl)	n/a	84.0 " 18.3	93.5 " 28.8
WBC (#)	10,771 " 3,765	8,283 " 2,979	9,025 " 2538
Heterophils (%)	61.0 " 6.8	53.8 " 10.7	50.5 " 4.4
Lymphocytes (%)	21.1 " 2.4	26.4 " 8.0	25.5 " 10.0
Monocytes (%)	8.7 " 3.9	6.7 " 4.3	10.0 " 3.7
Eosinophils (%)	9.0 " 3.2	265.3 " 7.4	13.5 " 4.1
Basophils (%)	0. " 0.0	0.0 " 0.0	0.0 " 0.0
Glucose (mg/dl)	99.5 " 17.4	113.8 " 28.3	135.0 " 35.4
Sodium (mmol/L)	151.6 " 2.9	158.5 " 11.3	166.3 " 2.2
Potassium (mmol/L)	3.6 "0.5	4.3 " 0.3	5.1 " 0.2
Chloride (mmol/L)	115.0 " 4.2	129.3 " 12.7	131.3 " 3.9
CO_2 (mmol/L)	23.6 " 6.5	22.8 " 5.9	17.3 " 1.3
BUN (mg/dl)	8.5 " 2.7	86.8 " 27.5	111.8 " 16.6
Creatinine (mg/dl)	0.1 " 0.1	0.5 " 0.4	0.5 " 0.1
BUN/creatinine (ratio)	7.8 " 29.2	256.8 " 144.8	254.0 " 50.7
TP (g/dl)	5.7 " 0.7	4.0 " 1.6	5.7 " 0.7
Albumin (g/dl)	1.6 " 0.2	1.2 " 0.3	1.5 " 0.2
Globulin (g/dl)	3.8 " 1.1	2.6 " 1.0	3.6 " 0.4
A/G (ratio)	0.6 " 0.1	0.3 " 0.1	0.3 " 0.0
Total bilirubin (mg/dl)	0.1 " 0.1	0.1" 0.0	0.1 " 0.0
Direct bilirubin (mg/dl)	0.0 " 0.1	0.0 " 0.0	0.0 " 0.0
Calcium (mg/dl)	8.4 " 3.6	8.1 " 2.2	8.0 " 1.3
Phosphorus (mg/dl)	10.3 " 2.0	7.2 " 1.6	8.2 " 0.8
Uric acid (mg/dl)	0.6 " 0.3	1.1 " 0.6	0.9 " 0.3
Alkaline phosphatate (U/L)	22.5 " 4.1	33.3 " 16.8	40.0 " 28.9
ALT (U/L)	8.5 " 2.8	18.8 " 4.9	19.8 " 2.5
AST (U/L)	204.5 " 80.0	204. 3" 66.5	238.8 " 42.8
LDH (U/L)	963.1 " 337.1	881.8 " 549.8	1063.3 " 262.2
CPK (U/L)	673.1 " 1210.5	513.6 "272.9	643.8 " 312.9
Amylase (U/L)	623.5 " 150.1	378.1 " 81.7	438.3 " 107.1
Lipase (U/L)	25.3 " 10.0	5.5 " 4.7	7.0 " 1.8
GGT (U/L)	6.0 " 1.6	<5 " 0.0	<5 " 0.0
Cholesterol (mg/dl)	261.6 " 51.7	84.9 " 50.3	130.5 " 61.6
Triglyercide (mg/dl)	698.1 " 310.1	73.3 " 48.7	132.5 " 73.5
EPH Total Protein (g/dl)	5.7 " 0.7	4.0 " 1.6	5.7 " 0.7
EPH Albumin (g/dl)	1.8 " 0.3	0.9 " 0.4	0.1 " 0.0
EPH Alpha-1 (g/dl)	0.2 " 0.0	0.1 " 0.0	0.1 " 0.1
EPH Alpha-2 (g/dl)	0.3 " 0.2	0.1 " 0.0	0.1 " 0.0
EPH Beta (g/dl)	1.5 " 0.3	1.2 " 0.5	1.7 " 0.3
EPH Gamma (g/dl)	1.6 " 0.6	1.7 " 0.8	2.6 " 0.5

Pathologic findings in loggerhead turtles found with polyneuropathy in coastal waters off South Florida

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Starting in October 2000, subadult loggerhead sea turtles (*Caretta caretta*) showing clinical signs of a neurological disorder were found in waters off south Florida. Neurologic examination supported a diagnosis of neuromuscular junction transmission block and/or a severe demyelinating polyneuropathy that had spared axons and caused a conduction block of nerves. Seventeen turtles that were brought into rehabilitation facilities subsequently died and were necropsied. Using light microscopy, the most prominent lesions included tracheitis, proliferative pneumonia and spirorchidiasis. Ulnar nerve and biceps brachii and sciatic nerve and semimembranosus were collected were electron microscopically evaluated. A polyneuropathy may have been responsible for the tracheitis and pneumonia since these animals probably could not clear inhaled material from their respiratory passages. The spirorchid trematode eggs and or adults were seen in a variety of tissues including spinal cord, meninges and brain. Eggs of these parasites were often surrounded by a granulomatous inflammatory response. Myocarditis was also seen in several cases with small round cells (probably lymphocytes) infiltrating the myocardium. A range of other lesions were seen in the various turtles evaluated. Since tracheitis and proliferative pneumonia have been associated with a specific herpesvirus infection in green turtles (*Chelonia mydas*) in a turtle farm in the Cayman islands, tissues from one affected turtle were cultured for herpesvirus and assayed by PCR for presence of herpesvirus gene sequences, and plasma samples from affected turtles have been assayed by ELISA for specific antibody to a herpesvirus isolated from green turtles. These tests have been negative to date.

Organochlorine residues in the tissues of loggerhead sea turtles (*Caretta caretta*) from Florida waters

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Matched liver and kidney tissues were collected during necropsies from loggerhead sea turtles (*Caretta caretta*) involved in an unusual stranding event that occurred along the Florida coast from Fall 2000 to Spring 2001. These tissues along with tissues collected from loggerheads that died in incidents unrelated to the epizootic were analyzed for organochlorines. Findings between the two groups are compared.

The development of recombinant viral antigens for detecting herpesvirus infections in sea turtles

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Sea turtle conservation efforts must include the means to monitor sea turtle populations for exposure to disease-associated microorganisms. Critically needed are improvements in diagnostics, including the development of pathogen-specific antigens for use in immunoassays that measure disease exposure. Herpesviruses are associated with several diseases of marine turtles including lung-eye-tracheal disease (LETD) and fibropapillomatosis (FP). Using cultured virus, we have developed and applied an ELISA to demonstrate that wild green turtles in Florida are exposed to the LETD-associated herpesvirus (LETV). In contrast, efforts to cultivate the FP-associated herpesvirus (FPHV) have been unsuccessful, limiting diagnostic assay development and seroepidemiological studies. Recombinant protein technology can provide an unlimited supply of antigen for LETV and FPHV diagnostic assays once immunodominant viral antigens are identified. Two approaches were used to address this problem. The first approach targeted viral proteins known to be immunogenic in other herpesviruses. The second approach directly resolved LETV proteins that are consistently recognized by anti-LETV antibodies in plasma from LETV-immunized and naturally infected wild green turtles. A 38 kD LETV protein was identified as an immunodominant LETV antigen using one and two dimensional gel electrophoresis and Western blotting. This protein was isolated, digested, and sequenced. The sequence was compared to a LETV genomic library where the protein was identified as a viral structural protein known as the minor capsid protein. Experiments suggested that some FPHV infected turtles also recognize the minor capsid protein. These approaches will yield genuine FPHV antigens for assays to detect exposure of sea turtles to FPHV.

Anthropogenic insults are now widely recognized to impact ecosystem health. Pollution from agricultural run-off and pesticides are known agents in causing marine environmental degradation. It is suspected that sea turtles are highly susceptible to these insults and affected wild sea turtle populations operate sub-optimally under stressful conditions with reduced fitness. One of the most important manifestations of general stress is a compromised immune system which opens the animal to infectious agents. The best established association is between immunosuppression and fibropapillomatosis in green turtles (*Chelonia mydas*). However, the immune response of sea turtles is poorly understood. In order to determine the relationship between immune competence and sea turtle health we performed flow cytometry to determine CD4/CD8 ratios, serum protein electrophoresis to identify immunoglobulins and complement proteins, clinical chemistries, leukocyte differentials and hematological panels in green turtles from three different populations.

Immune status of Florida sea turtles in relationship to sea turtle health

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Anthropogenic insults are now widely recognized to impact ecosystem health. Pollution from agricultural run-off and pesticides are known agents in causing marine environmental degradation. It is suspected that sea turtles are highly susceptible to these insults and affected wild sea turtle populations operate sub-optimally under stressful conditions with reduced fitness. One of the most important manifestations of general stress is a compromised immune system which opens the animal to infectious agents. The best established association is between immunosuppression and fibropapillomatosis in green turtles (*Chelonia mydas*). However, the immune response of sea turtles is poorly understood. In order to determine the relationship between immune competence and sea turtle health we performed flow cytometry to determine CD4/CD8 ratios, serum protein electrophoresis to identify immunoglobulins and complement proteins, clinical chemistries, leukocyte differentials and hematological panels in green turtles from three different populations.

Are contaminants affecting loggerhead health?

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Very few studies have reported contaminant concentrations in sea turtles. Generally, these studies demonstrated that sea turtles accumulate lower levels of organochlorine contaminants than other wildlife species, such as fish-eating birds and marine mammals, but their sensitivity to these compounds is completely unknown. Therefore, we compared organochlorine contaminant concentrations in tissues of juvenile loggerhead sea turtles to health indicators. Forty-four live, juvenile loggerhead turtles (46-78 cm straight carapace length) were sampled from July to August in 2000 and 2001 from Core Sound, North Carolina, USA. Using GC-ECD and GC-MS, low levels of organochlorines were detected in the fat biopsies (256 ± 269 ng total PCBs/g wet weight; 67.0 ± 68.7 ng total DDTs/g wet weight) and blood samples (5560 ± 5280 pg total PCBs/g wet weight; 801 ± 809 pg total DDTs/g wet weight). The blood concentrations for all major classes of compounds (PCBs, DDTs, chlordanes, and other organochlorine pesticides) were significantly correlated to those found in the fat biopsies ($p < 0.05$). Several significant correlations were also observed between contaminant levels and indicators of poor health. Turtles with higher contaminant levels had decreased body condition (weight to length ratio), decreased blood glucose, and a reduced ratio of albumin to globulin. Contaminants also correlated to indicators of ionic imbalance, such as increased blood sodium and decreased magnesium. White blood cell counts were skewed; turtles with higher levels of contaminants had decreased numbers of circulating lymphocytes, increased numbers of eosinophils, and an increased ratio of heterophils to lymphocytes. An elevated ratio of heterophils to lymphocytes suggests that these contaminants may be stressing the immune system. Contaminants were also positively correlated to blood urea nitrogen (BUN) and aspartate aminotransferase (AST), which are indicators of kidney and liver damage, respectively. It is difficult to interpret these latter results, because BUN can fluctuate dramatically over short time periods within an individual turtle and the distribution and concentration of AST in loggerhead soft tissues is not yet known. Testosterone levels did not correlate to any contaminant identified in either males or females. However, one juvenile female (56 cm SCL) had detectable vitellogenin, a protein involved in egg production in adult female turtles. The presence of this protein in a small juvenile turtle suggests a possible disruption of the endocrine system. Interestingly, this turtle had the second highest total PCBs and 4,4'-DDE concentrations on a wet weight basis in fat compared to all other turtles examined. We now have the capacity to monitor organochlorine contaminants using loggerhead blood. Moreover, we now have the first line of evidence that, even at low concentrations, organochlorine contaminants may affect loggerhead health.

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Heavy metal concentration in the Kemp's ridley (*Lepidochelys kempii*) and its blue crab (*Callinectes sapidus*) prey

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Concentrations of heavy metals (Ag, Cu, Hg, Pb and Zn) were determined and compared between in the blood of Kemp's ridley (*Lepidochelys kempii*) and its blue crabs (*Callinectes sapidus*) prey taken in the entanglement nets along the upper Texas and Louisiana coast during May-August 1994, 1995 and 2000. Hg and Zn concentrations in the blood of Kemp's ridleys were positively related to size of turtles. Kemp's ridleys captured during 1994 and 1995 exhibited higher levels of Ag, Cu, Hg and Pb than those netted in 2001. Zn was the only metal to exhibit peak levels in 2001. Ag, Cu, Pb and Zn levels in tissues of blue crabs were 5 to 40 times higher than for those from turtle blood. Hg levels in ridley blood were similar to those in blue crab tissue. Future research includes developing safe protocols for assessing heavy metal concentrations in internal organs (e.g. liver and kidney) of Kemp's ridleys across constituent life stages and identifying other tissue sources (e.g. shells of infertile egg and dead hatchlings) with which to trace contaminant pathways.

Re-examination of the holotype of *Chelonia agassizi* (Bocourt)

Jacques Fretey

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In 1868, Bocourt (Ann. Sci. nat. France, 1868 10: 122) briefly described a new species of marine turtle that he considered to be distinct from the "Chélonée vergetée" (*Chelonia virgata*), attributed to Schweigger (1812) (or possibly to Duméril). Bocourt named the new species in honor of Professor Louis Agassiz who, he wrote, had already identified the principal characteristics of this "Chélonée" in 1857 in his Contributions to the Natural History of the United States (Vol. 1 pt II: 379). In his description, Bocourt specifies that the new species had a tectiform carapace, more elevated than that of the "Chelonée vergetée." He also mentioned a few differences in the size or proportions of the carapace scutes and head scales. Bocourt's specimen still exists in the collection of the Muséum national d'Histoire naturelle in Paris, where it is catalogued with the number MNHNP 9357. The specimen is a dry (stuffed) mount, affixed to a wooden base with various handwritten inscriptions including "*Chelonia agassizii* Bocourt Océan Pacifique," "A l'embouchure du Nagualate (Guatemala)," and "1872.1." The male symbol (circle with downward arrow) is also represented. The limbs are desiccated and contorted. The shell and head have been varnished, but it is still evident that the overall coloration was coppery-brown mottled with yellow. The pectoral region of the plastron is yellow, while the humeral and femoral areas are orange-brown. Two large postocular scales are evident in each side, and three suboculars, the first of which contacts the posterior edge of the upper rhamphotheca.

Molecular ecology of *Chelonia mydas* in the Eastern Pacific Ocean

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Little is known about the population stock structure of green turtles in the eastern Pacific. Molecular genetic techniques are useful for identifying management units and gaining insights into the ecology of these migratory animals. The continuing decline of the nesting populations on the coast of Michoacan, Mexico, despite over 20 years of beach protection, illustrates the importance of identifying the linkages between forage areas, where catastrophic mortality persists, and the different nesting stocks. Analysis using mitochondrial DNA (mtDNA) sequences indicate that key nesting populations at Michoacan, Mexico; Galapagos Islands, Ecuador; and Islas Revillagigedos, Mexico can be considered distinct management units. Nesting assemblages throughout the Pacific broadly group into 2 distinct regional clades comprised of 1) western Pacific and South Pacific islands, and 2) eastern Pacific and central Pacific, including the rookery at French Frigate Shoals in the Hawaiian Islands. Coastal foraging areas in the eastern Pacific range from San Diego Bay, California, USA in the north, to Mejillones, Chile in the south. The mtDNA data indicate that animals found on foraging grounds along the coast of Chile are from the Galapagos nesting stocks, while those foraging in the Gulf of California are primarily from the Michoacan nesting stock. The foraging areas along the Pacific coast of Baja California and in San Diego Bay, California, comprised animals primarily from the Islas Revillagigedos. These results allow dispersal and migration patterns to be inferred, and do not support previous speculation of a Hawaiian stock contribution to these continental foraging areas. These results are also consistent with results of tagging and telemetry studies that are beginning to document migration of adults between San Diego Bay and Islas Revillgigedos. Further work is needed to include the smaller nesting assemblages in Central America, and the potentially important foraging areas throughout Central and South America and around the Galapagos Islands.

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Reproductive biology and current status of the black turtle in Michoacan, Mexico

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From 1981 to 2001 annual nest counts and observed clutch frequency values were used to estimate numbers of black turtle nesting females at Colola beach (main continental rookery for the black turtle in the east Pacific). Survey coverage to register number of nests and calculate clutch frequency was similar among years. Interannual variation in numbers of nesting females was high, with an average of 677 (range=2500 in 2001 to 98 in 1988). Highest numbers were registered in the first and final years of the monitoring period: 2200 in 1981, 1350 in 1982, 1227 in 2000 and 2500 in 2001. Using as a reference the number of nesters in 1981 and 1982, for 17 years (1983 to 1999) the black turtle population nesting at Colola showed a drastic reduction as a result of the harvest of eggs, juveniles and adults in the nesting and foraging grounds. Although the increase in numbers registered in the 2000 and 2001 after 17 years of low numbers suggest possible cause for optimism, the historical numbers of black turtle nesters during the 60´s indicate that the population is still far below its natural level.

First study of the green/black turtles of the Revillagigedo Archipelago: a unique nesting stock in the Eastern Pacific

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The Biosphere Reserve of the Archipelago of Revillagigedo, an isolated group of islands far offshore from the Pacific Mexican coast, contains a previously unstudied population of eastern Pacific green/black turtles (*Chelonia mydas*) consisting of nesting females and foraging animals of a range of development stages (hatchlings, juveniles and adults). The animals described in this study showed a variation of morphology and coloration, with some nesting animals showing classic "black" turtle characteristics, and others "green" turtle characteristics. The geographic isolation, and intermediary location between Hawaii and mainland Mexico, the two nearest nesting areas of greens in the central and eastern Pacific, make this population of particular interest with regards to population ecology and evolution of green turtles in the eastern Pacific. We present data on nesting and foraging biology of this population gathered during 2 consecutive seasons (1999-2001) for at 3 beaches on Clarión Island and 5 beaches on Socorro. Nesting occurs year-round but increases seasonally between July and March, with peak nesting activity during October and November. Although this population is relatively small compared to the mainland population at Michoacan, we believe it is fairly pristine and productive (with an average hatch success of 89.7%), providing a major source of animals that are found foraging along the coast of Baja California and southern California, USA. The adult female Revillagigedo greens were generally larger than those of the mainland population in Michoacan, with curved carapace lengths averaging 94.4 cm (s= 6.76, 81:108.8, n= 42). Genetic analysis revealed four new mtDNA haplotypes endemic to the Revillagigedo nesting population, which had previously only been found at forage areas in Baja California and San Diego Bay. These genetic results combined with the discovery of a nesting female originally tagged at the forage ground in San Diego Bay, confirm that the Revillagigedo population is a genetically distinct stock that is distributed throughout the Baja California and western USA region.

First results of the East Pacific green turtle, *Chelonia mydas*, nesting population assessment in the Galapagos Islands

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INTRODUCTION

The East Pacific green turtle is the only marine turtle species that nests in the Galapagos Islands, and is present at almost every island, except Rábida, Genovesa, Pinzón and Fernandina (Green 1994). The most important nesting beaches in the Galapagos Archipelago are Quinta Playa and Bahía Barahona in Isabela Island, Las Bachas in Santa Cruz Island, Las Salinas in Seymour Island and Espumilla in Santiago Island (Green and Ortiz-Crespo 1981). However, there are other sites such as La Picona Beach (Floreana), and Bartolomé (Bartolomé), which have been sporadically studied where nesting activity for this species has been observed (Hurtado 1984).

According to the Management Plan for terrestrial areas most of beaches are protected under National Park category, the exception to this are the beaches located in Seymour Island, those are under military jurisdiction because de island is an Ecuadorian Air Force base. Besides that, the zonification that governs the Galapagos Marine Reserve has classified Las Bachas under the tourist site category.

Taking into consideration the high number of nesting females observed during 1975-1982 (N=1500 tagged females), investigators arrived to the conclusion that the nesting population in the Galapagos Islands was one of the most important ones of the East Pacific Ocean (Pritchard 1975, Green and Ortiz-Crespo 1981, Hurtado 1984).

The main threats that have been registered in the past for the green turtle nesting activity were the presence of the feral pig *Sus scrofa*, that is an introduced species and the beetle *Omorgus suberosus*, a native species (Allgoewer 1980, Hurtado 1984). The individual or combined effect of these species has been important in several of the studied sites, dramatically reducing the green turtle hatchling success (Hurtado 1984).

After almost twenty years without information, the investigations and monitoring activities of the Galapagos green turtle have recommenced. Here we present the first results for the 2002 East Pacific green turtle nesting season in the main nesting sites of the Archipelago.

METHODS

Study Area. The study sites are Quinta Playa and Bahía Barahona, located in southern Isabela Island, Las Bachas in northwest of Santa Cruz Island and Las Salinas in western of Seymour Island (Fig. 1).

Monitoring techniques. The nesting activity was monitored for almost four months in Las Bachas and approximately three months in each of the remaining sites. The study sites were patrolled on foot by groups of four people from 8:00 pm until 5:00 am. Every new female on the beach was tagged and the curve carapace length (CCL cm) and the maximum curved carapace width (CCW cm) were measured using a measuring tape. Inconel tags for individual identification were placed on the left front flipper and tagging took place during or after oviposition, trying not to disturb the turtles' nesting activity. Turtles tagged seen in following occasions during the season were recorded as "recaptures". Turtle's activities were recorded as nest (N), body pit (BP), U turn (U) and false Walk (FW). Eggs were counted when the turtle was found previous to oviposition and recorded under two different categories: fertile and infertile eggs. When hatchlings emerged, the total number of individuals was counted, detailing the number of dead and alive. The CCL and the CCW were measured in a random sample of ten hatchlings per nest. After each emergence, the nest was excavated to count the number of empty shells and eggs that didn't hatch. The emergence success was estimated according to

Miller (1999). During the night survey, the number of introduced species and destroyed nests were recorded.

RESULTS

Tagging. During the 2002 nesting season, a total of 2756 females were tagged in the four nesting beaches studied. The highest number were recorded in Las Bachas with 925 tagged individuals, 704 in Quinta Playa, 680 in Bahía Barahona and 447 in Las Salinas.

Size structure. A total of 2709 nesting turtles were measured during the present season, obtaining an average CCL of 86.7 cm (± 6.2) and a size range between 60.7 and 109.0 cm. The greatest number of turtles is concentrated between the sizes 80 and 95 cm CCL in all the studied beaches. Nesting females in the smallest size class (60-65 cm) are observed in every site except Quinta Playa; females from the largest size class (105-110 cm) were only observed in Las Bachas. The modal size is similar for Quinta Playa, Bahía Barahona and Las Salinas; only in Las Bachas it is greater (Table 1). The *C. mydas* total length measurements for every beach were compared, showing that the size variation is significant (ANOVA; F=18.491, gl=3, P=0.0001)

Nesting Activity. 5072 green turtles were observed in the studied beaches. Of this total, 1368 individuals (27.0%) nested in one opportunity, 467 (9.2%) nested twice and 157 (3.1%) nested three, four and five times during the 2002-nesting season. For the remaining 60.7%, which represents 3080 turtles, no nests were recorded. Their activity was a FW, BP or U, and others were not recaptured. The average size clutch was of 82.9 eggs per nest. The average number of nests was 1.37 nests/female green turtle (N=2756). The nesting interval was calculated using the data on every turtle that had nested at least twice, giving an average nesting interval of 14.7± 4.7 days with a range of 5 to 25 days (N=674). The maximum number of consecutive nests was five and observed in only 4 nesting turtles.

The total number of recorded nests was 3790. In each site, the highest number of nests was on week 8 (25 February - 3 March 2002), with the exception of Quinta Playa with maximum value obtained on week 12. In every site a tendency towards a gradual increase while the season develops and a fall while the season gets closer to its end is observed. Because high numbers of nests (N=90) are still counted during week 16 in Quinta Playa, nesting season in that site could be longer than the survey period. Only Las Salinas shows an end of the nesting season since it has a very low number of nests during the lasts weeks of the study period.

Hatchling emergences. The total of eggs counted was of 29856 with 89.9% emergence success (N=19). The highest value of hatchlings was 4538 individuals in Las Bachas, followed by Bahía Barahona with 1731 hatchlings, Las Salinas with 1890, and Quinta Playa with 1138 individuals. The total number of hatchlings observed during the monitoring period was of 9297. The average hatchling size was 4.9 cm and 4.4 cm (N=772) for SCL and SCW respectively.

Introduced species. The number of feral pigs recorded was low and only observed in Quinta Playa. By contrast, feral cats were abundant in Las Bachas, Quinta Playa and Bahía Barahona. At Las Salinas no feral cats or feral pigs were observed. Feral pigs predate eggs and destroy nests; therefore, the effect is seen on the hatching success. On the other hand, feral cats predate hatchlings when these are emerging from their nests. In some occasions feral cats have been observed digging up a nest from which hatchlings were emerging, eating their heads. The beetle *Omorgus suberosus* was only observed in two occasions at Bahía Barahona.

DISCUSSION

The information gathered during the 2002 nesting season shows the highest abundance of nesting females ever recorded in the region (Fig. 2) confirming that Galapagos Island remains an important nesting site for the green turtle in the East Pacific Ocean. Green turtles present annual cyclic variation in their abundance and some populations prove this, such as the colony in Florida (Bagley et al. 1998) where years of abundance are followed by years of scarcity. However, the annual variability in number of turtles in Galapagos has been related to the oceanographic conditions of the region, which presents a significant variation in the interannual water temperature and productivity, associated to El Niño Southern Oscillation (ENSO) (Fiedler and Philbrick 1991). These variations affect the survival and reproduction of some vertebrate organisms in the Eastern Tropical Pacific Ocean (Arntz and Fahrbach 1996) and also the quality and availability of the green turtle feeding resources (Limpus and Nicholls 1988), and their reproductive cycles increasing metabolism and shorten the follicular maturation period (Márquez 1996).

In the years when El Niño affected the Archipelago, low numbers of turtles were recorded in the nesting beaches of Galapagos. Such is the case for the years 1975, 1976 and 1983 and also for the years when no equatorial front was recorded as in 1979. On the other hand, the highest numbers of turtles were recorded in the years 1978 and 1982, when there was a well developed equatorial front during the previous months of the nesting season (Hurtado 1984). This situation was also recorded in Colola, Michoacan, Mexico where in 1982, 900 turtles were recorded and in 1983, affected by El Niño, the value fell abruptly to 200 individuals (Fuentes et al. 1999). The 2756-tagged turtles in the study sites during the 2002 nesting season outnumber the values recorded in previous studies (Cifuentes 1975, Green 1984, Hurtado 1984), presuming the presence of high productivity in the region. Therefore this 2002 season can be compared to the "good years", such as in 1982.

The average size of the Galapagos nesting females was similar to the one reported by Green (1994). However, the smallest turtle observed nesting has a CCL of 60.7 cm and differs from Green's recordings (1995) for Galapagos. In this study, 0.4% (N=11) of the total number of nesting females has a CCL below Green's value. The average size recorded here are higher to the one reported in Mexico (Cornelius 1976, Alvarado and Figueroa 1990; Table 3).

Approximately 40% of the beaches in Galapagos are potential green turtle nesting sites according to surveys done in the past (Pritchard 1975). The coast line of the majority of these sites (87%), however, are considered extractive sites where the artisanal fishery is allowed; only 5.8% of the beaches are within tourist sites; 4.3% of the sites are in protected areas and 2.9% in areas of multiple uses close to human settlements. Of the total potential sites only 4.5% (N= 7) have been studied (Table 4).

The studied sites have been considered as the most important nesting beaches for the green turtle in Galapagos (Hurtado 1984, Green 1994). However, during this season Las Salinas showed to have lesser abundance, historic recordings placed the site in a second or third place of importance (Hurtado 1984). Considering the constant observation during the 2002-nesting season, the possible causes for the lower number of nests and nesting turtles are human impact and artificial light.

Special attention must be paid to other sites in Galapagos like Espumilla beach since until five years ago it was invaded by feral pigs that were responsible for the low hatching percentages recorded (Hurtado 1984). The introduced species eradication program conducted by the Galapagos National Park eliminated the pigs in this island and nowadays the importance of this place as a green turtle nesting site remains unknown.

The green turtle nesting cycle varies according to the geographic region. In Michoacán, Mexico, the females nest every two to three years (Alvarado and Figueroa 1990); in Naranjo Beach, Costa Rica, nesting takes place every year (Cornelius 1986). Hurtado (1984) described the Galapagos green turtle nesting cycle as longer than the mentioned above, a cycle of three to five years. In the present study a turtle tagged in Las Salinas in 2001 was recaptured in Las Bachas during the 2002-nesting season, 369 days after and in both opportunities it nested but a longer period of time to establish the nesting cycle in Galapagos is required.

The range of eggs laid in the nests registered for the 2002 nesting season was 29 to 157 eggs and is similar to the one found by Green (1994) from 28 to 144 but is not coincident with the minimum range value recorded by Hurtado (1984) of 52 eggs. In some occasions females stopped while laying only a few eggs and returned to the sea probably due because Galapagos green turtles are very sensitive to noise and artificial light and they suspend nesting activity as soon as they become perturbed.

The average number of 82.9 eggs per nesting during the 2002 is not significantly different with the value reported before (Cifuentes 1975b, Hurtado 1984) and can be compared with the average found in Costa Rica (Cornelius 1976). However this average is higher than the 65.0 eggs per nest found in Michoacán, Mexico (Alvarado and Figueroa 1990) and considerably lower in comparison to the average of 113 eggs per nest in El Cuyo, Yucatán (Zambrano and Rodríguez 1992) or 155 in North Carolina (Miller et al. 1998) and therefore the size of the Galapagos green turtle clutch is considered one of the smallest recorded within the green turtle populations of the world.

The clutch frequency or the average number of nests laid per turtle calculated here was higher than the one recorded by Hurtado (1984), 0.86 nest/turtle, for the period of time between 1980-1982 and is lower to those found in Tortuguero, Costa Rica (Carr et al. 1978) and French Frigate Shoals, Hawaii (Balazs 1980) estimated in 2.8 and 1.8, respectively.

The threats of the introduced species, feral pig, have varied in comparison with past studies. The cause for the low number seen on the sites can be attributed to continuous human presence during the whole nesting season that kept these animals away from the area, or that the intense rain recorded during the season provided feral pigs with another food source. Feral cats, on the other hand, recorded in Quinta Playa, Bahía Barahona and Las Bachas, were seen in high numbers. Therefore, when the highest number of hatchlings is recorded, cats can be an important threat to their survival. No cats were recorded in Las Salinas because the eradication program conducted by the Galapagos National Park and Charles Darwin Research Station is having success.

The 89.9% of the coastline of the green turtle nesting beaches is in non-protected areas, whether these are extractive areas or zones near the settlements (Zonification that governs the Galapagos Marine Reserve). Areas of extraction represent a threat for the green turtles since certain fishing gears could cause the entanglement of juvenile and adult individuals. In some settlements, such as Puerto Villamil in Isabela Island, the habit of egg poaching is still practiced. Also, the excessive number of tourists at the nesting beaches could generate an important impact on the sand to nests and hatchlings. These threats become important during the nesting season when turtles come out to the beach to lay their eggs.

LITERATURE CITED

Alvarado, J., and A. Figueroa. 1990. The ecological recovery of sea turtles of Michoacán, Mexico. Special attention: the black turtle, *Chelonia agassizi.* Unpubl. Report to U.S Fish and Wildlife Service.

Allgoewer, K. 1980. Egg predation on the green sea turtle *Chelonia mydas agassizi* by the scarabeid beetle *Trox suberosis* on the Galapagos Islands. Progress Report. Files, CDRS

Arntz, W.E., and E. Fahrbach. 1996. El Niño: Experimento climático de la Naturaleza. Fondo de Cultura Económica, México. 312 pp.

Bagley, D.A., L.T. Uong, A.B. Danner, S. Hirama, L.A. Wick and L.M. Ehrhart. 1998. Marine turtle nesting at the Archie Carr National Wildlife Refuge in 1997. In: F.A. Abreu-Grobois, R. Briseño-Dueñas, R. Márquez-Millan, and L. Sarti-Martinez. Proceedings of the Eighteenth International Sea Turtle Symposium. NOAA Tech. Memo. NMFS-SEFSC-436. p. 175-177.

Balazs, G.H. 1980. Synopsis of biological data on the green turtle in the Hawaiian islands. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-SWFC-7 141p.

Bjorndal, K.A. 1995. Biology and Conservation of Sea Turtles. Smithsonian Institution Press. Washington, D.C.

Carr, A., M. Carr and A. Meylan. 1978. The ecology and migration of sea turtles, 7: the west Caribbean green turtle colony. In: M. Hurtado. 1984. Registro de anidación de la tortuga negra, *Chelonia nydas* en las Islas Galápagos. Boletín Científico y Técnico 6:77-104.

Cifuentes, M. 1975. La reproducción y varios aspectos de la ecología de la tortuga negra, *Chelonia mydas agassizi*, de las islas Galápagos. Tesis de Licenciado, Universidad Católica, Quito.

Cornelius, S.E. 1976. Marine turtle nesting activity at Playa Naranjo, Costa Rica. National Marine Fisheries Service and U.S Fish and Wildlife Service. 1998. Recovery Plan for U.S. Pacific Populations of the East Pacific Green Turtle (*Chelonia mydas*). National Marine Fisheries Service, Silver Spring, MD.

Cornelius, S.E. 1986. The sea turtles of Santa Rosa National Park. In National Marine Fisheries Service and U.S Fish and Wildlife Service. 1998. Recovery Plan for U.S. Pacific Populations of the East Pacific Green Turtle (*Chelonia mydas*). National Marine Fisheries Service, Silver Spring, MD.

Fiedler, P.C. and V. Philbrick. 1991. Oceanic upwelling and productivity in the Eastern tropical Pacific. Limnol. Oceanogr., 36:1834-1850.

Fuentes, A.L., V.H. Garduño, J. Alvarado and C. Delgado. 1999. Possible effects of El Niño- Southern Oscillation on the black turtle nesting population at Michoacán, Mexico. In: H.J. Kalb and T. Wibbels, comps. Proceedings of the Nineteenth Annual Symposium on Biology and Conservation. NOAA Tech. Memo. NMFS-SEFSC-443. p. 269-271.

Green, D. 1978. The east Pacific green sea turtle in Galapagos. Noticias de Galapagos No 28. Charles Darwin Research Station. Pp 9-12.

Green, D. and M. Hurtado. 1978. Ecología de la población de la tortuga verde (*Chelonia mydas agassizi*) del Pacífico Este en las Islas Galápagos. Instituto Nacional de Pesca. Segundas Jornadas Ecuatorianas de Biología.

Green, D. and F. Ortiz-Crespo. 1981. Status of sea turtle populations in the Central Eastern Pacific. In: K.A. Bjorndal, ed. Biological and Conservation of Sea Turtles. Smithsonian Institution Press, Washington, D.C. p. 211-233.

Hurtado, M. 1984. Registro de anidación de la tortuga negra, *Chelonia mydas* en las Islas Galápagos. Boletín científico y Técnico. Vol. 6 N 3.

Limpus, P.C. and N. Nicholls. 1988. The southern oscillation regulates the annual numbers of green turtles (*Chelonia mydas*) breeding around northern Australia. Aust. Wildl. Res., 5,157.

Márquez, R. 1996. Las Tortugas Marinas y Nuestro Tiempo. Fondo de Cultura Económica, México. 191 pp.

Miller, J.D. 1999. Determining clutch size and hatchling success. In: K. Eckert, K.A. Bjorndal, F.A. Abreu-Grobois and M. Donnelly, eds. Research Management Techniques for the Conservation of Sea Turtles. IUCN/SSC Marine Turtle Specialist Group Publication N° 4. p. 101-109.

Plan de Manejo de Conservación y Uso Sustentable para la Reserva Marina de Galápagos. 1999. Publicado en el Registro Oficial n° 173.

Pritchard, P.C.H. 1975. Galapagos sea turtles - research and conservation. Progress report on WWF project number 790. In: Archivo en Estación Científica Charles Darwin, Santa Cruz, Galápagos.

Zambrano, R. y E. Rodríguez. 1992. The nesting biology of hawksbill (*Eretmochelys imbricata*) and green (*Chelonia mydas*) sea turtles in El Cuyo, Yucatán; Mexico. In: J.I. Richardson and T.H. Richardson, comps. Proceedings of the Twelfth Annual Workshop on Sea Turtle Biology and Conservation. NOAA Tech. Memo. NMFS-SEFSC-361. p. 252-256.

Table 1. Descriptive statistical data for green turtle nesting females un the four studied sites during the 2002-nesting season.

	Quinta Blanca	Bahia Barahona	Las Bachas	Las Salinas
Mean	86.1	85.6	87.8	87.1
SD	6.2	6.1	7.9	6.1
Mode	80.0	83.0	92.0	84.0
Med	86.0	85.3	87.4	87.1
Min	66.0	60.7	62.0	61.3
Max	104.3	105.0	109.0	102.0
N	701	677	899	432

Table 2. Statistical data for the Galapagos green nesting females in studies conducted by Green (1994) and the present study. [a]Green 1994, [b]This study, [c]Alvarado and Figueroa 1990, [d]Cornelius 1976.

	Galapagos[a]	Galapagos[b]	Michoacán(Mexico)[c]	Playa Naranjo (CR)[d]
Mean	85.60	86.7	82.0	82.9
Min	71.00	60.7	60.0	73.0
Max	110.56	109.0	102.0	97.0
SD		6.2		
N		2709	718	73

Table 3. Distribution of Galapagos potential nesting beaches and their zonification category according to the Galapagos Marine Reserve Management Plan. Source: Pritchard 1975.

Isla	2.1*	2.2**	2.3***	2.4****
Santa Cruz	1	3	30	2
Santiago	1	1	17	0
Isabela	0	0	3	0
Floreana	1	0	0	0
Cristóbal	0	0	10	0
Total	3	4	60	2
Percentage	4.3%	5.8%	87.0%	2.9%

Conservation sites; ** Tourist sites; ***Extractive sites (artisanal fishery); **** Multiple uses sites (near settlements)

Table 4. Total hatchling production in beaches of Galapagos between 1980 and 1982. Source: Hurtado (1984)

Nesting Beach	Island	*Total hatchling production*
Bahía Barahona	Isabela	16918
Las Bachas	Santa Cruz	12290
Quinta Playa	Isabela	11777
Las Salinas	Baltra	9144
La Picona	Floreana	4462
Bartolomé	Bartolomé	1421
Espumilla	Santiago	185
Total		56197

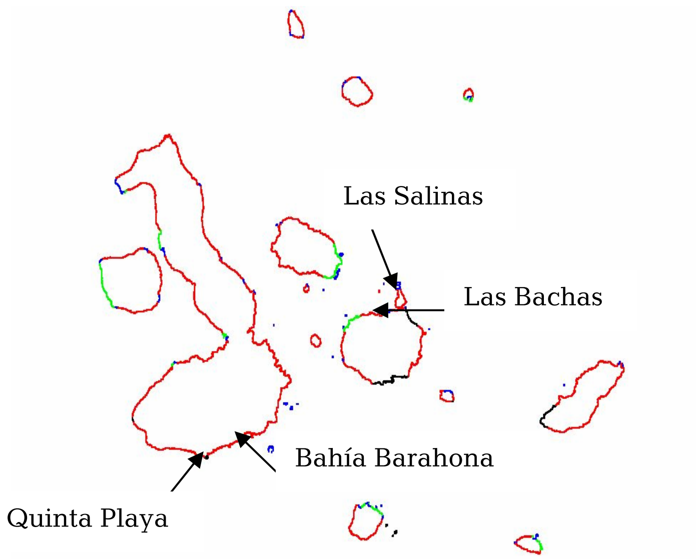

Fig. 1. Nesting sites studied during the 2002 nesting season. Las Salinas (Seymour Island); Las Bachas (Santa Cruz Island); Quinta Playa and Bahía Barahona (Isabela Island).

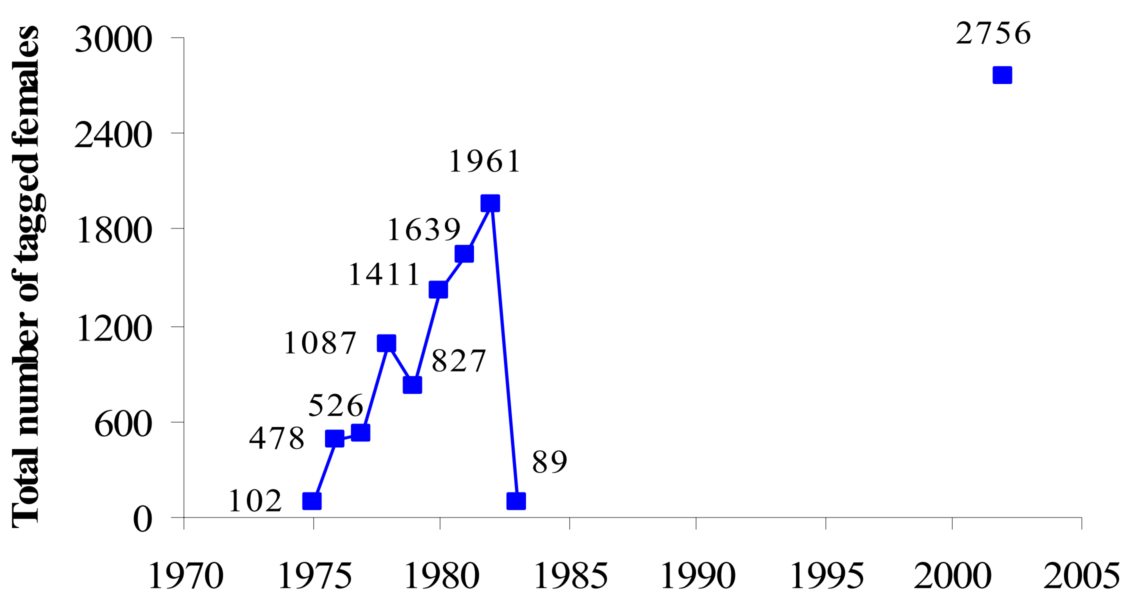

Fig. 2. Historic data of turtles tagged in Galapagos during the period of time between 1979-1983 in nesting sites of Galapagos. Source: Hurtado (1984). Year 1975 from Cifuentes (1975); 1976-1979 Green (1984); 1980-1983 Hurtado (1984); 2002 present study.

Movements of green turtles within and without the Galapagos Archipelago, Ecuador

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Movement of green turtles tagged in the Galápagos Archipelago occurs both outside of Galápagos waters (migration) and within Galápagos waters, including movement among the nesting beaches, movement between the nesting beaches and feeding grounds, and movement at the feeding grounds. The Galápagos Archipelago straddles the equator some 950 km off the coast of Ecuador between longitudes 89° W and 92° W (Fig. 1).

Migration. As with many green turtle populations elsewhere, the Galápagos breeding colony, or at least part of it, undertakes long-distance movements to, and is therefore recruited from, distant and widespread feeding grounds. Twenty females and three males tagged in the Galápagos Islands between 1970 and 1979 were recaptured outside of Galápagos waters (Green 1984). Ten recoveries, including two males, were from Peru, five from mainland Ecuador, one from Colombia, four from Panama, and three (including the third male) from Costa Rica. The minimum distances ranged from 1,120 to 2,163 km and the times between the last recorded sighting and recapture ranged from 98 days to 8.7 years. One female, recaptured off the coast of mainland Ecuador after nesting at Quinta Playa on Isabela Island, subsequently renested at Quinta Playa four years later.

Movement among nesting beaches. While most turtles nesting in Galápagos remain faithful to a particular beach during a given season, many change beaches, some several times. Quinta Playa and Bahía Barahona on southern Isabela are approximately 8 km apart. Of the 328 turtles observed on Quinta Playa during 1979, 19.2 percent also emerged on Bahía Barahona, while 40.1 percent of the 157 individuals encountered on Bahía Barahona also emerged on Quinta Playa. Similarly, 4.5 percent of the 444 turtles encountered at Las Salinas, Baltra during 1979 and 1980 also emerged at Las Bachas on northern Santa Cruz, while 5.2 percent of the 386 turtles encountered on Las Bachas also emerged on Baltra. Las Salinas and Las Bachas are approximately 5.5 km apart.

Longer-distance within-season changes also occur. Turtles nesting at Espumilla on Santiago Island and at Bartolomé Island have interchanged beaches, a distance of approximately 43 km. A female emerged on Baltra 17 days after last nesting on Espumilla, a minimum distance of 77 km. Finally, four Baltra-tagged turtles emerged on Quinta Playa, a distance of >110 km.

Movement between nesting beaches and feeding grounds. While many turtles may remain in the immediate vicinity of the nesting beaches during the internesting interval, some, at least, are capable of short journeys of around 8 km coupled with the ability to relocate the original nesting beach. Turtle Cove on northern Santa Cruz is approximately 3 km from Las Bachas and 7 km from Bahía Borero, also on northern Santa Cruz, and 5 km from (Las Salinas),Baltra. Eight (1.9 percent) of the 416 turtles tagged at Baltra and 11 (3.1 percent) of the 357 tagged at Las Bachas during 1979 and 1980 were recaptured in Turtle Cove. Nine of these 19 turtles (3 from Baltra and 6 from Las Bachas made a round trip from the nesting beach to Turtle Cove and back. One turtle went from Baltra to Turtle Cove via Las Bachas, a journey of at least 8.5 km.

Of the 222 females tagged in Turtle Cove during the same two years, 47 (21.2 percent) were subsequently recorded on nesting beaches: 23 (10.4 percent) each on Baltra and Las Bachas and 1 (0.5 percent) on Bahía Borero. In addition to the above turtles, which all emerged on the nesting beaches within a few months of being tagged, four other Turtle Cove females were seen on the beaches three or four years later (three on Las Bachas, one on Baltra).

Elizabeth Bay, a feeding area on western Isabela, lies approximately 94 to 262 km from the monitored nesting beaches. One female tagged at Elizabeth Bay nested on Quinta Playa after 184 days, then was recaptured in the same lagoon 116 days later, while a second female, tagged on the same day and at the same lagoon, emerged on Quinta Playa almost 5 years later. The distance between the two sites is at least 113 km, a round trip of 226 km. Three other females also moved between Elizabeth Bay and Quinta Playa. The two longest-distance tag recoveries, however, involve Baltra. One Baltra female was recaptured at Elizabeth Bay, while an Elizabeth Bay female emerged on Baltra, journeys of at least 262 km.

Movements at the feeding grounds. The turtle population at the Elizabeth Bay feeding grounds exhibits a high degree of residency, whereas the population at Turtle Cove tends to be more migratory, relatively few turtles being present there outside of the breeding season. Nevertheless, turtles at both areas show similar diurnal patterns. While some individuals remain in the lagoons all day to feed, many leave the lagoons in the early morning to feed along the more open coastal areas of the main bays, returning in the late afternoon or early evening. It is unknown how many of the turtles arriving in the evening are the same ones that leave earlier in the day or how many are returning after an indeterminate absence or are new arrivals.

Some turtles stay in or around a particular lagoon for one to three days, move out to deeper water, and return to the same lagoon after an absence of two weeks or so; others appear to stay away for much longer periods. This suggests that the Elizabeth Bay turtles have a home range. Coupled with a home range is the ability to find, or at least to recognize, a "home base," which may be a particular lagoon, area, or even a specific rock. Numerous individuals have demonstrated such an ability. For example, 130 Elizabeth Bay-tagged turtles were recaptured 154 times during subsequent visits, with the recapture interval ranging from 3 months to 3.5 years. Only 8 (6.2 percent) of the 130 recaptured turtles and 8 (5.2 percent) of the 154 recaptures were not retaken in the same lagoon in which they were tagged. These eight turtles moved distances of 11.5 to 21 km.

One turtle tagged in Elizabeth Bay was recaptured there in the same lagoon during the next three visits, intervals of 300 days, 125 days, and 160 days. Two other turtles were both recaptured while basking on the same rock they were on when first captured after intervals of 321 days and 949 days (2.6 y).

Such fidelity to a home base was also apparent elsewhere in Galápagos. A subadult tagged at Punta Espinoza on Fernandina Island was recaptured one year later in the same small lagoon. A subadult at Turtle Cove was recaptured twice in the original lagoon at yearly intervals, while another Turtle Cove subadult was recaptured in its original lagoon after three years.

Swimming speeds. Despite the numerous same-night or same-day recaptures of turtles at the nesting beaches and the feeding grounds, there have been very few from which swimming speeds could be calculated. Two individuals at Quinta Playa in 1976 each made a 15-min journey along the beach at speeds of 3.0 and 5.5 km per hr. In 1979, two Quinta Playa turtles traveled the 8 km to Bahía Barahona in a maximum of 90 min and 205 min, sustained swimming speeds of at least 5.3 and 2.3 km per hr, respectively. The Galápagos record for this study is held by yet another Quinta Playa turtle that reemerged 1 km away 8 min after reaching the surf, a speed of 7.5 km/hr.

LITERATURE CITED

Green, D.J. 1984. Long-distance movements of Galápagos green turtles. Journal of Herpetology 18:121-130.

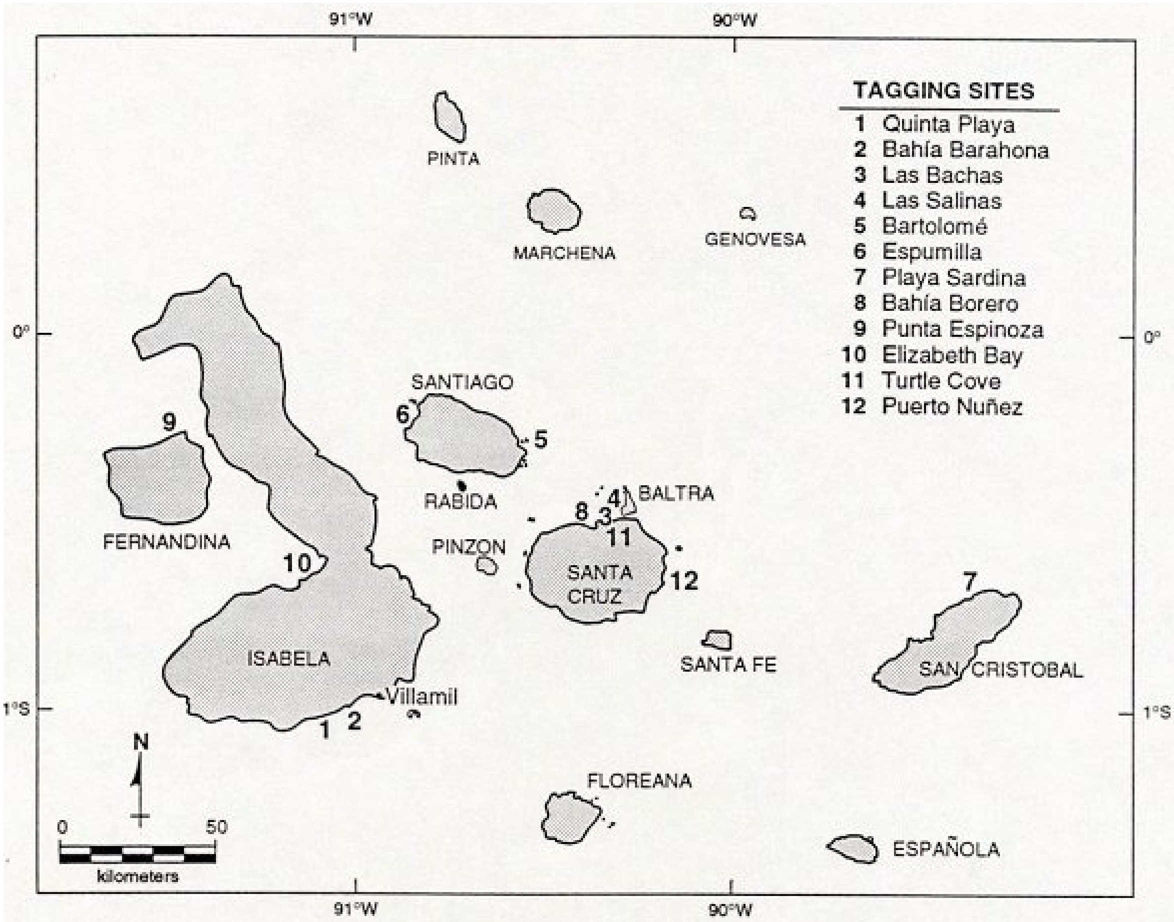

Fig. 1. Map of the Galápagos Archipelago showing the tagging sites of the East Pacific Green Turtle.

Reconnecting the Eastern Pacific Ocean: long distance movements of the black turtle

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INTRODUCTION

Why migrate? The most well known migratory species in the Californias is the gray whale (*Eschrichtius robustus*), which makes an annual round trip migration of more than 12,000 km between krill-rich feeding areas in arctic waters to shallow calving lagoons along the Pacific coast of the Baja California peninsula. By protecting the gray whale on its feeding and reproductive areas, the species has made a nearly full recovery and now provides a charismatic example of the interconnectedness of the oceans.

Typically animals migrate as an adaptation to temperature changes, availability of food resources, and/or reproduction. Some black turtles or East Pacific green turtles (*Chelonia mydas*) make long distance migrations from algae and sea grass rich feeding areas on the coast of the Californias and Gulf of California to nesting beaches in southern Mexico. Migratory behavior is distinct from station keeping movement on feeding grounds in that it is persistent and active, relatively straight, and generally involves the suppression of growth/development. In the case of the black turtle, optimal feeding/developmental areas are up to 2,000 km distant from nesting beaches, requiring turtles to traverse vast areas of ocean during homing and post-nesting movements.

Why study sea turtle migration? Migration may represent a temporally important component of sea turtle life history for some populations. Homing movements can take as long one year to complete. As such, understanding the details of sea turtle migration can improve energy budget and population models. Large amounts of energy are expended during long distance migrations, requiring substantial stores accumulated during months or even years on foraging grounds. Further, migrations, particularly in pelagic waters, are some of the least known portions of sea turtle life history. During these movements sea turtles may be especially vulnerable to bycatch in nets or furtive hunting.

STUDY AREAS

The coast of the Baja California peninsula and the Gulf of California, Mexico, are recognized as some of the most ecologically important coastal areas of the North American continent.

Sea turtles are the most endangered group of marine animal that inhabits these waters - all five species are endangered or threatened and are protected under Mexican law. The region is considered important to black turtle recovery efforts in the eastern Pacific as its rich seagrass and algae beds provide important developmental and feeding areas for juvenile, subadult and adult turtles.

METHODS

A variety of challenges exist when studying the migration of aquatic animals. For example, direct observation is difficult as surface times of animals may be limited, the harsh marine environment can impede options for observation, and the costs of overcoming these challenges can be prohibitively high. Collaborative institutional partnerships, mark-recapture, molecular genetics and satellite telemetry have been used to elucidate the long distance movements of black turtles from the Baja California region. When combined, these approaches provide the clearest understanding of black turtle migration. While any one method for studying movement may have shortcomings, such as cost, small sample sizes, or limited data provided, such limitations are overcome by a synergistic approach. In addition, recognizing that we are working with a remnant sea turtle population, the results of hundreds of semi-structured interviews with fishermen from the region have guided our understanding of black turtle biology, especially regarding historical information.

RESULTS

Detailed results of specific studies using tagging, molecular genetics and telemetry have been reported elsewhere. In summary, several important points are worth emphasizing.

Interviews. Most fishers stated that black turtles migrate south during fall months when water temperatures drop. Some fishers reported sporadic black turtle nesting in the Gulf of California. Many fishers report tag recoveries, but most discarded them for fear of retribution. Older fishers reported "peak" landings of black turtles in the 1960s
and a population "crash" in late 1980s to early 1990s.

Size of black turtles. The size of black turtles in the region ranges from approximately 40 cm to more than 105 cm (SCL, notch to tip). The majority of black turtles are smaller than the mean size of nesting females at Colola (77.3 cm SCL), however mean size varies significantly between sites. In general, greater numbers of juvenile turtles are captured in the shallow Pacific lagoons (e.g. Bahía Magdalena, Laguna San Ignacio, Laguna Ojo de Liebre) than are in the Gulf of California. However, both regions report all size classes. Thus, the coastal waters of northwestern Mexico are important as feeding areas for all black turtle size classes larger than 40 cm SCL.

Tagging. Delgado (this symposium) reported that black turtles tagged on Mexican beaches (Colola and Maruata, Michoacan) have moved both to the north and south. The primary feeding areas in the north lie along the mainland coast of Mexico, into the Gulf of California and along the Pacific coast of Baja California as far north as San Diego Bay, California. We expect that if not for the fear many fishermen have of sharing recovered tags, the data set from flipper tag recoveries would be far more substantial for the northern feeding areas. Notably, as the time interval decreases between tagging and recovery, mean swimming speed increases. This loosely suggests that the initial post-reproductive displacement from nesting beaches is somewhat straight and fast, followed by station-keeping movements at feeding areas.

Molecular genetics. The results of mtDNA studies of black turtles on Baja California feeding areas suggest a strong connection to Michoacan rookeries and, to a lesser extent, Isla Revillagigedo rookeries.

Satellite telemetry. Of ten satellite transmitters deployed on black turtles in Baja California, 3 turtles completed homing migrations to Michoacan beaches. All three turtles had the Michoacan haplotypes. When we pooled movement intervals and calculated mean swimming speeds, homing migration speeds were significantly higher than station keeping movements on feeding grounds. Station keeping on feeding grounds=15.8 km/d $\pm$ 1.69. Homing migration=44.75 km/d $\pm$ 1.69. Migratory movements were significantly straighter than "station-keeping" movements.

These data allow us to calculate swimming duration between black turtle rookeries and important foraging areas of the Californias. Swimming duration based on a minimum mean swim speed (45 km/d) calculated using data from the complete tracks of three homing green turtles suggests that in order to reach nesting beaches for the late fall/winter reproductive season, turtles must depart northernmost feeding areas (e.g. San Diego Bay) by late summer, returning to feeding areas in early spring. Based on the homing movements of three black turtles, migration routes lie primarily in coastal waters. Of the ten turtles tracked, three are known to have been captured/consumed within one year of release. For example, one 310 lb female black turtle named "Gata" was released 9 July 2000 in Bahía Magdalena and reported BBQ-ed on Isla Magdalena in April 2001. Results of the tracking experiment indicate that the turtle never left the region, likely feeding on the bay's vast sea grass beds.

CONSERVATION IMPLICATIONS

Several important conclusions emerge from the study of black turtle migration that can aid conservation and recovery efforts. Sea turtle researchers often assume that a management regime exists that will utilize generated knowledge to calibrate population models and fine-tune management plans. In *many* regions, this is not the case. With regard to the black turtle, it has become clear that we must work to build the capacity of regional managers and fishers to utilize detailed life history information to guide management decisions. It is important to generate knowledge that is *RELEVANT* within the context of regional conservation needs.

The most conservation-relevant results of this study were that at least 30% of adult animals studied were hunted within one year. Survival of adult sea turtles on foraging grounds is critical. Addressing the high mortality rates by furtive hunting is the highest priority. These findings are consistent with mortality rates presented by Koch et al. (this symposium).

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Ecology of *Chelonia mydas* at feeding grounds in the Eastern Pacific: perspectives from Baja California

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Understanding the biology of sea turtles at coastal foraging areas is fundamental to their conservation. Knowledge about population structure, diet, habitat use, and survival can guide decisions regarding the management of endangered sea turtle populations and help mitigate the effects from anthropogenic impacts such as illegal poaching, habitat degredation and fisheries impacts. In contrast to nesting beach surveys that focus on adult females, studies of sea turtles in foraging areas (i.e. in-water studies) can provide information on a broad range of age-classes of both sexes. When genetic data are available, these studies can also identify the particular nesting stocks threatened by human impacts at foraging areas.

Green turtles (a.k.a., east Pacific green turtles, black turtles), *Chelonia mydas* (=*agassizii*), inhabit neritic foraging areas in tropical and subtropical regions throughout the eastern Pacific. Due to overexploitation of eggs and turtles as a food resource and, to a lesser extent, incidental mortality relating to marine fisheries and degradation of marine and nesting habitats, green turtles in this region have declined substantially (Nichols et al. 2002c, Seminoff 2002, Seminoff et al., in review). This decline has been largely attributed to continued threats in distant neritic habitats, particularly near Baja California (Gardner and Nichols 2001, Nichols et al. 2002). Efforts to learn more about the in-water ecology of green turtles in this region have been undertaken by a variety of researchers from several institutions. In this note I summarize the areas of research that have been pursued in northwestern Mexico.

Recent studies have resulted in a better understanding of the status and biology of green turtles in foraging areas the eastern Pacific Ocean. These advances have been made in the areas of population size structure (Seminoff 2000, Seminoff et al., in press b, Seminoff et al., in review), stock analysis and nesting beach origin (Dutton, this symposium, Nichols et al. 1999, Seminoff et al. 2002), growth (Seminoff et al. 2002c), foraging ecology (McDermott et al., in press, Lopez-Mendilaharsu 2002, Lopez-Mendilaharsu 2002, Lopez-Mendilaharsu et al. 2003, this symposium, Seminoff et al. 2000a, 2000b, 2002c), home range and habitat use (Nichols et al. 2001, Seminoff 2000, Seminoff et al. 2002a), diving behavior (Seminoff et al., in press a), energetics (Jones et al., in press), and health (Presti 1999, Gardner, this symposium). In addition to these scientific gains, knowledge of the human impacts has increased (Gardner and Nichols 2001, Nichols 2002, Nichols et al. 2002c, Seminoff 2000, Seminoff et al., in review).

Despite these advances in research and impact assessment, threats to green turtles continue, particularly in northwestern Mexico. To prevent further declines, it is imperative that hunting of green turtles in neritic habitats throughout the eastern Pacific cease, and that substantial efforts are made to reduce bycatch mortality and habitat degredation. Conservation actions must be developed and implemented that are long-term in nature and target all life-stages of green turtles. As suggested by Nichols et al. (2002a, 2002b), these conservation efforts must be broad-based, extending from marine habitats to encompass cultural and social aspects as well as consumers at urban centers that are often the source of demands for illegal turtle products.

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LITERATURE CITED

Dutton, P.H. This symposium. Molecular ecology of *Chelonia mydas* in the eastern Pacific Ocean. In: J.A. Seminoff. comp. Proceedings of the Twenty-second Annual Symposium on Sea Turtle Biology and Conservation, Miami, Florida.

Gardner, S.C. This symposium. Assessment of health of sea turtle populaitons in the Baja California Peninsula. In: J.A. Seminoff, comp. Proceedings of the Twenty-second Annual Symposium on Sea Turtle Biology and Conservation, Miami, Florida.

Gardner, S.C. and W.J. Nichols. 2001. Assessment of sea turtle mortality rates in the Bahía Magdalena region, Baja California Sur, México. Chelonian Conservation and Biology 4:197–199.

Jones, T.T., J.A. Seminoff, A. Resendiz, and P. Lutz. In press. Energetics of the East Pacific green turtle at a Gulf of California foraging habitat. In: M. Coyne, comp. Proceedings of the Twenty-first Annual Symposium on Sea Turtle Biology and Conservation, Philadelphia, PA.

López-Mendilaharsu, M. 2002. Ecología alimenticia de *Chelonia mydas agassizii* en Bahía Magdalena, Baja California Sur, México. MS Thesis. Centro de Investigaciones Biologicas del Noroeste, La Paz, BCS. 89 pp.

Lopez-Mendilaharsu, M., S. Gardner, J.A. Seminoff. 2003. Natural History Notes. *Chelonia mydas agassizii* (East Pacific Green Turtle). Diet. Herpetol. Review 34:139-140.

Lopez-Mendilaharsu, M., S.C. Gardner, J.A. Seminoff, and R. Riosmena. This symposium. Feeding ecology of the East Pacific green turtle (*Chelonia mydas agassizii*) in Bahía Magdalena, B.C.S. México. In: J.A. Seminoff, comp. Proceedings of the Twenty-second Annual Symposium on Sea Turtle Biology and Conservation, Miami, Florida.

McDermott, A, J.A. Seminoff, T.T. Jones, and A. Resendiz. In press. Intake and passage time for green turtles in the Gulf of California: preliminary development of a digestive model. Proceedings of the Twenty-third Annual Symposium on Sea Turtle Biology and Conservation, Kuala Lumpur, Malaysia.

Nichols, W.J. 2002. The biology and conservation of the sea turtles of Baja California. Ph.D. Dissertation. University of Arizona, Tucson. 546 pp.

Nichols, W.J., J.A. Seminoff, A. Resendiz, P. Dutton, and F.A. Abreu-Grobois. 1999. Using molecular genetics and biotelemetry to study life history and long distance movement: A tale of two turtles. In: F.A. Abreu-Grobois, R. Briseño, R. Márquez, and L. Sarti, comps. Proceedings of the Eighteenth Annual Symposium on Sea Turtle Biology and Conservation. NOAA Tech. Mem. NMFS-SEFC. p. 102-103.

Nichols, W.J., L. Brooks, M. Lopez, and J.A. Seminoff. 2001. Record of pelagic East Pacific green turtles associated with *Macrocystis* mats near Baja California Sur, Mexico. Marine Turtle Newsletter 93:10-11.

Nichols, W. J., K. E. Bird, and S. Garcia. 2002a. Community-based research and its application to sea turtle conservation in Bahía Magdalena, BCS, Mexico. Marine Turtle Newsletter 89:4-7.

Nichols, W.J., J.A. Seminoff, and A. Resendiz. 2002b. The status of sea turtle conservation in Baja California, México: From 'black steer' to sacred cow. In: A. Mosier, A. Foley, and B. Brost, comps. Proceedings of the Twentieth Annual Symposium on Biology and Conservation. NOAA Tech. Memo. NMFS-SEFSC-477. p. 136.

Nichols, W.J., H. Aridjis, A. Hernandez, B. Machovina, and J. Villavicencio. 2002c. Black market sea turtle trade in the Californias. Unpublished Wildcoast Report. Davenport, CA.

Presti, S., A. Resendiz S. Hidalgo, A. Sollod, and J.A. Seminoff. 1999. Mercury presence in the scutes of black sea turtles, *Chelonia mydas agassizii*, in the Gulf of California. Chelonian Conservation and Biology 3:531-533.

Seminoff, J.A. 2000. Biology of the east Pacific green turtle, *Chelonia mydas agassizii*, at a temperate foraging area in the Gulf of California, Mexico. Ph.D. Dissertation, University of Arizona, Tucson. 249 pp.

Seminoff, J.A., W.J. Nichols, and A. Resendiz S. Hidalgo. 2000a. Natural History Notes: *Chelonia mydas agassizii* (East Pacific Green Turtle), Diet. Herpetological Review 31:103.

Seminoff, J.A., A. Resendiz, S. Snider, and G. Marshall. 2000b. Use of carapace-mounted submersible cameras to study black sea turtle foraging behavior. In: H.J. Kalb and T. Wibbels, comps. Proceedings of the Nineteenth Annual Symposium on Sea Turtle Biology and Conservation. NOAA Tech. Memo. NMFS-SEFSC-443. p. 185-187.

Seminoff, J.A., A. Resendiz, and W.J. Nichols. 2002a. Home range of the green turtle (Chelonia mydas) at a coastal foraging ground in the Gulf of California, México. Marine Ecology Progress Series 242:253-265

Seminoff, J.A., A. Resendiz S. Hidalgo, and W.J. Nichols. 2002b. Diet of the East Pacific green turtle, *Chelonia mydas*, in the central Gulf of California, México. Journal of Herpetology 36:447-453.

Seminoff, J.A., A. Resendiz, W.J. Nichols, and T.T. Jones. 2002c. Growth rates of wild green turtles (*Chelonia mydas*) at a temperate foraging habitat in the Gulf of California, México. Copeia 2002:610-617.

Seminoff, J.A., J. Alvarado, C. Delgado, J.L. Lopez, and G. Hoeffer. 2002d. First direct evidence of migration by an East Pacific green seaturtle from Michoacán, México, to a foraging ground on the Sonoran Coast of the Gulf of California. Southwestern Naturalist 47:314-316.

Seminoff, J.A., A. Resendiz, L. Yarnell, and T. Smith. In press a. Diving patterns of the East Pacific green turtle at a Gulf of California feeding area: evidence of deep water benthic foraging. In: M. Coyne, comp. Proceedings of the Twenty-first Annual Symposium on Sea Turtle Biology and Conservation, Philadelphia, Pennsylvania.

Seminoff, J.A., J.L. Lopez, G. Hoeffer, H. Romero, L. Monti, and G. Nabhan. In press b. Sea turtles and Seris: Benefits of a binational stewardship program in the Infiernillo Channel, Gulf of California, México. In: M. Coyne, comp. Proceedings of the Twenty-first Annual Symposium on Sea Turtle Biology and Conservation, Philadelphia, Pennsylvania.

Seminoff, J.A., T.T. Jones, A. Resendiz, W.J. Nichols, and M.Y. Chaloupka. In review. In-water monitoring of sea turtles at a coastal foraging area: the current status of green turtles (*Chelonia mydas*) in the Gulf of California, Mexico. Journal of the Marine Biological Association of the UK.

Distribution and conservation status of the black turtle, *Chelonia agassizii*

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In the language of the retail trade or the military profession, we chelonian systematists are currently living in an era of promotions. Computer vendors or the airline industry might call them upgrades – subspecies becoming species; species becoming genera. Familiar forms like *Emys orbicularis* and *Mauremys leprosa* have been split into multitudinous subspecies (sixteen and nine respectively; see Vetter 2002). Four different color morphs of *Cyclemys dentata* are now recognized as distinct species (Fritz et al. 1997). The Mediterranean tortoise species *Testudo kleinmanni* and *Testudo marginata* have each been bisected into two full species, Horsfield's tortoise (*Testudo horsfieldi*) is now considered to be an assemblage of four species in their own genus (*Agrionemys*), the Aldabra tortoises are now at least three species, while the wide-ranging *Testudo graeca*, long recognized as variable but with just a few named subspecies, is now broken into an even dozen named binomial forms, and half a dozen more, yet to be named (Vetter 2002, Perala 2002, Schleich 1996, Fritz 1996) .

An optimistic evaluation of this trend would note that it reflects ever better understanding of speciation events and recognizable forms within familiar genera, and draws attention to unrecognized or localized populations that, without taxonomic recognition, might never become the subject of necessary conservation or protection efforts. On the other hand, a few voices (e.g., that of Bernard Devaux) have been raised to protest this proliferation, noting that the new forms are not really new; it is simply that new taxonomic criteria are being applied. Others might note that the "easy," truly distinctive chelonian species are now almost all known, and young studs in the systematics field, eager to claim first blood and strike their own claims to taxonomic immortality, routinely name modestly differentiated populations, promote subspecies to species, species to genera, and sometimes even genera to subfamilies (e.g. *Deirochelys* becomes Deirochelyinae), marching under the banner of a commitment to the concept of "phylogenetic species," with a binomial for every clade or even incipient clade.

There are other objections to this practice, including the observation that, while the nomenclatural system should indeed reflect phylogeny, it becomes useless if it does not also show some elements of stability, and traditional concepts of biological species (coexisting with or without intergradation, for example) are not yet obsolete. Those who simply seek to know the names they should use do not forgive the "experts" who decline to give clear answers. Furthermore, fine detail within a classification of species-group taxa within a genus or family is lost if everything is promoted to full species level or beyond, and, properly utilized, the taxonomic process not only recognizes differences, it also recognizes similarities. And some have suggested that the policy (rarely actually practiced) of deliberately exaggerating differences between taxa so as to elevate them to high rank and thus qualify them for more conservation attention and dollars may ultimately cause the entire discipline of systematics to lose credibility (Karl and Bowen 1999). The subspecies concept as a whole has had some prestigious detractors, including E.O. Wilson (Wilson and Brown 1953), on the grounds that, at least among certain widespread, variable species, one finds an entirely different array of "subspecies" if one emphasizes different sets of characters; if skull characters tell you one thing, coloration another, and morphometrics a third, what is one to believe? It is almost as bad as when comparisons of nuclear and of mitochondrial DNA lead one in opposite directions, to take a *fin-de-siecle* example.

So where does this trend of nomenclatural proliferation and taxon promotion leave the sea turtles? Does the current classification, recognizing just seven or eight species within six genera (*Chelonia, Caretta*, *Lepidochelys, Eretmochelys, Natator, Dermochelys*) and two families (one with three subfamilies or tribes) reflect an unforgivable wave of "promotions" (rather like the

Albanian Army in the 19th century, when military officers decided their own rank)? The answer, I believe, is in the negative. Certainly there have been promotions – the flatback turtle has gone from *Chelonia depressa* to *Natator depressus*, and *Caretta kempi* has become *Lepidochelys kempi*, but there have been downgradings also, including the recognition that the species *kempi* and *olivacea* were congeneric. The existence of rare natural hybrids between several pairs of sea turtle genera (*Chelonia / Eretmochelys; Lepidochelys / Caretta*; *Caretta / Eretmochelys*) is disturbing; but these hybrids are rare indeed, and their fertility has not been demonstrated. Sometimes behavioral or geographic considerations are sufficient to assure reproductive isolation almost all the time, and there may be no selective pressure to achieve actual genetic incompatibility. The surviving sea turtle species represent very ancient separate lineages, and their extensive and presumably stable gross sympatry today has been achieved by the divergent adaptation of each of the genera for profoundly different feeding niches – leatherbacks for medusans, hawksbills for sponges, green turtles for marine grasses and macroalgae, loggerheads for durophagy, Kemp's ridleys for crabs, etc.

One could also justify the high percentage of monotypic genera among extant sea turtle taxa by noting that the global sea turtle game has been running for a long time, is at a very advanced stage, and perhaps is approaching its conclusion, with most of the players long since removed from the board in the inexorable chess game of evolution. Pritchard and Trebbau (1984) recognized 31 genera in the Cheloniidae alone, only five surviving today, and it may be assumed that many other genera, and certainly a host of species, disappeared without leaving any trace. Furthermore, other marine families (Protostegidae, Toxochelyidae, Thalassemyidae, etc) have become completely extinct, and only one Dermochelyid survives today. So the living sea turtle genera represent a shrunken band of only distantly related, almost random survivors rather than a modest, recent adaptive radiation, and it would seem to be predictable and correct that they should be recognized as strongly diversified, at least at the generic level. The marine environment, far more than the terrestrial or freshwater ones, generally fails to provide physical separation of related taxa, and closely related sympatric marine turtle species with similar feeding and ecological niches may have been subjected to a degree of competition that was ultimately fatal to all but one of the competitors. Thus, the survival of only a single species of dermochelyid turtle, *Dermochelys coriacea*, like that of the survival of only a single hominid species (*Homo sapiens*), may reflect, not the brink of extinction or failure, but rather the successful colonization of the entire habitable world (marine or terrestrial) by single, highly competitive species with remarkable dispersal powers.

Where does this leave the two genera (i.e. *Chelonia* and *Lepidochelys*) each thought to include more than one species? The genus *Lepidochelys* has basically been "sorted out" by both the morphologists and the geneticists, and need not be discussed further here. Instead, the focus of this mini-symposium is the status of the black turtle, originally called *Chelonia agassizii* by Bocourt (1868), and subsequently re-baptised *Chelonia mydas carrinegra* by Caldwell (1962). Current controversy centers upon the status (subspecific or specific) of the black turtle in relation to the large, lighter-colored green turtles with unpigmented plastra found elsewhere in the Pacific as well as in the Indian and Atlantic Oceans. Few would deny the different appearance of the two forms, but some (e.g. Karl and Bowen 1999) have argued that these differences are not backed up by significant detectable genetic divergence. In response to my photo of two highly distinctive *Chelonia* specimens, representing *agassizii* and *mydas*, from a single locality in New Guinea (on the cover of Conservation Biology 13 (5), October 1999), Karl responded with a photo (not accepted for publication!) of the equally divergent-looking athletes Wilt Chamberlain and Willie Shoemaker. The subspecies or species status of the latter individuals is a subject that appears to have been avoided.

While genetic analysis and DNA sequencing have become the touchstones for taxonomic decisions in recent years, they do not render more traditional criteria (especially those pertaining to intergradation and hybridization issues) completely obsolescent. The entire genome is not usually sequenced in such studies, and it is quite possible that DNA or polypeptide bands of very different composition could appear, by coincidence, in similar positions. Furthermore, very slight genetic differences may set off a cascade of developmental changes within the overall category of neoteny, and Kordikova (2000) has demonstrated that the phenomenon of heterochrony (i.e., staggering , changing, or postponing the relative timing of developmental events, without the development of neomorphic structures) can alone facilitate or trigger the development of profound adaptive differences among chelonians, probably with changes in very few genes.

Seizing, then, upon the criterion of sympatry without blending or intergradation as a still-useful criterion for species-level distinction between taxa, I would offer the follow personal observations.

Some systematists have accused me of living in a cave. This is not true, but I do sometimes visit caves, one of the most memorable being an artificial one, laboriously constructed of lava blocks on the shore of Academy Bay, in Santa Cruz in the Galapagos, by a German settler by the name of Gusch Angermeyer. In this cave, Gusch kept the marine curiosities and treasures he had accumulated during his adult life spent in and around the archipelago, and I was particularly interested to see that he had a wide series of shells of sea turtles of the genus *Chelonia*. Furthermore, it was clear that this series of shells of Galapagos *Chelonia* was dichotomous, and that this dichotomy extended down even to juvenile turtles not more than 25 cm in carapace length. One of the two types was characterized by extreme intensity of pigmentation, the carapaces being virtually black, and the shape was distinctive by virtue of the pronounced taper of the rear of the shell, with marked incurving above each of the posterior flippers. The other carapaces had a rich, red-brown ground color of the carapace, with bold yellowish or black, generally radiating markings on each scute; and the shell outline was broadly heart-shaped, with no incurving above the hind flippers.

Gusch's sister-in-law, Carmen Angermeyer, had earlier written to Archie Carr in Gainesville with her observations about Galapagos green turtles, and the most remarkable feature of her findings was also that there seemed to be two types, distinctive enough to have different names in Galapagos English, namely "Black Turtle" and "Yellow Turtle." She had even sent some adult carapaces of the "yellow turtle" to Archie Carr's office seeking his opinion, and my presence in the Galapagos some months later was entirely in response to Carmen's initiatives. Her observations reflected the carapace differences mentioned above, and her accompanying correspondence indicated that there were other differences too. For example, the yellow turtles, even though sometimes larger than the largest black turtles, were never found nesting in the Galapagos, and indeed, when slaughtered, never even showed evidence of sexual maturity – neither tail elongation in males, nor ovarian follicles nor ova in females. Furthermore, the yellow turtles were very fat, very good to eat, and their fat made excellent butter, whereas the black turtles were leaner, less delectable and somewhat "fishy" in taste, and useless for making butter. These subjective observations presumably reflect some profound biochemical differences, or at the very least different feeding regimens.

My conclusion has been that these sympatric, non-intergrading stocks of the genus *Chelonia* represented a resident (or partially resident – tag recoveries of Galapagos black turtles from the South American coast have been made) stock, existing in sympatry with immature individuals of a mid-Pacific stock of larger, more far-ranging turtles that corresponded much more closely with the typical morphology and coloration of *mydas* rather than *agassizii*. And, to me, the sympatry was a strong indicator that we were dealing with a difference at the full species level, even though the reproductive isolation in the face of geographic juxtaposition may have been a result of the outmigration of the "yellow" stock to distant shores when the time came for reproduction (i.e., both mating and oviposition) rather than absolute genetic incompatibility.

Since then, I have encountered other examples of sympatry between typical *agassizii* and typical *mydas*. Both occur, for example, on the Pacific coast of Mexico, where the former is called "tortuga blanca" and the latter "caguama prieta." In 1979, on the far side of the Pacific in Manus Island, Papua New Guinea, I was amazed to see a freshly caught classical *agassizii* alongside a typical young *mydas*, with the captor claiming he had caught both in the same place. And now Kuroyanagi et al. (1999) have reported the first confirmed black turtle records for Japanese waters – a 10.7 kg animal from northern Iriomote Island, and a 49.7 kg specimen from Sakiyame Bay, southwestern Iriomote Island, caught in April and May 1998 respectively.

The famous evolutionist Ernst Mayr, who believes firmly in the criterion of sympatry without intergradation as an earmark of full species, has also utilized an interesting and completely different approach: to compare the taxonomic conclusions of trained and knowledgeable systematists with the parallel and independent conclusions of isolated tribal or subsistence people within the range of the forms in question. Both have good reason to know the species in "their" geographic areas, but their criteria for enumerating "kinds" (i.e. species) of organisms, while valid and justified, are different and independently derived. In the remote Arfak mountains of New Guinea, Mayr (1946) found that local people identified 136 vernacular names for the 137 species of birds recognized by scientists in the same region – remarkable concordance indeed. In the much simpler case of whether *Chelonia* includes one or two species, it is worth asking the people of western Mexico or of the Galapagos Islands what they think. In both cases, their use of different everyday names for the two animals may be considered to be important supporting evidence that those who live among them indeed recognize them as different species.

LITERATURE CITED

Bocourt, M.-F. 1868. Description de quelques cheloniens nouveaux appartenant a la faune mexicaine. Asnnals des sciences Naturelles, Series 5, Zoology 10: 1211-122.

Caldwell, D.W. 1962. Sea turtles in Baja Californian waters (with special reference to those of the Gulf of California), and the description of a new subspecies of northeastern Pacific green turtle. Los Angelkes County Mus., Cointrib. In Sci. 61: 3-31.

Fritz, U. 1996. Zur innerartlichen Variabilitat von *Emys orbicularis* (Linnaeus, 1758) 5B. Intraspezifische Hierarchie und Zoogeographie (Reptilia: Testudines: Emydidae). Zool. Abhandl., Staatliches Museum fur Tierkunde Dresden 49 (3):31-71.

Fritz, U., M. Gaulke and E. Lehr. 1997. Revision der sudostasiatischen Dornschildkroten-Gattung *Cyclemys* Bell, 1834, mit Beschreibung einer neuen Art. Salamandra 33:182-212.

Karl, S.A. and B.W. Bowen. 1999. Evolutionary significant units versus geopolitical taxonomy: molecular systematics of an endangered sea turtle (genus *Chelonia*). Conservation Biology, 990-999.

Kordikova, E.G. 2000. Paedomorphosis in the shell of fossil and living turtles. N. Jb. Geol. Palaeont. Abh., Stuttgart. 218: 399-446.

Kuroyanagi, K., N. Kamezaki and S. Sugiyama. 1999. [first confirmed black sea turtle (*C. m. agassizii*) in Japanese waters]. (in Japanese). Unigame Newsletter of Japan, no. 39: 13-14,

Mayr, E. 1946. The naturalist in Leidy's time and today. Proc. Academy Nat. Sci. of the United States of America 98: 271-276.

Perala, J. 2002. The genus *Testudo* (Testudines: Testudinidae) – phylogenetic influences. Chelonii 3:32-39.

Pritchard, P.C.H. and P. Trebbau. 1984. The turtles of Venezuela. Soc. Study Amph. Rept., 404 p.

Schleich, H.H. 1996. Beitrag zur Systematik des Formenkreises von *Mauremys leprosa* (Schweigger) in Marokko. Teil 1. Spixiana (Munchen), suppl. 22: 29-569.

Vetter, H. 2002. Turtles of the World, vol. 1. Edit. Chimaira, Frankfurt-a-M. 96 p.

Wilson, E.O. and W.L. Brown Jr. 1953. The subspecies concept and its taxonomic application. Systematic Zoology 2:97-111.

The investigation and conservation of the black turtle in Mexico: the first years

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The first activities began in 1964, in the National Biological and Fisheries Research Institute, and they were directed toward the investigation, the conservation and the management of the marine turtles. Through these works the nesting beaches, localities of capture and places where the products were disembarked were identified. At the same time it was organized a program of tagging and carried out the biological sampling. This species nests mainly in the beaches of Colola and Maruata, Michoacán. This area was described the first time by Peters (1954). Even when the information was known, it went up to 1968 that the first visits began and up to 1975 it could settle a turtle camp, in Maruata, beginning this way the study and protection of the species (Márquez et al. 1990). At the end of the 70´s the University of Arizona began investigations on this species in the Gulf of California and soon after they started to visit the beach of Maruata. In 1982 the University of Michoacán was integrated to this work and in 1983 established a turtle camp, in which they continue working until nowadays. At the same time the unions of fishermen of the coast of Michoacán has been a very important support in these activities.

The "black turtle" is an endemic species throughout the oriental central region of the Pacific Ocean, it is present from California to Peru including the Galapagos and Revillagigedo Islands, and it can be distinguished from the variety of the Atlantic *Chelonia mydas* for their morphology, reproductive habits and feeding behavior. Only it reproduces in massive form in the costs of Michoacán and in the Galapagos Islands and with lower abundance in Revillagigedo Islands and beaches of Centro America. The feeding areas extend in this whole region, in Mexico particularly in the Gulf of California, Baja California west coast and the Isthmus of Tehuantepec.

This species has had great importance among the ethnic groups living along the Mexican Pacific coast, since pre-Spanish times. Inside the Gulf of California for the Indian Seris, in the coast of Michoacán for the Nahuas and in the Lagoons of the Isthmus of Tehuantepec for the Huaves and Mexicans of the Zapoteca south-oriental region. The Indian Seris and the Huaves consumed the meat, the Zapotecas also the eggs (dry) and the Nahuas the eggs. The over-exploitation began when being increased the consumption of turtles in the northwest of the country and the export of the turtle's leather, by the middle of the 60´s. The illegal capture in smaller scale, in the distribution area, still affects the survival and recovery of the species.

The capture of the "black turtle" until the end of the 50´s it can consider as of sustainable level, starting from the 60´s it begins to increase. At same time the capture of the "olive ridley turtle" (*Lepidochelys olivacea*) was increasing but in larger proportion, until reaching in 1968 more than 14,500 metric tons. Unfortunately the official registration of the capture of sea turtles was not carried out appropriately, since the species didn't differ. For that period the proportion of "black turtle" in the total of the commercial capture could only separate through the origin place. It is until middle of the years 60´s when the species register separately, however in some cases there is confusion, as it is not easy to decide which register corresponds to each species.

The average annual catch of the "black turtle" in the period of 1948 to 1990 was of 265.6 tons. and it arrived to a maximum of 825.6 tons in 1969, in fact in the year that the capture of "olive ridley turtle" starting to collapsed. Since then the capture of all species was reduced and declining for several causes. In 1972-1973 there was a "total ban" to give time to reorganize the exploitation but nevertheless in 1990 was necessary to close the capture of all the species officially (DOF 1990). Starting from 1973 the exploitation of "black turtle" was allowed exclusively for the ethnic groups and to those who were authorized quotas, they were of males.

The hatchlings and juvenile of this species are carnivorous, it is ignored the age, which they become vegetarians. "Black turtles", bigger than 50 cm of curve carapace length (CCL) feed of the vegetable like red, brown and green algae, present in the rocky coasts and of the marine grasses that are plentiful in the shallow waters of the coastal platform, including lagoons and bays. To know the stomach contents they were studied 12 specimens whose sizes (CCL) varied between 51 and 83 cm: 7 males, 4 females and 1 juvenile. Of these, 8 had remains of foods and in 5 also carried parasitic worms (trematodes) stuck to the wall of the first part of the intestine (Table 1).

Between 1966 and 1979 they were carried out samplings of the commercial catch, in the sea and in the nesting beaches. The results are described in this report, although not all the obtained figures neither the statistical charts can be included, due to the reduced available space, but will be presented in a preparation paper.

Data of Weight and CCL of "black turtle" were obtained of the Commercial Capture in: 1) North Baja California - 517 turtles, 2) South Baja California - 528, 3) Oaxaca - 162, and 4) Data average of 45 samples of: BCN - 8, BCS - 7, Colima - 1, Jalisco - 12, Michoacán - 6, Oaxaca - 8 and Sonora – 3, that include 2020 turtles, captured between 1964 and 1978.

The information on the distribution of CCL and Weight of tagged "black turtle's comes from the following localities and number of specimens: BCN - 47, BCS - 93, California (USA) - 6, Michoacán - 7102, Oaxaca - 85, Sinaloa - 3 and Sonora - 38. From 1966 to 1986 9,820 "black turtle's were marked and of these they were captured 211 again. The majority of the recaptures happened between 1000 and 2000 Km of distance from the tagging places, these recaptures happened among the States of Sinaloa to Sonora, of Guerrero to Oaxaca and of Guatemala to El Salvador (Gulf of Fonseca), the most distant recapture was in Pacific of Colombia.

The States of recapture were: BCN - 6, BCS -11, Sonora - 11, Sinaloa - 7, Nayarit - 9, Jalisco - 6, Colima - 3, Michoacán - 43, Guerrero - 15, Oaxaca - 40, Chiapas - 5, Guatemala - 11, El Salvador - 36, Nicaragua - 1, Costa Rica - 3, Panama - 2, Colombia - 2. The distance between the tagging and the recapture points varied from 0 to 3500 Km. The elapsed days among tag and recapture go from: 0 days (2 turtles) and between 2 and 2,376 days, with a maximum of frequencies around 500 days. The recapture methods were the following ones, with the suitable frequency and percentage: harpoon -11 (5.2%), fish entangling nets - 115 (54.5), shrimp nets - 57 (27.0), captures by swimming - 11 (5.2), dead on beach 5 (2.4), fish trawls - 7 (3.3), nesting - 1 (0.5), purse seines -0 (0.0), set nets -1 (0.5), cast nets - 1 (0.5), floating dead - 2 (0.9). Total 211 turtles (100.0%).

The tendency of the nesting of the "black turtle" in Michoacán was made by analysis of the period from 1982 to the 2001 and it includes the annual number of nests registered in Colola and Maruata (Data of: INP, University of Michoacán, X. Alvarado, C. Delgado and A. Figueroa). The calculations were carried out by the use of the movable average of each 3 years, that is to say the first point corresponds to the mean value between 1982 and 1984, the second between 1983 and 1985, etc. The tendency was considered for minima squares, in a polynomial equation of 2º order. In the curve it is observed that there is a slight recovery.

LITERATURE CITED

DOF. 1990. Acuerdo por el que se establece veda total para todas las especies y subespecies de tortugas marinas en aguas de jurisdicción nacional de los litoralesdel Océano Pacífico, Golfo de México y Mar Caribe. Diario Oficial de la Federación. México. Mayo 31. p. 21-22.

Márquez-M., R. 1990. FAO Species Catalogue. Vol. 11. Sea Turtles of the World. An annotated and Illustrated Catalogue of Sea Turtle Species Known to Date. FAO Fisheries Synopsis. 125:81p.

Peters, J.A. 1954. The amphibians and reptiles of the coast and coastal sierra of Michoacan, Mexico. Occ. Papers Mus. Zool. Univ. Mich. 554:1-37.

Table 1. Stomach content in 8 "Black Turtles" from Bahia de los Angeles, Guerrero Negro, Puerto Vallarta and Zihuatanejo, México.

Group	Genus	Volume (ml)	%
Rhodophyta	*Gracilaria*	240	19.5
(red algae)	*Rhodymenia*	160	13
	Gelidium	150	12.2
	Grateulopia	20	1.62
	Gigartina	14	1.14
	Griffitsia	14	1.14
	Laurentia	12	0.97
	Liagora	11	0.89
	Polysiphonia	10	0.81
	7 Species	15.5	1.24
Phaeophyta	*Sargassum*	260	21.1
(brown algae)	*Padina*	16	1.29
	Scystociphon	7	0.57
Chlorophyta	*Ulva*	42	3.41
(green algae)	Cladophora	6	0.47
Miscellaneous *	Several Sp.	12	0.97
Unknown		230	18

* Molusca, Crustacea, Bryozoa, Spongiaria, Coelenteratta, Echinodermata, Trematoda

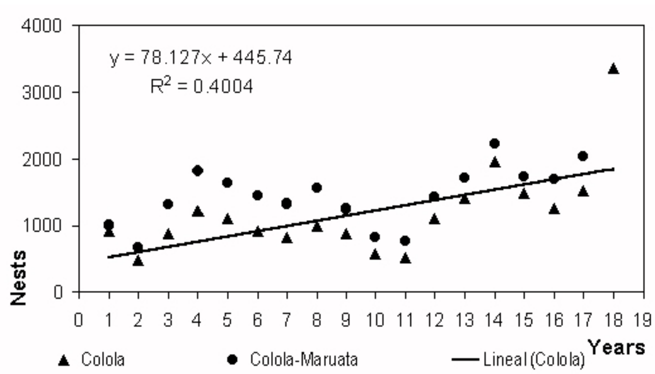

Fig. 1. Tendency of the nesting of the "black turtle" in Colola and Maruata, Michoacan. Period 1982–2001. Y=Mobile Averages of the Number of Nests, every 3 years.

Sea turtles in northwestern Mexico: conservation, ethnobiology, and desperation

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During the mid-1960s I was a graduate student at the University of Arizona, studying the vegetation and flora of the coast of Sonora and the nearby islands. This is the area Shreve (1951) designated as the Sonora side of the Gulf Coast region of the Sonoran Desert. This is also the traditional homeland of the Comcáac, or the Seris as they are known to outsiders. While working there I met Mary Beck "Becky" Moser and her husband Ed Moser who lived in the Seri Indian village of El Desemboque. They were engaged in linguistic and literacy work with the Seris, translated the New Testament into the Seri language, collaborated with various researchers, and published works on Seri culture (Felger 2000, 2002).

During the 1970s while Becky Moser and I were working on the Seri ethnobotany (Felger and Moser 1985), Ed Moser and I started accumulating information on Seri knowledge of sea turtles. This knowledge was vast but like the turtles, it was fading. We soon realized that Seri sea turtle knowledge was remarkably consistent with scientific information, although there were significant aspects of Seri knowledge unknown to sea turtle biologists. The Seris distinguished 16 kinds or variants of sea turtles: 10 green turtles, 2 loggerheads, 2 hawksbills, the olive ridley, and the leatherback (for more details see Felger and Moser 1985 and Felger et al., in press). Each genus recognized by biologists was clearly distinguished as an ethnogenus, and some of the ethnotaxa may represent micro-races, or populations from different nesting regions converging on feeding grounds. The green turtle was their single most important food resource, a fact known to the outside world since McGee's (1898) racist, blather-filled report.

I was surprised that the Seris continued to bring in *Chelonia* during wintertime, using harpoons about 9 meters long. (The mainshaft for warm weather use was about half as long.) The Seris called a partially buried, overwintering green turtle *mosni hant coit* 'green-turtle land touch' or "touch down." The same expression is used for the landing of a bird or an airplane. These "buried" turtles were sought at specific places on the muddy-sandy sea floor of the Canal del Infiernillo, involving special techniques employing the long harpoons. The harpooners were young men with exceptional vision who could discern the faint outline of the exposed portion of the carapace on the sea floor, and conditions had to be just right—a cloudless, cool, calm day with clear water.

At about the time Ed Moser and I were learning about sea turtles from the Seris I met Kim Cliffton, a field biologist who was among the small but illustrious crowd of students and faculty from the early, heady days of Prescott College. Kim had been a heavyweight boxer in the U.S. Army and took to working with Mexican and the Seri fishermen like a sea turtle to water. We soon began collaborating. Kim learned that Mexican fishermen from Bahía Kino had discovered substantial concentrations of overwintering *Chelonia* along the rocky shores of the Gulf Coast of Baja California and Gulf of California midriff islands. They called such a turtle *caguama echada* 'sea-turtle lying-down.' Using hookah arrangements with aged compressor-diving equipment, they harvested these torpid turtles fast and furiously from 1973 to 1975. For these men, the discovery was an economic bonanza, and they took pride in providing their families with newfound, albeit short-lived relative prosperity.

After documenting overwintering sea turtles as known to the Seris and the Kino Bay fishermen, we sent copies of our manuscript to several marine biologist for comments. We witnessed the Kino Bay fishermen plucking torpid turtles from 10 to 15 m below the sea surface and accumulated a wealth of Seri experience with wintertime "buried" turtles. One scientist suggested we should wait for stronger documentation. Is information from indigenous people or rough and tumble fishermen less valuable than information from a scientist? Soon after our report was published in *Science* (Felger et al. 1976) I heard from my number one hero Archie Carr, who complimented us on documenting a phenomenon he had known only from anecdotal reports from the Atlantic side of the continent.

It was common knowledge among the Seris, the Mexican fishermen, and any biologists working in the region that the numbers and sizes of the various sea turtles were declining. The Kino Bay fishermen knew they were overharvesting the *caguama echada* in a boom and bust venture. They also knew about unrestrained harvests on nesting beaches much farther south in Mexico and wondered why nobody was curbing such destructive practices. Kino Bay fishermen said they would stop if everyone else would do the same—the classic tragedy of the commons. As predicted (Felger et al. 1976), the *caguama echada* became economically extinct in only several years. In the decades since then, overwintering *Chelonia* have been discovered on rocky ledges and caves throughout the central and northern Gulf of California (WJ Nichols and JA Seminoff, pers. comm.). In addition, divers harvesting sea cucumbers (*Isostichopus fuscus*) opportunistically continue to take torpid sea turtles when they find them, but nowhere approaching the levels of the 1970s harvests (Felger et al., in press). Nichols and Seminoff (pers. comm.) have also documented torpid, overwintering *Chelonia* in San Ignacio Lagoon on the Pacific Coast of Baja California. And overwintering behavior might not be confined to the green turtle. Torpid, probably overwintering, loggerheads have been encountered off the Sonora coast and in Magdalena Bay in Baja California Sur (Cliffton et al. 1982).

Support from the World Wildlife Fund, the New York Zoological Society, Robert Truland of the Chelonia Institute, and the Roy Chapman Andrews Fund of the Arizona-Sonora Desert Museum in the late 1970s and early 1980s made it possible to expand our research and conservation efforts, hook up with the international conservation scene, and interact more closely with biologists and students farther south in Mexico. Following leads from the Kino Bay fishermen and field work by Kim Cliffton and Dennis Cornejo, who had joined our team, the link was established between *Chelonia* nesting on beaches in Colola and Maruata, in Michoacán and the Sonora/midriff island populations (Cliffton et al. 1982).

Kim easily made friends with young Mexican sea turtle biologists, fishermen, and soldiers variously guarding nesting beaches, and they respected his dedication. He was fearless and often confronted poachers. Keep in mind the times. Mexican agencies responsible for sea turtles were understaffed and poorly funded, and part of a fisheries department strongly influenced by the commercial sector. Kim and Dennis witnessed sea turtle destruction up and down the west coast of Mexico. Nesting olive ridleys were slaughtered only for swatches of skin for the luxury leather trade. Truckloads of green turtles were being taken for the meat. And as much as 75 percent of all eggs of ridleys, greens, and leatherbacks were taken for sale, consumed largely as a supposed aphrodisiac. Dogs, pigs and poachers were decimating nesting beaches.

On one trip to Washington I found myself in an elegant oak-paneled conference room giving a presentation on the sea turtle situation on the west coast of Mexico to conservationists from powerful organizations. Among the slides were Kim's photos of unrestrained sea turtle carnage including Antonio Suarez's industrial slaughter house in Oaxaca: butchering of gravid olive ridleys, mountains of rotting carapaces, spoiled eggs in Styrofoam containers, wholesale harvesting of mating olive ridleys offshore from nesting beaches. This group of international conservationists was outraged.

The U.S. was foot-dragging on giving proper conservation status for sea turtles. Mexico was foot-dragging on signing onto CITES. Action was needed. Mexico depended on tourism, mostly from the United States. A boycott of tourism in Mexico was suggested to force Mexico and the international community to do something about the problem. Suddenly I realized the potential for political power, how easy it was, but also that innocent people would be hurt. I made phone calls to friends in Mexico and the U.S. I was cautioned, especially by Carlos Nagel, how much economic damage a boycott would do, and realized the unacceptable level of collateral damage, and how playing with power can turn around in unexpected ways. I halted any further effort at a boycott.

As a researcher at the Arizona-Sonora Desert Museum, I became involved in the Survival Service Commission of the IUCN and a wider conservation net. Dennis calculated preindustrial population sizes for the west coast Mexican greens and olive ridleys, and contemporary harvest rates and population sizes, primarily using information he and Kim obtained from their daring and sometimes dangerous field work. Peter Pritchard tells me that our predictions for potential extinction of populations of the Mexican Pacific green and olive ridley resulted in the United States finally classifying these populations as endangered.

Carlos Nagel, then at the Arizona-Sonora Desert Museum, was active in U.S.-Mexico conservation and facilitating broader dialogue. Carlos and Peter Pritchard arranged a meeting in Mexico in September, 1979, for dialogue between Antonio Suarez and sea turtle biologists and conservationists, even though most sea turtle conservationists regarded "Suarez as unreachable, dangerous, and to be avoided at all costs" (P. Pritchard, pers. comm.). The participants at the 1979 meeting included George H. Balazs, Archie Carr, Kim Cliffton, David Ehrenfeld, Angie McGehee, Carlos Nagel, Peter Pritchard, Georgita Ruiz, Laura Tangley, Jack B. Woody, and myself. Suarez, an aristocratic Spaniard, was politically well connected and making a pile of money from sea turtles in Mexico, especially from the skins for the European luxury trade. He had a family background in mink farms and animal skins (P. Pritchard, pers. comm.).

At Suarez's Mexico City home I enjoyed the finest cognac and marveled at his art collection. Later the group traveled to Suarez's sea turtle processing plant on the Pacific Coast of Oaxaca. I know that an abattoir is no place for one with a queasy stomach, but the scene at the Puerto Angel slaughter house was truly appalling (see Cahill 1978). Did Suarez, ever the gracious host, think we would be impressed and support him? Or did we think we would reform him? Archie Carr never wavered in his disgust for Suarez's actions on the coast of Oaxaca and most of us agreed with him.

Carlos Nagel believed that Suarez was ready to change his ways and become a conservation ally. At least we had what seemed like open dialogue rather than a stonewalling government agency. In 1980 Carlos and Peter arranged direct dialogue between Suarez and the broader sea turtle conservation community resulting in an infamous meeting in Washington, DC. At that meeting U.S. marshals attempted to serve Suarez a subpoena to appear in court to testify at a turtle meat smuggling case. Suarez understandably felt betrayed, although it was not by Carlos or Peter. The great olive ridley arribadas on the west coast of Mexico were crashing and Suarez sold his sea turtle business to a government agency and moved into tuna fishing off the coast of Africa.

LITERATURE CITED

Cahill, T. 1978. The shame of Escobilla. Outside Magazine February 1978. p. 22-64.

Cliffton, K, D.O. Cornejo, and R.S. Felger. 1982. Sea turtles of the Pacific coast of Mexico. In: K. Bjorndal, ed. Biology and Conservation of Sea Turtles. Smithsonian Institution Press, Washington, D.C. p. 199-209,

Felger, R.S. 2002. Sinaloa Shootout. In: T. Bowen (ed). Backcountry Pilot: flying adventures, Ike Russell. University of Arizona Press, Tucson. p. 2-14.

Felger, R.S. 2000. The Seris and the Guy Who Cuts the Tops Off Plants. "Seri Hands, a special issue," Journal of the Southwest 42:521-543.

Felger, R.S., K. Cliffton, and P.J. Regal. 1976. Winter dormancy in sea turtles: independent discovery and exploitation in the Gulf of California by two local cultures. Science 191: 283-285.

Felger, R.S. and M.B. Moser. 1985. People of the Desert and Sea: ethnobotany of the Seri Indians. University of Arizona Press, Tucson.

Felger, R.S., W.J. Nichols, and J.A. Seminoff. In press. Sea turtle conservation, diversity and desperation in northwestern Mexico. In: J.E. Cartron, G. Ceballos, and R.S. Felger, eds. Biodiversity, Ecosystems, and Conservation in northern Mexico. Oxford University Press, New York.

McGee, W.J. 1898. The Seri Indians. Seventeenth Annual Report of the Bureau of American Ethnology, Part I. Smithsonian Institution, Washington, D.C.

Shreve, F. 1951. Vegetation of the Sonoran Desert. Carnegie Institution of Washington Publication 591:1-192.

Black turtle (*Chelonia mydas*) mortality in Bahía Magdalena, Baja California Sur, México

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Population recovery of the black turtle has stagnated despite extensive conservation work at the nesting beaches in Michoacán for more than 20 years. Although legally protected, both, nationally and internationally, sea turtles continue to be harvested for consumption on their nursery and feeding grounds. This study examines the mortality of black turtles in Bahia Magdalena, a large lagoon complex on the Pacific coast of Baja California Sur, Mexico. It focuses on the number of carapaces found, cause of death, size composition and the distribution of dead turtles throughout the region. Out of 583 black turtle carapaces found in the region over the last six years, over 90% had been eaten. 86% of all turtles found were considered juveniles or subadults and the average carapace length of black turtles has declined consistently over the past six years from 63.2 to 53.9cm. All these are alarming signs of overexploitation and the illegal fishery can be considered as the single most important source of mortality for black turtles in Bahía Magdalena. Our data strongly suggest that the population is being exploited at a high and unsustainable rate. If harvest rates for the Bahia Magdalena region are considered typical, annual take in Northwestern Mexico could exceed 10,000 animals. This could explain the stagnating recovery of the population over the past twenty years.

Community participation in the conservation of the black turtle in Michoacan, Mexico

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The participation of the people of Colola and Maruata (Michoacán, México) in the conservation actions to protect the breeding black turtle population of Michoacán has proved seminal. For the last 20 years (1981-2001) the children of Colola have participated in the placement of the nests in protected hatcheries and in the release of millions of hatchlings into the waters of the east Pacific. The community involvement has allowed a yearly increase in the size of a natural nest area in Colola. In 2001, a third of the beach (1.5 km) was designated as a natural nest area.

The black turtle in the south Eastern Pacific Ocean

Mario Hurtado

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This paper includes an overview of the available information about research and management of the black turtle (*Chelonia mydas*) in the South Eastern Pacific Ocean (Panama, Colombia, Ecuador, Peru and Chile). These information proceeding from national Workshops realized during 2001 with the purpose of to define priorities and lines of action for design a marine turtle conservation regional program. The activity was conducted for the Permanent Commission for the Southeast Pacific in its function of the Regional Coordination Unit of the Plan of Action for the Protection of the Marine Environment and Coastal Areas of the Southeast Pacific, according to the mandate of the national governments of the region. The process received the WWF, NMFS and UNEP support. In the principal, to summarize the results of the consultation and consensus building process in respect to problems, priorities and action lines, which were identified for researchers, resources managers, academics, NGO's and community representatives, artisanal fishermen, and Fisheries industry. In addition to include an regional approach discussion in order to consolidate the marine turtles international cooperation in the region.

Nesting records of East Pacific green turtles (*Chelonia mydas agassizii*) in south Pacific Costa Rica, including notes on incidental capture by shrimping and longline activities

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INTRODUCTION

In 1996 PRETOMA began a community based sea turtle conservation project in the Southern Pacific coastal community of Punta Banco. In 1998 the project extended to include Caña Blanca, a small indigenous Guaymí community in the Conte Burica Indigenous Reserve, as well as San Miguel, a small coastal community in the Northwestern Coast. Locals are trained at these sites on proper nesting sea turtle monitoring techniques, and work under the supervision of an advanced biology student or recently graduated biologist. All of these nesting sites are considered solitary nesting beaches for olive ridley turtles (*Lepidochelys olivacea*), where hundreds of females nest each season. Other species are sporadically recorded, such as leatherbacks (*Dermochelys coriacea*), Eastern Pacific greens (*Chelonia mydas agassizi*) and hawksbills (*Eretmochelys imbricata*).

METHODS

Beach monitoring teams consist of local community members, student interns, and volunteers. Nesting beach study sites are divided into 2 or 3 sectors of 500 m to 1 Km each. Each sector is patrolled 4-6 hours each night. Observed turtles are identified, measured and tagged in the fore flippers with inconel tags. The eggs in each nest are counted and transferred to a hatchery, where they are protected until they hatch, at which point the number of hatchlings is counted and live newborns are released into the sea

The nest is then excavated in an attempt to investigate the cause of unhatched eggs and dead hatchlings (Arauz et al. 2000).On board observers work on coastal shrimp trawls and high seas mahimahi longline vessels. Captured turtles are identified, sexed and measured (CCL, CCW, SH). Notes are collected on the condition of the turtle (alive or dead) and obvious injuries (hooks, cracked carapaces, monofilament lines, gill nets). Stranded and dead sea turtles are also counted.

RESULTS

At both study sites, Pacific green records were scarce, from 1 to 7 records per year (Tables 1 and 2), and their occurrence is to be considered sporadic. The curved carapace length of nesting females in Caña Blanca (average=86 cm, SD=6.7 cm, min=77 cm, max=93cm) seems to be slightly greater than in Punta Banco (average=75.6 cm, SD=8.34 cm, min=64 cm, max=91 cm), but the sample size is quite small to establish any significance (Table 3). Of 268 eggs, 189 produced hatchlings (HS =70.5%), and 156 of these (Recruitment=58.2%) were successfully released into the sea (Table 4). The average nest size of *C. mydas agassizi* was 53.6 (SD=32.9, min=15, max=95). Average incubation period for 5 nests was 66.8 (SD=5.5, min=60, max=75).

Two hundred eighty-one turtles were incidentally captured during 2556.5 hours of observed shrimp trawling operations off the Pacific coast of Costa Rica, 27 of which (9.6%) were Pacific greens (*C. m. agassizi*). 11 were dead upon capture (40.7%), 11 were alive (40.7%), and no records exist for 5 (18.5%) (Arauz et. al. 1996). The average curved carapace length of 6 incidentally caught female Pacific green turtles and 1 incidentally caught male (Power and Moertel 1980) was 72.8 cm (min=63, max=86.5) 76.8 respectively. Likewise, the average curved carapace length for 5 incidentally caught males and 11 females was 68.9 (min=66, max=73) and 68.9 (min=52, max=84) (Arauz et al. 1996) (Table 5).

During 9 fishing excursions in the high seas mahimahi longline fishery from August 1999 to January 2000, 12 Pacific green turtles were captured, for a total Catch Per Unit of Effort (CPUE) of 0.305 individuals per 1000 hooks (Table 6). The average curved carapace length of the 9 captured females was 54.9 (SD=12.8, min=35, max=69.1) and the curved carapace length of the 3 males was 70 (SD=1.5, min 68, max=71) (Table 7). 8 of the Pacific green turtles were hooked in the mouth, (66.7%), and 4 (33.3%) were hooked in the foreflippers. All hooks were removed by crew members and the turtles released (Arauz 2001). In November 2001, 24 Pacific green turtles stranded in Punta Banco, 4 in Caña Blanca.

DISCUSSION

In spite of the low number of nesting activities recorded for Pacific green turtles in South Pacific Costa Rica, incidental capture data is indicating that this species is common in these waters. However, it still must be determined if this a foraging ground, breeding site or migratory route. Morphometric data of incidentally caught turtles indicates the presence of juveniles in the pelagic waters. Approximately 15,000 sea turtles are captured by Costa Rican shrimpers per year (without TEDs), some 1500 of which (9.6%) are Pacific greens. An average of 400-500 hooks are deployed during each mahimahi longline set, and each fishing excursion may consist of 10-15 sets. Thus, roughly 5000 hooks are deployed each fishing excursion. At a CPUE of 0.305/turtles/1000 hooks, the catch rate of Pacific green turtles per excursion is 1-2 turtles.

Acknowledgements. We thank the David and Lucile Packard Foundation, People's Trust for Endangered Species, Sea Turtle Protection Project, Tiskita Foundation, ANAI, Jeff Seminoff, for their support to carry out this project and travel assistance to attend this Symposium. We greatly appreciate the collaboration of the communities of Punta Banco, San Miguel and the indigenous Guaymi as well as the local and international program assistants and volunteers. Special thanks to Noah Anderson, Isabel Naranjo, Randall Arauz, Didiher Chacón, Jorge Ballestero and Roberto Zeledón.

LITERATURE CITED

Arauz, R.M., I. Naranjo, R. Rojas, and R. Vargas. 1997. Evaluation and technology transfer of the turtle excluder device in the Pacific shrimp fishery of Costa Rica. In: S.P. Epperly and J. Braun, comps. Proceedings of the Seventeenth Annual Sea Turtle Symposium. NOAA Tech. Memo. NMFS-SEFSC-415. p. 1-5.

Arauz. R., A. Myers, S. Crossland, S. Dougan and G. Miller. 2000. Report: Sea Turtle Conservation and Research Using Coastal Community Organizations as the Cornerstone of Support. Submitted to the Sea Turtle Restoration Project and the Tiskita Foundation.

Power, C.J. and D.M. Moertel. 1980. A study of the sea turtles captured along the Pacific coast of Costa Rica- A Second Look-.Unpubl. Thesis, St. Olaf College. Associated Colleges of the Midwest, USA.

Table 1. Total sea turtle nesting activity, and total *Chelonia mydas agassizi* records in 1998, 1999 and 2001 in Caña Blanca, Costa Rica.

Year	Total Turtle Activity		Total number of records		
	Total Records	Total Nests	Total Records	Total Nests in Hatchery	False Crawls
1998	94	47	1	1	0
1999	161	106	1	1	0
2001	102	59	7	5	2
Total	357	212	9	7	2

Table 2. Total sea turtle nesting activity, and total *Chelonia mydas agassizi* records in 1996, 1997, 1998, 1999, 2000 and 2001 in Punta Banco, Costa Rica.

Year	Turtle Activity		Total number of records			
	Total Records	Total Nests	Total Records	Nests in Hatchery	False Crawls	Nests Poached
1996	242	141	1	1	0	0
1997	184	136	4	3	2	1
1998	116	73	1	1	0	0
1999	407	233	5	0	5	0
2000	288	203	2	1	1	0
2001	240	140	1	0	1	0
Total	1477	926	14	6	9	1

Table 3. Morphometric data of nesting turtles *C.m. agassizi* in the beaches of Caña Blanca and Punta Banco, between 1997 and 2001, Costa Rica.

	n	Mean SCL (cm)	SD	min	max	Mean SCW (cm)	SD	min	max
Caña Blanca 1998, 2001									
	4	86.0	6.7	77.0	93.0	79.3	6.7	70.0	85.0
Punta Banco 1997, 1999, 2000, 2001									
	9	75.6	8.34	64.0	91.0	75.8	5.2	69.0	85.5

Table 4. Destiny of 268 eggs from *Chelonia. mydas agassizi* hatched and unhatched in Caña Blanca, Costa Rica 2001.

	Unhatched Eggs						Hatched Eggs			
	Pipped	Dead Embryo	Whithout Embryos	Unknown	Didnt find Uncounted	Total	Dead	Emerged Dead	Released	Total
Subtotal	8	7	52	9	3	79	24	9	156	189
%	3.0	2.6	19.4	3.4	1.1	29.5	9	3.4	58.2	70.5

Table 5. Morphometric data of Pacific green sea turtles examined during commercial shrimp fishing operations on Costa Rica's Pacific coast from March-May, 1980 (Power and Moertel 1980) and from May, 1995-January, 1996 (Arauz et al. 1996).

Sex	n	Mean SCL (cm)	min	max	Mean SCW (cm)	min	max
March to May of 1980 (Power and Moertel, 1980).							
Male	1	76.8			59.5		
Female	6	72.8	63	86.5	56.9	50.5	64
May 1995 to January 1996 (Arauz et. al.)							
Male	5	68.9	66	73	67.8	64.5	71
Female	11	68.9	52	84	67.3	51	79

Table 6. Number of Pacific green individuals captured during 9 mahimahi fishing excursions from August of 1999 to January of 2000, percentage of the total sea turtle catch, and CPUE (# of individuals per 1000 hooks) (Arauz 2001).

Excursions	1	2	3	4	5	6	7	8	9	# indiv.	%	CPUE
C. m. agassizi	4	4	1	2	1	0	0	0	0	12	0.35	0.305

Table 7. Mean Curved Carapace Length (CCL) and Width (CCW) of the sea turtles captured during 9 longline fishing excursions from August of 1999 to January of 2000.

Sex	n	CCL	SD	min	max	CCW	SD	min	max
females	9	54.9	12.8	35	69.1	54.9	12.8	36	71
males	3	70	1.5	68	71	73.3	1.5	72	75

PART 2: POSTER PRESENTATIONS

Procosta 2000-2001: integrated local development program for the conservation of marine turtles, Miranda State, Venezuela

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BACKGROUND

Integrated conservation and development programs offer new alternatives for the conservation of natural areas and their biodiversity. The Integrated Program of Conservation and Development Barlovento Coast (ProCosta) was established in 1999, with the contribution of Petroleum of Venezuela (PDVSA) and the support to the Oscar Ochoa Palacios Ecological Foundation.

This program attempts to establish awareness for the conservation and recuperation of marine turtles, environmental conservation, and sustainable development in the central coast of country and to promote better management of natural resources what it will improve the life quality of local communities (PROVITA 2000, 2001).

At ProCosta, sea turtles are a symbol of conservation, since all seven species that exist worldwide are endangered species. Five of them have been reported in Venezuela. In the area where the project takes place, four of those species arrive, and up to date, they have all nested and are being protected by PROVITA. They are hawksbill turtles (*Eretmochelys imbricata*), loggerhead turtles (*Caretta caretta*), leatherback turtles (*Dermochelys coriacea*) and green turtles (*Chelonia mydas*). This study is following recommendations of the "Sea Turtle Recovery Action for Venezuela" (Guada and Sole 2000).

In the first phase of the program were identified problems affecting to the marines turtles, the environmental, social and economic situation of the Barlovento region in the Miranda State. PROVITA began campaigns to divulge the program objectives to the communities, visitors, governmental and nongovernmental organizations. Strategic alliances were identified with local institutions. As result of this activities, Chirimena was selected as pilot community of the study region. Chirimena´s Culture House Association is one of participants in the program.

ACTIVITIES OF THE PROGRAM

Investigation and manipulation. The main objective is to collect basic information about the biology of the sea turtles through monitoring activities, which consist in daily walks around the beaches where the sea turtles and their nests are located.

Nest Protection. Currently, in the Chirimena beaches of the Miranda State is the hatchery for the protection of the sea turtle nesting. These activities are supported through strategic alliances with the community, the Oscar Ochoa Palacios Foundation, and the Civil Association of the Casa de la Cultura of Chirimena.

Environmental Education. In the environmental education area, a series of recreational activities and sensitizing campaigns have been held at courses, and the Conservationist Brigade "Sea Turtles" , integrated by Chirimena children, has been created. Likewise, several cultural and environmental education activities have been organized with diverse educational institutes and the Brion Mayor from Miranda State.

Community Participation, Divulgence and Social Development. With the main goal of getting the communities involved in the conservation of sea turtles, the Beach Cleansing activities at Chirimena and at the Parque Nacional Tacarigua have taken place; Two sea turtle Conservation Festivals have taken place as well. Support for the organization and preparation of people involved in the community with the elaboration of sustainable development projects, through the establishment of Eco MicroCompanies.

METHODS

During 2000 and 2001 sea turtle conservation activities were done in El Banquito, Miranda State. Beach surveys were conducted along 5 km of interrupted coast: sand and rocky beach. Seven beaches were monitored: El Banquito, La Escalera, Maspano, Playa Grande, La Virgen, El Rincón and Majaguitas. The nests remained in situ unless some factors fishermen were threatening their survival like the high freatic level, inundation by tides, depredation, erosion, root growth and possibility of poaching (Pritchard et al. 1983). The tracks and nests were camouflaged to avoid their lost. Educational program based on the participation of the community and awareness building, as well as the organization of a annual festival for the conservation of marine turtles in the region.

RESULTS AND DISCUSSION

A total of 60 nests were protected between 2000 and 2001: 36 from the leatherback turtle, 8 from the loggerhead turtle, 17 from the hawksbill turtle, and 1 of the green turtle (Fig. 1). Twenty-eight of these nests were translocated to a hatchery in El Banquito beach, while the remaining were camouflaged and left on the beaches where they were found. Hatching success in situ were higher (58%) than those recorded at our hatchery (52%), which suggests that the presence of field personnel may be a critical component of achieving high hatching success rates. We recorded a recruitment of 2465 turtles into the sea. Likewise, during this most recent breeding season we lost only 10% of nests because of the poachers, comparing wit the results of 41% and 98% in previous years (Vernet 1999). The difference may be due to our educational program, based on the participation of the community and awareness building, as well as an annual festival for the conservation of marine turtles in the region. Otherwise, problems have continued as the intentional caught of turtles for sale of meat and other product like shells, degradation of nesting beaches by construction, sand mining, contamination by sewage and solid waste, and disorientation of turtles hatchlings by artificial lighting. The participation of the different actors to solve these problems is important and, this will be promoted through campaigns to divulge the program to local communities, visitors, and strategic alliances with both government and nongovernmental organizations.

In 2002, one training activity have been organized in Barlovento Universitary Institute in order to improve the capacity of the personal to register information. This course was prepared with MSc. Hedelvy Guada (WIDECAST-CICTMAR) .

CONCLUSIONS

In the last two years, the leatherback turtle was the principal species using the El Banquito´s beaches. The loggerhead, hawksbill, and green turtles were present but lower proportion. The presence of field personnel may be a critical component of achieving high hatching success. Nest poaching for sale and local consumption of eggs may be reduced through environmental education activities, community participation and awareness building. ProCosta Program of PROVITA appreciates the importance of the participation of the different stakeholders to solve the problems identified.

Acknowledgements. PROVITA are deeply recognized to the support provided by Petroleum of Venezuela (PDVSA) and Oscar Ochoa Palacios Ecological Foundation. We are grateful to the contributions provided by the Chirimena´s Culture House Association, Chirimena community, Barlovento Cultural Groups, Miranda State Government, Municipal Government of Brión, Barlovento Universitary Institute, Chirimena elementary school and CICTMAR (Centro de Investigación y Conservación de Tortugas Marinas).The financial support to present this study in 22nd Annual Symposium Sea Turtle Biology and Conservation was provided by David and Lucile Packard Foundation and The National Fish and Wildlife Foundation.

LITERATURE CITED

Guada, H. and G. Solé. 2000. WIDECAST Plan de Acción para la Recuperación de las Tortugas Marinas de Venezuela. A. Suarez, ed. Informe Técnico del PAC No. 39.. UNEP Caribbean Environment Programme. Kingston, Jamaica. xiv + 112 p.

Pritchard P., P. Bacon, F. Berry, A. Carr, J. Fletmeyer, R. Galagher, S. Hopkins, R. Lankford, R. Márquez M., L. Ogren, W. Pringle, Jr., H. Reichart and R. Witham. 1983. Manual Sobre Técnicas de Investigación y Conservación de las Tortugas Marinas, Simposio Sobre Tortugas Marinas del Atlántico Occidental, IOCARIBE.

PROVITA. 2000. Proyecto Integrado de Desarrollo y Conservación Costa de Barlovento. Informe de Actividades Fase de Diagnóstico - Primera Etapa. Octubre 1999-Marzo 2000. Informe Técnico para PDVSA. Caracas.

PROVITA. 2001. Proyecto Integrado de Desarrollo y Conservación Costa de Barlovento. Informe de Actividades Fase de Implantación - Primera Etapa. Abril 2000-marzo 2001. Informe Técnico para PDVSA. Caracas.

Rodríguez, J.P. and F. Rojas-Suárez. 1999. Libro Rojo de la Fauna Venezolana. PROVITA, Fundación Polar. Segunda Edición. Caracas. 421 p.

Vernet, P. 1999. Seguimiento y manejo de las tortugas marinas para la recuperación de las especies nidificantes en las playas de "El Banquito" zona centro costera de Venezuela. Informe Técnico Interno. Fundación Ecológica Oscar Ochoa Palacios. 3 p.

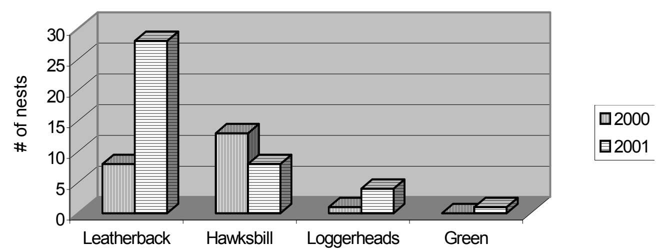

Fig. 1. Nesting trends of the four sea turtles species during 2000 and 2001 in seven beaches of the study area.

The continued assessment of the reproductive status of the marine turtle rookery in the Cayman Islands

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INTRODUCTION

The Cayman Islands' breeding marine turtle population was once considered the largest in the Caribbean (Groombridge 1982 and King 1982) but was presumed to be extinct by the 1800's following considerable harvesting pressure (Groombridge 1982). The Marine Turtle Nesting Survey established in 1998 by the Cayman Islands' Department of Environment has documented that a remnant of that breeding population still remains today, although at a fraction of it's former size and in increasingly fragile numbers.

METHODS

On both Grand and Little Cayman potential marine turtle nesting beaches covering 32km and 21km respectively, are monitored every 3-4 days during the months of April to September for evidence of nesting activity. Species and individual identification is based on track symmetry and measurements, emergence dates, body pit depth, geographic location, and verification with live or dead hatchlings. The site is assessed for potential anthropogenic and non-anthropogenic threats. Nest sites and tracks are disguised to deter tampering and poaching. Nest location is fixed by triangulation using 100m survey tape and pre-established markers. When necessary, nests are relocated (salt-water inundation) or are covered with a cylindrical mesh (photo-pollution). Reproductive output (fecundity/success) is determined by excavation of the nest following the predicted emergence dates of hatchlings.

RESULTS AND DISCUSSION

Three year data sets have been collected for both Grand Cayman (1999/2000/2001) and Little Cayman (1998/2000/2001). On Grand Cayman 19 of 24 beaches surveyed experienced nesting by either hawksbill, loggerhead or green turtles since 1999. Nesting activity was not distributed equally geographically, with the majority of nesting incidents (5+ nests per year) occurring on only 6 beaches, and some of these beaches did not experience nesting every year. In Little Cayman, 8 of the 20 beaches surveyed experienced some form of activity since 1998, though only 4 recorded more than one nest a year.

The levels of *E. imbricata* nesting activity were considered low with nests only observed on Little Cayman in 1998 (2 nests) and on Grand Cayman in 1999 (2 nests). *C. caretta* nesting was not observed on Little Cayman until 2001. Nesting by *C. mydas* has occurred on both islands in every year (Table 1). No leatherback *Dermochelys coriacea* nests have been found although there are reports of leatherback nesting in the past (Wood and Wood 1994).

Numbers of *C. caretta* nests on both islands have increased in every year since the survey began. While clutch size for *C. caretta* in the Cayman Islands has increased from 1999 to 2001, (Table 3) hatch success has steadily decreased in these years (Table. 2). Very low levels of nesting coupled with consistently low hatch success for all species in Little Cayman are cause for concern. Nesting data collected to date, when combined with published data on internesting intervals (Miller 1997, Hays and Speakman 1992) and renesting distances (Bjorndal et al. 1983), reveal numbers of *C. caretta* breeding females lower than 20 in Grand Cayman and lower than 5 in Little Cayman. *C. mydas* also shows critically low levels, with an estimated breeding female population size of less than 10 in Grand and Little Cayman combined. *E. imbricata* breeding female populations may be considered even lower. Long term recovery of the breeding population will likely be nonexistent or extremely slow if the observed trends in nesting activity accurately reflect the current status of marine turtles in the Cayman Islands. It is clearly evident that the existence of a legal harvest of mature turtles in the Cayman Islands by licensed fishermen will continue to severely impact resident breeding population and further hinder recovery.

Emerging data support a status designation of 'Endangered' and demonstrate the highly precarious/threatened nature of all marine turtles species in the Cayman Islands. In light of this, population management methods are being utilised for threatened nests. Nest relocation and protection have assisted hatch success and reduced post-emergence death, ultimately contributing to the long-term recovery of these species. In addition educational outreach and a comprehensive coastal lighting reduction programme are underway to further reduce anthropogenic impacts on nesting habitat.

SUMMARY

Three years of standardised monitoring on both Grand and Little Cayman have demonstrated distinct trends in several aspects of the reproductive activity output (fecundity/success) for all three nesting species. These trends have highlighted the need for immediate action to safeguard remaining breeding populations and their associated nesting habitat to provide for the long-term recovery of the species. Although few firm conclusions can be established until the programme has monitored at least two reproductive periods (between 5-10 years), the advent in each year of new anthropogenic threats, coupled with an increase in intensity of existing threats, renders the creation and implementation of an immediate action plan containing, at it's core the abolition of the legal turtle fishery, critical.

LITERATURE CITED

Bjorndal, K.A., A.B. Meylan, and B.J. Turner. 1983. Sea turtles nesting at Melbourne Beach, Florida. I. size, growth and reproductive biology. Biol. Conserv. 26:65.

Groombridge, B. 1982 The IUCN Amphibia-Reptilia Red Data Book. Gland, Switzerland. 426 p.

Hays, G.C. and J.R. Speakman. 1992. Clutch size for Mediterranean loggerhead turtles (*Caretta caretta*). J. Zool. Lond. 226:321-327

King, F.W. 1982. The Decline of the green turtle and the hawksbill. In: K.A. Bjorndal, ed. The Biology and Conservation of Sea Turtles, Smithsonian Institution Press, Washington D.C.

Miller, J.D. 1997. Reproduction in Sea Turtles. In: P.L. Lutz and J.A. Musick, eds. The Biology of Sea Turtles, CRC Press, Boca Raton, Boston, London, New York, Washington D.C.

Wood F.E. and J.R. Wood. 1984. The Sea Turtles of the Cayman Islands. In: M.A. Brunt and J.E. Davies, eds. The Cayman Islands: Natural History and Biogeography Kluwer Academic Publishers, Dordredcht. p. 229-236.

Table 1. Summary of total nests found for each species *Chelonia mydas*, *Eretmochelys imbricata*, and *Caretta caretta* on Grand and Little Cayman in each year the survey was conducted.

	Grand Cayman			Little Cayman		
	1999	2000	2001	1998	2000	2001
Green	1	18	2	9	9	3
Loggerhead	18	25	27	0	0	5
Hawksbill	2	0	0	2	0	0
Unidentified	2	2	1	4	2	0
total nests	23	45	30	15	11	8

Table 2. Summary of hatch success for each nesting species *Chelonia mydas*, *Eretmochelys imbricata*, and *Caretta caretta* on Grand and Little Cayman in each year the survey was conducted. 'No study' indicates a year in which the survey was not carried out on this island, and 'No nests' indicates a year in which no nests were found by surveyors for this species.

hatch success %	Grand Cayman			Little Cayman		
	C. caretta	*C. mydas*	*E. imbricata*	*C. caretta*	*C. mydas*	*E. imbricata*
1998	no study	no study	no study	no nests	31% n=9	31% n=3
1999	86% n=18	2% n=1	77% n=2	no study	no study	no study
2000	67% n=20	82% n=11	no nests	no nests	71% n=9	no nests
2001	69% n=24	50% n=2	no nests	49% n=4	51% n=3	no nests

Table 3. Summary of clutch size for each nesting species *Chelonia mydas*, *Eretmochelys imbricata*, and *Caretta caretta* on Grand and Little Cayman in each year the survey was conducted.

clutch size	Grand Cayman			Little Cayman		
	C. caretta	*C. mydas*	*E. imbricata*	*C. caretta*	*C. mydas*	*E. imbricata*
1998	no study	no study	no study	no nests	120 n=9	157 n=2
1999	119 n=18	53 n=1	151 n=2	no study	no study	no study
2000	125 n=20	107 n=17	no nests	no nests	109 n=9	no nests
2001	130 n=26	88 n=2	no nests	103 n=5	103 n=3	no nests

Florida's statewide nesting beach survey program

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Loggerhead turtles (*Caretta caretta*), green turtles (*Chelonia mydas*), and leatherbacks (*Dermochelys coriacea*) nest regularly on Florida's beaches. In an effort to help promote the recovery of sea turtles, the Florida Fish and Wildlife Conservation Commission (FWC, then DNR) created the Statewide Nesting Beach Survey (SNBS) program in 1979, under a cooperative agreement with the U.S. Fish and Wildlife Service. The purpose of the survey is to document the total distribution, seasonality, and abundance of nesting by sea turtles in Florida. In 2001, the survey included 181 beaches, covering 1,280 km. FWC coordinates the collection of data through a network of local, state and federal agencies, private conservation groups, universities, consultants, and private citizens that are permitted by FWC to conduct sea turtle conservation activities. The survey data are compiled into reports and made available on CD's as ARCVIEW maps and on the Internet (http://www.floridamarine.org). Using this information, managers and planners are able to assess and reduce the potential impacts of coastal projects such as beach renourishment, armoring, construction, and dredging on sea turtles, their nests, hatchlings, and nesting habitat, primarily by adjusting the nature, timing, and sequence of authorized activities. Information on sea turtle nesting densities and distributions are also used to guide land acquisition decisions and to help with oil spill contingency planning. A complementary FWC program, the Index Nesting Beach Survey, is designed to provide data on the status and trends of the nesting populations.

The sea turtle network of WWF-Italy

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Conservation of sea turtles requires both preservation of nesting sites and reduction of human-induced mortality at sea. While many programs are working for the protection of nesting beaches, providing information about number of nests and trends, the marine phase of turtles is still poorly protected and known. Hence, it seems particularly important and urgent to have efficient programs about turtles at sea, focused on fishermen (who are both a source of information and the target of awareness campaign for reducing fishing-induced mortality) and strandings. In this context, networks of permanent local groups working on the above subjects can be a very powerful tool for assessing and monitoring the status of the populations at sea. Italy is one of the Mediterranean countries with the greatest coast extension and the largest fishing fleet; it faces both the western and eastern basin and some of the most important marine areas for Mediterranean sea turtles. Hence, it is likely that conservation programs based in Italy are fundamental for the conservation of sea turtles in the Mediterranean. WWF-Italy is the most important NGO in Italy, with more than 260,000 members. Along the Italian coast it has 64 local offices, 26 protected areas, and 7 sea turtle rescue centres. Such an extensive network could be very effective for monitoring sea turtles occurring in waters around Italy. As a whole, the 7 rescue centers are equipped with 52 tanks, which have an overall maximum capacity of 87.9 m3. Most of them are also equipped for surgical operations. WWF-Italy is involved in sea turtle conservation and research since early '80s, and many persons have acquired specific skills in this field. In 2001 a total of 703 turtles, stranded or incidentally caught by fishermen, were treated in some way by the WWF-Italy personnel; of these, 621 spent a period of rehabilitation in a rescue center. 148 specimens needed to be operated on. Through this activity, a great number of people (fishermen, tourists, authorities, local people) are continuously informed on sea turtle conservation issues. For the next future, the sea turtle network of WWF-Italy has the following goals: i) collecting data about the interaction of sea turtles with the most important fishing gears in different areas; ii) collecting data on biological parameters; iii) providing fishermen and authorities with recommendations aimed to reduce the impact on populations at sea; iv) improving and enhancing WWF's sea turtle monitoring and rescuing activities. In order to reach these goals, the network will focus on good collaboration with fishermen of several Italian port and with national authorities.

Nesting biology and conservation of the olive ridley sea turtle (*Lepidochelys olivacea*) in the state of Sergipe, Brazil

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The olive ridley sea turtle (*Lepidochelys olivacea*), considered to be probably the most abundant of the sea turtles, has a nearly circumglobal distribution in tropical oceans. In Brazil, the most important nesting area for this species is located on the northeastern coast, in the State of Sergipe. Nesting occurs mainly at Santa Isabel Biological Reserve, on the northern portion of the State, and, in smaller numbers, at the Abaís Environmental Protection Area. Projeto TAMAR-IBAMA, the Brazilian sea turtle conservation program, has been working in the State of Sergipe since 1981. Nowadays, Projeto TAMAR maintains three stations in the State, monitoring 125 km of nesting beaches and conducting environmental conservation and educational activities with the coastal communities. In this work we present data gathered from 1990 to 2001 covering eleven nesting seasons: nest spatial and temporal distributions, nesting data (clutch size, incubation time, hatching success) and size distribution of the nesting turtles. Finally, a review of the conservation status of olive ridley turtles in the State of Sergipe is presented.

U.S. Department of Agriculture, Wildlife Services aids a coalition of agencies across the Florida panhandle with control of non-native predators to protect sea turtle nests

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United States Department of Agriculture (USDA), Wildlife Services have joined State, Federal, and local agencies in the Florida panhandle to assist with the depredation issue of sea turtle nests on public lands. Land managers in the mid 1990s became concerned with the depredation of sea turtle nests by non-native predators such as coyotes and red fox. In 1996, St. Joseph State Park reported a depredation rate of 52.8 percent. As a result, the Fish and Wildlife Service funded USDA, Wildlife Services to initiate a pilot project to reduce nest predation by controlling predators in St. Joseph State Park. Implementation of this strategy resulted in nest predation being reduced to 6.3%. Due to the success of this pilot project, state and federal land managers across the panhandle requested assistance. Thus, a coalition was formed to address the concerns of depredation on public lands across the panhandle.

Since 1997, the coalition has funded USDA, Wildlife Services to implement the control of predators on public lands across the panhandle. As a result, a full-time USDA biologist was stationed in the panhandle to initiate predator control. A prioritized schedule of predator control needs is prepared and issued every year to the USDA biologist. The biologist conducts predator control in the top priority areas and also provides land managers with training and technical assistance. Wildlife Services, along with other land managers has succeeded in reducing turtle nest predation across the panhandle to 0% in some areas since the program has began.

Current status of sea turtles in Argentina

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In the Argentinean Seas there are three species of sea turtles cited: The green turtle (*Chelonia mydas*), loggerhead turtle (*Caretta caretta*) and the leatherback turtle (*Dermochelys coriacea*). The reports cover from Buenos Aires province to Chubut province (Rio de La Plata, Atlantic ocean), being this one the most austral zone for the sea turtles species in the western south Atlantic. The green and loggerhead turtles are found in the immature stage whereas the leatherback as an adult. In the 90´s there have been many reports of stranded turtles and incidental captures by fishermen. These are taken to different private aquariums where they are rehabilitated in order to set them free in the high sea later on. These species are protected by national laws in the resolution #144/83 and categorizes them in appendix I. The traffic of sea turtle parts are controlled by CITES in which Argentina is part of it since 1981. The problems about the conservation that are faced are the fisher markets (with different types of fishing) trafficking of carapaces, pollution and incidental captures made by ships. Now a days, it has been created the first project on research and conservation of sea turtles from Argentina –Peyu Project- by students, vets, biologists, and researchers.

Assessment of management strategies on survival rates of loggerhead sea turtle nests in Georgia, USA, 1999-2001

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Statewide monitoring and management of loggerhead turtle nesting was first established in 1989 on Georgia beaches. Because of concerns over the negative effects of tidal inundation on nest success, sea turtle cooperators in Georgia have historically relocated a large proportion of total nests (> 60% statewide in 1998). As a result of concerns over the effects of nest relocation on hatchling sex ratios and fitness, the Georgia Department of Natural Resources has asked cooperators to limit relocations to high risk nests located in unstable erosional areas. In this preliminary analysis, we use the MARK program to compare nest survival rates for combinations of management including relocations (in-situ, relocation) and predator control (no protection, wire screen). In addition, we will examine the correlation between tidal inundation and nest survival. Results will be used to assess the effects of management on nest survival rates.

Protecting sea turtles in Cuatro Islas, Leyte, Philippines throughout NIPAS

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INTRODUCTION

The loss of biological diversity, the need to conserve natural landscape for ecological balance, the sustainable use of resources from natural ecosystem and preserve cultural heritage are among the reasons that lead to the establishment of protected areas (PAs). Initially, protected areas were created to preserve spectacular scenery or particular wildlife concentrations. However in more recent decades, protected area concept has evolved considerably generating the need for much more flexible legal instruments (de Klemm et al. 1994). In particular, these instruments permit adapting the regulatory scheme to the conservation goal being pursued in each case. Thus, modern protected areas legislation seeks to allow for a variety of types and mechanisms, ranging from the traditional strict prohibition of human activities to the selective regulation of those which otherwise would defeat the conservation purpose of protected areas.

In the Philippines, Republic Act No. 7586 otherwise known as National Integrated Protected Area System Act of 1992 serves as the law on protected areas. The Department of Environment and Natural Resources (DENR) is the prime line agency for its implementation. NIPAS recognizes that effective administration of these areas is possible only through cooperation among national government, local government and concerned private organizations. It adopts a decentralized system of protective area management. The management of a PA rests with the Protected Area Management Board (PAMB), which is a multi-sectoral body consisting of representatives from the Local Government Units (LGUs), National Government Agencies (NGAs), Non-Government Organizations (NGOs) and Indigenous Cultural Communities (ICCs). This makes the local stakeholders more accountable in managing their resources.

Having the policy right may not, in effect, be sufficient enough to get the desired results. Protected areas administration has historically been weak, due to the many institutional reorganizations as well as institutional and juridical struggles (IUCN - Philippines 1992). This paper reviews the institutional arrangement and policy environment in the area which served as arms in managing the Cuatro Islas Protected Seascape.

METHODS

A semi-structured interview was conducted among the identified key informants in the government who have direct jurisdiction over the area. A Focus Group Discussion (FGD) among community leaders was conducted to assess the relationships and relative influence of institutions in managing coastal resources in the area.

Study area. In April 23, 2000, Presidential Proclamation No. 230 was issued declaring 12,500 hectares of Cuatro Islas' land and water as Protected Seascape under the NIPAS. Cuatro Islas is composed of 4 islands, namely, Apid, Digyo, Mahaba and Himokilan. The first 3 islands belong to the municipality of Inopacan while the latter belongs to Hindang. The islands of Apid, Mahaba and Digyo belong to one political unit, Barangay Apid, while Himokilan island is another political unit. The four islands have an aggregated area of 137.26 hectares (Himokilan - 74.91has; Apid - 35.928 has; Mahaba - 17.886 has; and Digyo - 8.534 has.). Based on the 2000 census, Himokilan has a total number of 100 households with household population of 511. Barangay Apid has a total population of 570 with Apid island having the highest number of households (83 households) compared to Mahaba (25 households) and Digyo (5 households). Fishing is the main source of livelihood. Pandan plants are also found abundant in the islands which are made into "lilas" as raw materials for mat weaving.

Historically, the islands have been known as nesting beaches and rich fishing ground. However, recent observation among the locals is that the number of sea turtles nesting in the islands has drastically decreased as the number of settlements along the beach increases. Destructive fishing, i.e. use of dynamite and poison, became also rampant resulting to forty-five percent (45%) of the coral cover remaining in the area which is classified as "Fair Condition" (DENR 1995). The need for protection and restoration of this habitat along with its potential for tourism has lead to the islands' declaration as protected seascape.

INSTITUTIONAL ARRANGEMENT

Before its declaration as Protected Seascape, the islands have been recipient to two different programs. The Small Islands Environmental Rehabilitation and Livelihood Program under the VISCA-GTZ Program on Applied Tropical Ecology was implemented in the Apid, Mahaba and Digyo islands from 1993 to 1998. While the DENR is implementing a Coastal Environment Program in Himokilan since 1996. Common objectives of these programs include community capability development and environmental protection and rehabilitation. Different community organizations emerged out of these projects and likewise marine sanctuaries have been established in each of the island.

Now more than a year has passed after being declared as protected area, PAMB which act as policy making body has not been organized. The change in political administration as a result of May 2001 election was cited as one of the reasons for putting the appointment of LGU representatives to the board on hold. But even without the existence of PAMB, the different institutions in the islands continue to play the role in managing its coastal resources.

In the case of Brgy. Himokilan, managing coastal resources is primarily seen as the responsibility of the local government (barangay). Community participation is less active compared to Brgy. Apid. BARAKUDA, which was formed in Apid primarily for the purpose of coastal law enforcement, continues to take the bigger role in protecting its coastal waters from illegal fishers. AWLA, the women's group, credited themselves for instilling environmental values both on their husband and children. Some members of AMCC are BARAKUDA members. As an organization, AMCC have considered themselves to have played a minor role despite the fact that are engaging into tourism related activities. The level of support given by each respective municipalities also varies. While support from the LGU of Inopacan comes in the form of providing funds for sanctuary maintenance and doing patrol operations, the LGU of Hindang has taken back the patrol boat which the barangay used during patrol operations. External institutions like VISCA and DENR continuously provide support in the area.

ENVIRONMENTAL POLICY

From 1993 to 1995, Barangay Apid has passed 12 ordinances in conjunction with resource management. Specifically, 7 are related to fishery ordinances; 2 for environmental protection; 2 for the protection of wildlife and endangered species (dolphins and turtles); and 1 for resource rent. The tagging activity on incidentally caught sea turtle by the locals and project staffs of VISCA in July 1995 has lead to the passage of the local ordinance for the protection of sea turtles. In Brgy. Himokilan, only 2 ordinances were passed in 1998. One is in relation to the management of their sanctuary while the other is related to fishery ordinance. Although there are existing National Laws that governs the protection and management of the environment, having local laws instill more accountability among the locals.

Political dynamics within the community also play a vital role with law implementation. Based on the anecdotal information from interviews conducted, the new BARAKUDA chairman is allegedly appointed by the mayor. This has lead to the resignation of some old members of the group. Others believed that the intervention was made because the old BARAKUDA members were not performing their jobs well. On one end, community pressure has also been a key factor in keeping the law in order. According to one key informant, a petition was filed by the residence of Brgy. Apid on the allegation that their Bgry. Captain is receiving money from commercial fishing operators for allowing them to operate in the area. This has lead to the resignation of the Brgy. Captain. Another is the case of the eviction of one transient fisherman in Himokilan where he hunted sea turtles. Pressures were said to be exerted to the host family.

CONCLUSION

Cuatro Islas Protected Seascape covers two political units having different sets of institutional and political arrangements. In order to properly manage its resources including sea turtles, there is a need to harmonize the plans and programs of both the LGUs of Inopacan and Hindang. The key may lies through the PAMB, but it is another institution that needs to be strengthen in order to perform its mandates accordingly.

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LITERATURE CITED

de Klemm, C., A. Tolentino, F. Guilmin, R. Tarasofsky, L. Glowka, and D. Craig. 1994. Conserving biological diversity: the legal and institutional issues. In: Proceeding of a Regional Conference on Biodiversity Conservation in the Asia and Pacific Region: Constraints and Opportunities. Asian Development Bank. Manila, Philippines. p. 402-449.

DENR - 8. 1995. Protected Area Suitability Assessment Report.

DENR and UNEP. 1997. Philippine Biodiversity: An Assessment and Action Plan

IIRR. 1998. Participatory methods in community-based coastal resource management. 3 vols. International Institute of Rural Reconstruction, Silang, Cavite, Philippines IUNC. 1992. 1992 Protected Areas of the World: A review of national system for the Philippines.

VISCA-GTZ Applied Tropical Ecology Program. 1998. Small Islands Environmental Rehabilitation and Livelihood Program Terminal Report

A potential management tool to improve hawksbill, *Eretmochelys imbricata*, hatch success

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INTRODUCTION

Incubation temperature determines sex ratio and hatching success of sea turtle nests (Ackerman 1997, Ewert 1979). At Buck Island Reef National Monument in St. Croix, U.S. Virgin Islands, hawksbill turtles (*Eretmochelys imbricata*) typically nest in beach forest where their clutches are shaded (Hillis and Phillips 1995). However, the beach forest canopy was destroyed in 1989 by hurricane Hugo. By 1995, the beach forest had begun to recover, but two successive hurricanes, Luis and Marilyn, prevented full recovery. This loss of shade has resulted in increased nest temperatures, occasionally exceeding the thermal tolerance range (25ºC-35ºC), especially in dark soil (Wibbels et al. 1999).

Studies from beaches used by sea turtles have shown that nest temperatures are significantly cooler in areas that are shaded by vegetation (Horrocks 1991, Janzen 1994, Mrosovsky 1992). Nest temperature is also correlated with nest depth, and the amplitude of the temperature cycle in the nest decreases with increasing depth, consequently shallower nests reach higher daily temperatures for longer periods of time than deeper nests (Wilson 1998, Hays et al. 1995). Due to their shallow nature, hawksbill nests are therefore at a greater risk of overheating due to vegetative loss by hurricanes or other tropical storms.

This study was conducted to test if covering the surface of nests laid in dark soil with white sand significantly reduces the temperature at the mean nest depth of hawksbill turtles (30 cm depth).

METHODS

We divided a 16 m^2 open area into 1 m^2 plots and randomly covered the surface of each plot with 4 gallons of white sand or soil/sand mixtures of 25%, 50% and 75% soil. At the center of each plot, we deployed a HOBO data logger (University of Alabama, Birmingham) at 30 cm depth. The area surrounding the study plots received random sand/soil treatments to avoid biasing the outer plots (Fig. 1). The data loggers, provided and calibrated by Dr. Thane Wibbels of the University of Alabama in Birmingham, were allowed to adjust to ambient temperature for twenty-four hours. Temperature was then recorded for three consecutive days in intervals of 1 hour. Data were analyzed using one-way ANOVA and Tukey-Kramer multiple-comparison procedure. The alpha level was set at 0.05.

RESULTS

Mean maximal temperatures were significantly different among treatments (ANOVA, F=9.0). Mean maximal temperatures of the white-sand treatment were 0.9 ºC and 1.1 ºC lower than the 50% and 75% sand/soil treatments, respectively (Table 1, Fig. 2).

DISCUSSION

We propose white-sand treatment as a potential management tool to reduce sea turtle nest temperatures. Covering a nest site with a treatment of white calcareous sand similar to what was used in this study may increase hawksbill hatching success. Due to the already high temperatures in the unshaded and dark soil nesting sites at BUIS, this treatment may be particularly useful to prevent high levels of late-term mortality caused by nest temperatures exceeding the thermal tolerance range. Once the beach forest canopy is regenerated, white-sand treatments may bring nest temperatures closer to the pivotal sex-determining temperatures (Standora 1985, Godfrey et al. 1999). Further studies with actual clutches should be conducted to ascertain the effects of metabolic heat, clutch size and other variables, which may adversely affect nest temperature.

LITERATURE CITED

Ackerman, R.A. 1997. The nest environment and the embryonic development of sea turtles. In: P.L. Lutz and J.A. Musick, eds. The biology of sea turtles. CRC Press, Boca Raton, FL. p. 83-106.

Ewert, M.A. 1979. The embryo and its egg: development and natural history. In: M. Harless and H. Morlock, eds. Turtles: perspectives and research. John Wiley and Sons. New York, New York, USA. p. 333-413.

Godfrey, M.H. et al. 1999. Pivotal temperature and predicted sex ratios for hatchling hawksbill turtles from Brazil. Canadian Journal of Zoology 77:1465-1473.

Hays, G.C. et al. 1995. Nest site selection by sea turtles. Journal of the Marine Biological Association of the United Kingdom 75:667-674.

Hillis, Z.M. and B. Phillips. 1995. The hurricane season of the century: Buck Island Reef National Monument, St. Croix, Virgin Islands. National Park Service Natural Resources Report.

Horrocks, J.A. and N. Scott. 1991. Nest site location and success in the hawksbill turtle. Marine Ecology Progress Series 69: 1-8.

Janzen, F.J. 1994. Vegetational cover predicts the sex ratio of hatchling turtles in natural nests. Ecology 75:1593-1599.

Mrosovsky, N. et al. 1992. Pivotal and beach temperatures for hawksbill turtles nesting in Antigua. Canadian Journal of Zoology 70: 1920-1925.

Standora, E.A. and J.R. Spotila. 1985. Temperature dependent sex determination in sea turtles. Copeia 1985:711-722.

Wibbels, T., Z.M. Hillis-Starr, and B.L. Phillips. 1999. Female-biased sex ratios of hatchling hawksbill sea turtles from a Caribbean nesting beach. J. Herp 33:142-144.

Wilson, D.S. 1998. Nest-site selection: microhabitat variation and its effects on the survival of turtle embryos. Ecology 79:1884-1892.

Table 1: Mean maximal temperatures between different soil treatments.

Treatment	Mean maximal temperature (ºC)	T-Grouping		
0%	30.0	A	N/A	N/A
25%	30.5	A	B	N/A
50%	31.0	Sig.	B	C
75%	31.1	Sig.	Sig.	C

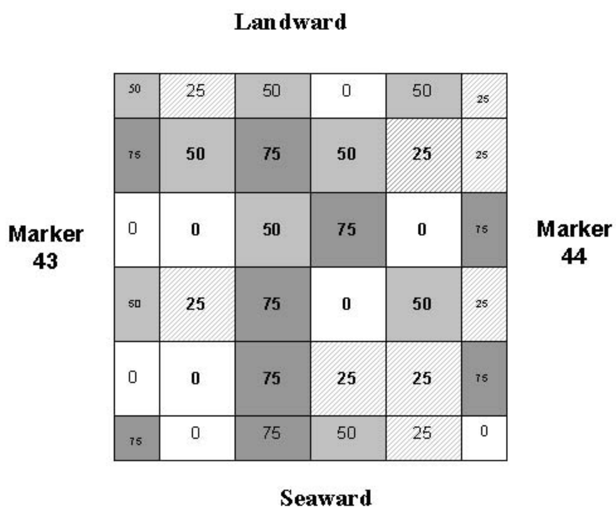

Fig. 1. 5 x 5 soil treatment grid. Highlighted inner squares hold hobo data loggers at depth of 30 cm. All numbers correspond to the percent soil treatment randomly assigned to that square.

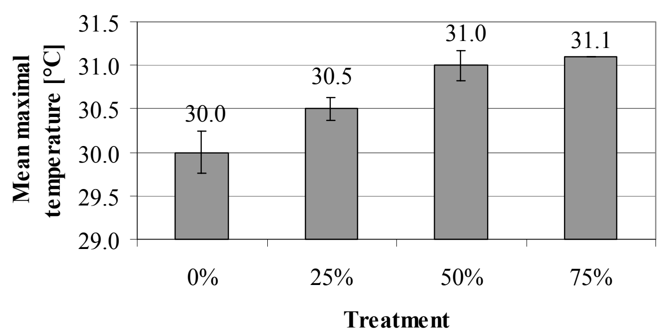

Fig. 2. Mean maximal temperatures for soil treatments.

Assessment of health of sea turtle populations in the Baja California Peninsula

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INTRODUCTION

Coastal lagoons of the Baja California Peninsula serve an important role as feeding and developmental grounds for five or the world's seven sea turtle species. The Baja California peninsula and its coastal regions hold highly diverse and productive marine ecosystems. The region is considered Mexico's most productive in terms of annual fisheries landings and well-developed commercial and artisanal fisheries encompass virtually all of the coastal areas. During the past 30 years, the population and development of this region have increased exponentially. The effects of economic development and changes in land use practices on the ecological productivity of the Baja California peninsula are unknown. Monitoring programs are essential to document changes in the ecosystem over time and provide adequate management of the natural resources along the Baja California Peninsula.

STATE OF KNOWLEDGE

The populations of the once abundant sea turtle species are currently decreasing at alarming rates around the world. Globally, all marine turtle species and most populations are considered either endangered or threatened with extinction. These species have gained international attention resulting in intensive study and worldwide conservation efforts. Unfortunately, national and international legislation designed to protect sea turtles have been largely unsuccessful and the threats to sea turtles appear to be escalating (Caldwell 1963, Venizelos 1991, Salmon 1992). Most researchers agree that human activities are responsible for threatening the survival of these species. Pollution and pollution-related disease present increasing threats to turtle populations (Waldichuk 1987, Vazquez et al. 1997). However, very little information is available on baseline levels of contaminants and their physiological effects on sea turtle populations. Much information is still needed in order to prove or refute the suggestions that environmental contaminants may be causative factors in the increased prevalence of diseases (such as fibropapillomatosis). The specific mechanisms involved in protecting sea turtle tissues from deleterious effects are not known and can only be studied in fresh tissues of organisms with a known cause of death. Most of the data currently available on the effects of anthropogenic disturbances on sea turtles is from stranded animals in which the cause of death was unknown, and most of those studies have taken place in other parts of the world (Duguy and Duron 1982 in France; Storelii et al. 1998 in the Adriatic Sea; Gramentz 1988, Demetropoulos 1989, and Venizelos 1991 in the Mediterranean; Duronslet et al. 1991 and Bjorndal et al. 1994 in the Southeastern United States; Lucas 1992 in Nova Scotia; White 1984 in Asia). Very little information is available from the Pacific coast of Mexico.

In 1998, a mortality event of nearly 100 sea turtles in the Laguna Ojo de Liebre, Baja California, arose the suspicion that the activities of a local salt producing company may have been responsible for the deaths. This led to an investigation directed by the SEMARNAP, in which it was determined that the combination of hypersaline conditions with exposure to contaminants was the cause of the lethal effects to the turtle. However, reviews of this report indicated that sufficient information was lacking to support this conclusion (Gardner 1998). This study was severely limited by the lack of a baseline data of the physiology and levels of contaminants in tissues of healthy turtles to provide a reference and comparison with the stranded turtles. The lack of data related to effects of toxic pollutants in sea turtles made it to be impossible to draw a conclusive evaluation.

Prior research on sea turtles conducted along the Baja California peninsula show that mortality rates due to incidental fishing harvests are high (Gardner and Nichols 2001, 2002). While the loss of so many turtles is unfortunate, the loss of all of these organisms without any benefit to science or turtle conservation is wasteful. The high mortality rates as a result of accidental fisheries captures provide a very unique situation in which tissues from healthy animals with a known cause of death can be examined.

HYPOTHESES

The fundamental hypothesis of this study is that information gained from the study of sea turtles obtained as a result of incidental fisheries harvest from the Baja California peninsula can be used as a baseline for future studies to establish the occurrence of non-natural mortality. It is also predicted that the mechanisms of immune system functions and detoxification responses will be altered by the presence of contaminants and as a result, the presence or absence of the manifestation of diseases are related to the organism's exposure to environmental toxic compounds.

METHODS

Over a three-year period, a search for sea turtles will be conducted throughout the regions of Bahía Magdalena and other bays of the peninsula to locate organisms that died as a result of incidental fisheries capture. Species predicted to be collected during this study include: *Chelonia mydas agassizii*, *Caretta caretta, Lepidochelys olivacea,* and *Eretmochelys imbricata*. Data on gender, location and age (using straight carapace length as an indication of size) will be recorded. Tissue samples from various organs will be obtained from sea turtles where the approximate time of death can be estimated. These tissues will be stored frozen and toxicological, pathological and physiological studies will be conducted. Toxicological assessments will include analyses of heavy metals and organochlorine contaminants within tissues of liver, kidney, muscle and fat.

ANTICIPATED PRODUCT

Through analyses of fresh tissues from presumably healthy animals, we can begin to develop a databank of baseline information on sea turtles. This information will enable toxicological, pathological and physiological studies on turtles of differing ages, species, and locations. This data is greatly needed in order to provide a reference for comparison to stranded animals in which pollution or other anthropogenic impacts are implicated as causative factors.

LITERATURE CITED

Bjorndal, K.A., A.B. Bolten, and C.J. Lagueux. 1994. Ingestion of marine debris by juvenile sea turtles in coastal Florida habitats Mar. Pollut. Bull. 28:154-158.

Caldwell, D.K. 1963. The sea turtle fishery of Baja California, Mexico. California Fish and Game 49:140-151.

Cliffton, K., D.O. Cornejo, and R. Felger 1982. Sea Turtles of the Pacific Coast of Mexico. In: K.A. Bjorndal, ed. Biology and Conservation of Sea Turtles. Smithsonian Institution Press. Washington, D.C. p.199-209.

Demetropoulos, A. 1989. On the rational management of marine resources and on turtle conservation. In: Proceedings of the International Seminar On The Combat Of Pollution and The Conservation Of Marine Wealth In The Mediterranean Sea, 5-8-June, 1989, Ras Lanuf, Gulf of Sirte. 1992 No. 9-A, p. 53-60.

Duguy, R. and M. Duron. 1982. Observations de Tortues Luth (*Dermochelys coriacea* L.) sur les Cotes de France on 1981 Ann. Soc. Sci. Nat. Charente Marit. 6:1015-1020.

Duronslet, M.J., D.B. Revera, and K.M. Stanley. 1991. Man-made marine debris and sea turtle strandings on beaches of the upper Texas and south-western Louisiana coasts, June 1987 through September 1989. NOAA Tech. Memo. 52 p.

Gardner, S.C. 1998 Mortalidad de tortugas marinas en la Laguna Ojo de Liebre, Guerro Negro, B.C.S., México. Technical report to the Scientific Consultant Committee.

Gardner S.C. and W.J. Nichols. 2001. Assessment of sea turtle mortality rates in the Bahía Magdalena region, Baja California Sur, México. Chelonian Conservation and Biology 4:197-199.

Gardner, S.C. and W.J. Nichols. 2002. Mortality rates of sea turtle species in the Bahía Magdalena region. In: A. Mosier, A. Foley, and B. Brost, comps. Proceedings of the Twentieth Annual Symposium on Biology and Conservation. NOAA Tech. Memo. NMFS-SEFSC-477. p. 83-85.

Gramentz, D. 1988. Involvement of loggerhead turtle with the plastic, metal, and hydrocarbon pollution in the Central Mediterranean. Mar. Pollut. Bull. 19:11-13.

Lucas, Z. 1992. Monitoring persistent litter in the marine environment on Sable Island, Nova Scotia. Mar. Pollut. Bull. 24:192-199.

Salmon, J.E. 1992. Conservation and environmental issues affecting the shrimp industry. Shrimp '92, Hong Kong. In: H. De-Saram and T. Singh, eds. Proceedings Of The 3rd Global Conference on The Shrimp Industry. Kuala-Lumpur, Malaysia, p. 30-34.

Storelii, M.M., E. Ceci, and G.O. Marcotrigiano. 1998. Distribution of heavy metal residues in some tissues of *Caretta caretta* (Linnaeus) specimen beached along the Adriatic Sea. Bull-Environ. Contam. Toxicol. 60:546-552.

Vazquez, G.F., M.C. Reyes, G. Fernandez, J.E.C. Aguayo, and V.K. Sharma. 1997. Contamination in marine turtle (*Dermochelys coriaca*) egg shells of Playon de Mexiquillo, Michoacan, Mexico. Bull. Environ. Contam. Toxicol. 58:326-333.

Venizelos, L.E. 1991. Pressure on the endangered Mediterranean marine turtles is increasing. The role of MEDASSET. In: T. Goda et al., eds. Environmental Management and Appropriate Use of Enclosed Coastal Seas Emecs. p. 613-616

Waldichuk, M. 1987. Sea turtles -- endangered species. Mar. Pollut. Bull. 18:623-627.

White, A. 1984. Vulnerable marine resources, coastal reserves, and pollution: A Southeast Asian perspective. National Parks, Conservation, and Development. The Role of Protected Areas in Sustaining Society. In: J.A. McNeely and K.R. Miller, eds. Proceedings of The World Congress on National Parks. p. 170-174.

New nesting areas and impacts toward the sea turtles in the Peninsula of Paria (Sucre State Venezuela) and recommendations for their conservation

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BACKGROUND

In the Paria Peninsula of the Sucre State Venezuela (61°55' - 63°15' W, 10°30' - 10°45' N) in the northeast part of Venezuela there are the five species of sea turtles: *Chelonia mydas*, *Eretmochelys imbricata*, *Caretta caretta*, *Lepidochelys olivacea* and *Dermochelys coriacea*. Field work conducted up to 1996 showed that the Paria Peninsula could be the most important nesting ground in the mainland of Venezuela (Guada 1993, Guada and Vera 1994, Guada and Vera unpblished data, Guada and Vernet 1988b, Guada et al. 1989, 1994a, 1994b). This work had the goal to identify potential and new nesting areas for the different species of sea turtles in the Paria Peninsula and, to estimate their importance as nesting localities; to identify the impacts affecting to the sea turtles through direct observation and interviews and, to propose guidelines for the research and conservation for the marine turtles in the study area.

METHODS

Phase I: Production of the map of spatial preferences (MASP) of sea turtles for nesting areas. A map of spatial preferences (MASP) is a cartographic tool to identify where and how a group of "users" spatially arranged their activities. This approach has been previously used in Venezuela for the coastal birds in order to establish recommendations for the land use (Sebastiani 1994, Sebastiani et al. 1995). This approach was applied to sea turtles in the Paria Peninsula in order to identify potential nesting sites for sea turtles. Therefore, it was necessary to identify the particular characteristics of coastal areas that favors the presence of the sea turtles and nesting: depth of the access to the beach, presence of obstacles in the beach, length and wide of the beach, availability of substrate for nesting, vegetation, presence of water courses and sensitivity of the sea turtles to the human activity. These characteristics were identified on cartographic charts of the area (scales: 1:100.000; 1:300.000) and on aerial photographs (scale 1:30.000) of the main part of the Paria Peninsula. Potential nesting sites were cartographically identified on maps at scale 1:500.000 and this information was verified with field information. In addition, field surveys were made in 1997 and 1998 to identify the nesting spots of the sea turtles by ground evidence, presence of tracks or nests, and by indirect information gained by interviews to local people to get information about new nesting beaches. Any carcass or live turtle was identified and measured, when possible, following the protocol of Pritchard et al. (1984).

Phase II: Identification of the activities and land uses causing impacts to the sea turtles. To identify natural impacts and impacts of human origin, a bibliographic review was carried out complemented with information gathered from interviews and direct observations. The impacts identified were classified according to the sea turtle stage: eggs, hatchlings, juveniles and adults. A qualitative validation index of the impact was established even if the impact was observed or reported by reference or interviews. The scale of value of the impact was as follows: 1- Very important, 2- Moderated, 3- Null and 4- Unknown. The information gathered was organized on tables to show the impact and its value, according to stage of the sea turtle life cycle. The impacts, when possible, were identified on a map at scale 1:500.000 by each studied location.

Phase III: Recommendations for research and conservation on the sea turtles in the Paria Peninsula. Recommendations for the research and conservation of sea turtles in the Paria Peninsula were established based on the results of the: MASP, importance of the sea turtle species and their nesting areas, identification of impacts and review of previous recommendations (Guada and Solé 2000). The priorities of the proposed actions were established following partially NMFS and USFWS guidelines (1992) that established the following priorities: Priority 1: An action that must be taken to prevent extinction or to prevent the species from declining irreversibly in the foreseeable future, with recommendation of immediate execution in a deadline not higher than 2 years; Priority 2: An action that must be taken to prevent a significant decline in species population/habitat quality or some other significant negative impact short of extinction, with recommendation of implementation between 3 to 4 years; Priority 3: All other actions necessary to provide for full recovery of the species, in a deadline not higher than 5 years.

RESULTS AND DISCUSSION

Phase I: Production of the map of spatial preferences (MASP) of sea turtles for nesting areas. The MASP for the Paria Peninsula was obtained considering the characteristics of the nesting habitats of the sea turtles worldwide and identified such characteristics on cartography and aerial photographs. Photointerpretation gave better results to estimate the potential nesting areas, with limitations inherited to the coastal physical and natural characteristics (quality of substrate, tidal influence, among others). However, as Diez and Ottenwalder (1999) stated interviews are the better strategy to get information about nesting areas when there are no reports available. The use of maps at least at scale 1:25.000 is highly recommended (Guada 2000). Results of the MASP indicates that following: Beaches of length higher than 500 m are better for the sea turtles in the north coast of the Peninsula, example of such beaches are Cipara and Querepare. Seven new nesting localities were identified in the north coast: Maroma, Chaguarama de Sotillo, Santa Isabel, Puerto Escondido, Las Hamacas, Puerto La Cruz and Agua Fria. Importance of turtle species varied according to coastal sections. In the north coast of the Paria Peninsula, the most important species, in number of females and nests, was the leatherback turtle (*D. coriacea*). In the south coast of the Paria Peninsula, the most important nesting areas are the sandy beaches in the eastern area. Only three new nesting areas were identified: La Ceiba, Patao and Yacua. The hawksbill turtle (*E. imbricata*) is the most important species in number of females and nests.

Phase II: Identification of the activities and uses causing impacts to the sea turtles. Causes of impacts on sea turtles in Paria Peninsula are both natural and of human origin. Within the natural impacts, the erosion has been reducing the available nesting areas in the whole peninsula. Predators as the crab fox (*Procyon cancrivorus*) are strong menace in the southern coast of the Peninsula. In relation to diseases, the fibropapillomas has been reported in the Gulf of Paria and it is attributed, according to fishermen, to the high amount of sediments in the gulf waters. The human impacts were classified as direct or indirect. Within the direct or intentional impacts, the egg poaching is widely extended in all the study area. The killing of females was registered in several beaches in the study area. The intentional caught in fishing nets was detected mainly in the south area of the Peninsula. Regarding the use and illegal commerce of sea turtle products, the higher prices were associated to the scutes of the hawksbill turtle, where these reached a cost of $1,000 for 1 kg of scutes.

Regarding the indirect impacts, the most widely distributed impact is the caught of the sea turtles in the artisanal fisheries, mainly in the gill nets (called "filetes" in the area). Out of 23 fishermen interviewed, 22 answered interaction between the sea turtles and this fishing gear is common. Twelve interviewed, 10 fishermen mentioned that the shrimp fishery present interactions with the sea turtle at sea. The number of artisanal boats surveyed or established from the Fisheries Service (SARPA) was higher in the south coast of the Peninsula (n=294) in front of the Gulf of Paria) than in the Caribbean coast (n=137). The incidental caught of sea turtles was roughly estimated based on the number of boats and gill nets. The numbers could be of near 500 sea turtles (mainly *C. mydas*) caught yearly in the north coast and over 1000 (mainly *C. caretta*) in the south coast.

Phase III: Recommendations for research and conservation on the sea turtles in the Paria Peninsula. In the "Sea Turtle Recovery Action Plan for Venezuela" (Guada and Solé 2000) were included recommendations for the work in the peninsula, but here there are more specific. Beside to establish the priority of execution, there are mentioned the GOs and NGOs which must be involved in the implementation. Twenty recommendations for the research and twenty-five recommendations for the conservation were formulated. Being the incidental caught in the fisheries one of the strongest impacts appreciated during this study, there are several priority recommendations of research and conservation related with the evaluation and diminishing of the marine turtles in the artisanal and shrimp fisheries. It is proposed that the recommendations proposed here be validated at a regional level.

CONCLUSIONS

(1) The sequential use of the cartographic analysis, the photointerpretation and the establishing of the habitat preferences and the differential sensitivity of the sea turtles as "users" of the beaches permit to predict the potential nesting sites of these species with a precision inherited to the use of the cartographic and aerial photographic material. New nesting localities were detected according to the potential areas estimated through the MASPs. Seven of them are in the north coast and three are in the south area. (2) The species of sea turtles most important in the north coast is the leatherback turtle and in the south area is the hawksbill turtle. The numbers are understimates but they show the importance of the area for the sea turtle nesting in the country. (3) The most dangerous impact for the sea turtles in the area is the incidental caught in the artisanal fisheries and it must be given priority to the efforts toward the reduction of the sea turtle mortality in the fisheries. (4) 20 recommendations of research and 25 recommendations of conservation were proposed with a priority of execution in a five-year schedule and should be validated in the region. The main part of the conservation recommendations include environmental divulgation and awareness.

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LITERATURE CITED

Diez, C.E. and J.A. Ottenwalder. 1999. Habitat surveys. In: K.L. Eckert, K.A. Bjorndal, F. Alberto Abreu-Grobois and M. Donnelly, eds. Research and Management Techniques for the Conservation of Sea Turtles. Marine Turtle Specialist Group Publication No. 4. p. 41-44.

Guada, H.J. 1993. Actividades de la salida conjunta INPARQUES – PROFAUNA y propuesta para la protección de areas de reproducción de Tortugas marinas en la vertiente norte de la Península de Paria. Informe interno de INPARQUES. Caracas. 16 p.

Guada, H.J. 2000. Areas de anidación e impactos hacia las tortugas marinas en la Península de Paria y recomendaciones de protección. Trabajo Especial de Grado para obtener la Maestría en Ciencias Biológicas. 228 p.

Guada, H.J., A. Fallabrino, D. Carrillo, A. Escudero and C. Martínez. In press. Results of the sea turtle conservation project in Cipara beach, Península de Paria, Sucre State, Venezuela. In: A. Mosier, A. Foley, and B. Brost, comps. Proceedings of the Twentieth Annual Symposium on Biology and Conservation. NOAA Tech. Memo. NMFS-SEFSC-477. p. 349-350.

Guada, H.J., A. Quijada and A.J. Martinez. 1994a. Sea turtle nesting in the northern Peninsula de Paria, Sucre State, Venezuela, 1993: a case for protection. Mar. Turtle Newsl. 64:16-18

Guada, H.J. and G. Solé. 2000. WIDECAST Plan de Acción para la Recuperación de las Tortugas Marinas de Venezuela. In: A. Suárez, ed. Informe Técnico del PAC No. 39. UNEP Caribbean Environment Prog. Kingston, Jamaica. 112 p.

Guada, H.J. and V.J. Vera. 1994. Results of the sea turtle surveys in the Peninsula de Paria (Sucre State, Venezuela) in 1992. In: B.A. Schroeder and B.E. Witherington, comps. Proceedings of the Thirteenth Annual Symposium on Sea Turtle Biology and Conservation. NOAA Tech. Memo. NMFS-SEFSC-341. p. 72-75

Guada, H.J. and P. Vernet. 1988b. Situación actual de las tortugas marinas en la costa caribeña de Venezuela. Estados Anzoátegui y Sucre. Informe de FUDENA. 24 p.

Guada, H.J., P. Vernet P. and G. Medina C. 1989. First tagging of leatherbacks in Venezuela. Mar. Turtle Newsl. 47:12

Guada, H.J., P. Vernet P., V.J. Vera, A. Quijada, A.J. Martínez and V. Reinoza. 1994b. The sea turtle nesting beaches in the Peninsula de Paria, Sucre State, Venezuela. In: K.A. Bjorndal., A.B. Bolten, D.A. Johnson and P.J. Eliazar, comps. Proceedings of the Fourteenth Annual Symposium on Sea Turtle Biology and Conservation. NOAA Tech. Memo. NMFS-SEFSC-351. p. 50-52.

Miller, J.D. 1997. Reproduction in sea turtles. In: P.L. Lutz and J.A. Musick, eds. The Biology of Sea Turtles. CRC Press. Boca Raton, Florida. p. 51-81.

National Marine Fisheries Service and U.S. Fish and Wildlife Service. 1992. Recovery plan for leatherback turtles in the U.S. Caribbean, Atlantic and Gulf of Mexico. National Marine Fisheries Service, Washington, D.C. 65 p.

Pritchard, P., P. Bacon, F. Berry, A. Carr, J. Fletmeyer, R. Gallagher, S. Hopkins, R. Lankford, R. Márquez M., L. Ogren, W. Pringle, Jr., H. Reichart and R. Witham. 1984. Manual sobre técnicas de investigación y conservación de las tortugas marinas, Segunda Edición. K.A. Bjorndal and G.H. Balazs, eds. Center for Environmental Education, Washington, D. C. 134 p.

Sebastiani, M. 1994. El conocimiento espacial de los usuarios. Metodologías para su incorporación en la caracterización del uso de la tierra en Evaluaciones de Impacto Ambiental. Trabajo de Ascenso realizado en la Universidad Simón Bolívar para ascender a la categoría de Profesor Asociado. 106 p.

Sebastiani, M., M. Vilaró, E. Estévez and M.M. Castillo. 1995. A map of spatial preferences of wildlife waterbirds of the Unare Coastal system of Eastern Venezuela J. Environ. Management 45:25-44

Sea turtle research and conservation project in Cipara, Paria Peninsula, Venezuela in the 2002 nesting season

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BACKGROUND

This project was initiated during the nesting season of 1999 following guidelines of the "Sea Turtle Recovery Action Plan for Venezuela" (Guada and Solé 2000), because it is one of the most important nesting beaches for the leatherback turtle (*Dermochelys coriacea*) in Venezuela. Cipara beach (62º42"W, 10º45'N) is located in the Municipio Arismendi (Sucre State). It is to the east of Cabo Tres Puntas in the Península of Paria.

METHODS

The field work was made between April 24 and August 28, 2001. Local field assistants worked between April 20 and October 15, 2001. We made surveys during night, although some gravid females arrived during the day. The females were tagged with metalic tags in the left fore-flipper and during this nesting season we began to use PIT tags in the right shoulder. We continued taking pictures of the pink spot in the head (crown) of the turtles. The main part of the nests were translated to a protected hatchery on the beach.

RESULTS AND DISCUSSION

We had a better coverage of the beach and fifty-one leatherback turtles were tagged. The number of females in 2001 was higher than the number of tagged females during 2000 nesting season (n=37) in Cipara (Guada et al. 2002), although the last year it seemed to be a "good" year in several localities of the Caribbean Sea and the Atlantic. A tagged female was entangled and released in Puy Puy. One leatherback female arrived from Trinidad and one of our tagged females moved to Isla de Margarita during the same nesting season (Guada 2002). A tagged female was reported in San Juan de Unare (to the west of Cipara) but the tag number was not registered. Over ninety-one nests were protected and over 5200 leatherback hatchlings were released. The reproductive success of the leatherback turtle in the 2002 nesting season in Cipara is still being analyzed.

During our stay at Cipara beach, we found the carcasses of five leatherback turtles and three dolphins (*Stenella* sp.). In one of the cases we were completely sure about that the turtle was entangled in a gill net (Guada 2002). In addition we got information about three additional carcasses in the north Peninsula of Paria during 2001 (one at Guatapanare in a gill net; one at Puy Puy and one at Chaguarama de Sotillo). This information causes a deep concern and indicates that it may be urgent to establish educational programs addressed to fishermen in the area. Divulgative materials provided by WIDECAST as well coloring sheets designed for the project were widely distributed in Cipara beach and adjacent towns as San Juan de Unare.

This is the only project in Venezuela with almost full coverage of the nesting season, providing an unique source of training in sea turtle biology and conservation in Venezuela (Guada et al. 2002). The coverage prevents the killing of turtles and the poaching of nests: previous to our arrival a green turtle (*Chelonia mydas*) was killed at the beach, but after our arrival the nesting females and their nests were disturbed.

We plan to establish a similar project in Querepare beach during 2002 nesting season, because our surveys indicate its strong use by the gravid leatherbacks. Then, we would be doubling easily the number of tagged females for 2002 as well the number of hatchlings released. We will be covering in this way the two most important leatherback nesting beaches in the continental coast of Venezuela.

CONCLUSIONS

(1) During 2001 we tagged 51 *D. coriacea*, a better estimate of the nesting population at Cipara. Over 5,200 hatchlings were released, more than the double than for the 2000 nesting season. (2) The female leatherback turtles of the Southeastern Caribbean seem to be using several beaches within this geographical area, as we could confirm with the visit of a leatherback from Trinidad and the travel to Isla de Margarita of a female tagged at Cipara.

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LITERATURE CITED

Guada, H.J. 2002. Informe del Proyecto de investigación y conservación de tortugas marinas en Cipara, Península de Paria, Estado Sucre, en el año 2000. WIDECAST. 16 p.

Guada, H.J. and G. Solé. 2000. WIDECAST Plan de Acción para la Recuperación de las Tortugas Marinas de Venezuela. In: A. Suárez, ed. Informe Técnico del PAC No. 39. UNEP Caribbean Environment Programme. xiv + 112 p.

Guada, H.J., A. Fallabrino, A.C. Martinez, D.A. Muñoz A., M.A. Rondón, S. Gómez, M. Morisson, L. Florez, A.M. Santana, G. Idrobo, J.L. Di Paola, E. Carabelli, L. Veiga, A. Naveda, D. Urbano, and C. Urbano. 2001. Sea turtle research and conservation project in Cipara, Peninsula de Paria (Sucre State, Venezuela): Preliminary results of the 2000 nesting season. Marine Turtle Newsletter 95:17-18.

Sea turtles, nesting biology, conservation and communities in Northern Australia

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The northern Australian coastline stretches many 1000's of kilometres, and is a home for a large proportion of indigenous people living on their traditional land. Indigenous people have a long and complex relationship with their environment, and in many coastal areas sea turtles are a major constituent of their culture and diet. While eastern Australian sea turtle populations are some of the most studied in the world, little is known about the northern Australian populations. The objectives of this project are two-fold first, to provide details of the community-based turtle project being established in the Sir Edward Pellew Islands, and second, to present initial data from an investigation into the distribution and biology of turtles in this remote region of Australia. The local people of this area share some of the concerns of western sea turtle scientists. They are seeing more turtles washing in dead, sick or tangled in discarded net. Before we can determine how indirect or direct mortality of turtles in this region may influence local and regional sea turtle populations. We need to develop a greater understanding of the genetic stock composition and demographic parameters of the local foraging and nesting populations. Working from the Mabunji Aboriginal Resource Centre at Borroloola, local traditional owners and their families have been involved in project design and the collection of biological data. With this two-way exchange of information it is hoped that we can extend our understanding of both turtles and turtle related issues in this area. Most importantly we hope to create an environment that allows continued protection of sea turtles so that in the future turtles will still remain an important part of local culture.

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Western Pacific sea turtle cooperative research and management workshop

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Sea turtle experts from 18 nations of the Pacific participated in a four day workshop convened by the Western Pacific Regional Fishery Management Council (WPRFMC) in Honolulu, Hawaii, February 5 - 8, 2002. At the workshop, sea turtle biologists, conservation specialists, and fishery scientists developed action items and strategies that are required to recover Pacific sea turtle stocks and identified areas where the WPRFMC could apply its abilities and resources towards the long term conservation goals of sea turtles in the region. Sea turtles migrate vast distances across ocean basins, living successively on the high seas, and within the EEZs and coastal habitats of numerous Pacific nations. Consequently a collaborative integrated approach to management and conservation between nations is essential for the recovery of depleted sea turtle populations in the Pacific Ocean. Due to stringent U.S. endangered species legislation, the continued operations of U.S. pelagic fisheries in the Pacific (one fleet among many which interact with sea turtles) are contingent on the recovery of Pacific sea turtle populations. Workshop participants focused on five objectives with emphasis on the western Pacific region: 1) to facilitate collaboration and exchange of technical information; 2) to coordinate education and conservation techniques with management strategies; 3) to identify information/knowledge gaps and prioritize research efforts; 4) to synthesize guidelines for standardized methods of data collection; and 5) to integrate the WPRFMC and its resources with pre-existing regional management regimes to promote population stabilization and recovery.

Level of knowledge of the fishing communities on marine turtles' actual problems in the Venezuelan Gulf

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For decades the adjacent populations to the Venezuelan Gulf have been related to the marine turtles to such commercial and folkloric point that have taken a important position in the customs from these communities and the nutritional scope. The intentional fishing has been one of the factors that the survival of these animals in the zone of study affects, which is it jeopardize by a North zone in where an abundance of turtles due to the high presence of faneromic extensions is observed, but when refers to the economic situation of these fishing communities is precarious and the education is very low or null. Whereas the settlers of the South zone are conscientious to the reality, that is to say, product of one better educative and economic situation. As also to the smaller presence of these species in this zone due to the sandy bottoms. The level of conscience of these populations about the situation of the marine turtles was determined by statistical analyses lead to an observation of two different slopes, one given by the North zone in where it visualized to the animals like an inexhaustible resource that fulfills the only purpose of covering with its necessities. But on the other hand the settlers of the South zone presents a deeper conscious vision with respect to the diminution of the populations of turtles in the last years. Due the situation before indicated, the creation of educative strategies different for each one is recommended from these zones.

Hatchlings in Peru: the first headstarting experience

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Peru harbors four species of sea turtles: *Chelonia mydas agassizi*, *Lepidochelys olivacea*, *Dermochelys coriacea* and *Eretmochelys imbricata*. *L. olivacea* is more abundant to the north of Peru due to the warmer conditions of the ocean but it has been found as far as Pisco (Lat. 13°45'S, 76°15' O). Sea turtles use Peruvian waters as migratory routes as well as feeding and development habitats. However in 1979, a nest of 80 eggs of the olive ridley (*L. olivacea*) was found at Punta Malpelo beach (3° 30'S). It was transplanted from its original site by a local fisherman. Twenty-one years later, in August 2000, the finding of a new nest by a fisherman was a high surprise. It was found at La Cruz inlet (3º35'S - 80º36'W). Fifty-seven hatchlings emerged from an artificial nest and were transported to a provisional wildlife farm of FONDEPES (Fondo Nacional para el Desarrollo Pesquero) at Puerto Pizarro, Tumbes (3º31' S – 80º25'W). Nine months later, in April 2001, the 35 individuals that survived were biologically evaluated, biometrics data were taken, the largest individuals were tagged and all individuals were released in the sea, one hour offshore, pictures were taken and their surroundings were video recorded. This research will help increase the data on this migratory species movements and the discovery of this possible nest suggests that northern beaches of Tumbes are suitable places for nesting activities and have adequate environmental conditions for the success of the eggs.

Local community involvement in monitoring and protection of sea turtles: loggerhead (*Caretta caretta*) and leatherback (*Dermochelys coriacea*) in Maputo Special Reserve, Mozambique

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INTRODUCTION

Two species of marine turtle nests along the Maputo Special Reserve's (MSR) coastline, the loggerhead, *Caretta caretta* and leatherback, *Dermochelys coriacea* (Tello 1973). The uncontrolled movements of people and cars along the MSR beaches had severe impact on the sea turtle nesting population. Breeding females and their eggs fell victim to the coastal villagers and tourists. To reverse the situation, a partnership programme was formed in 1996, between the government's wildlife personnel and local communities to monitor and protect the breeding turtles and their nest. This programme also attempts to provide data on number of nests, estimate number of nesting female per specie per season, major nesting sites and nesting period.

MATERIALS AND METHODS

Study area. The MSR is located in Matutuíne district, southern part of Mozambique, between Maputo River and Indian Ocean and measures approximately 800 km^2. The average annual rainfall is 690-1000mm and the average temperature is $20^o – 26^o$ C (DNFFB unpubl.). The Reserve lies along a coastline of approximately 35km composed by sand beaches and vegetated parabolic coastal dunes, which offer excellent conditions for sea turtle nesting.

Study method. The study was carried out along 25 km of the MSR coastline between north of Ponta Chimucane and south of Ponta Dobela. Three monitoring camps were established in Ponta Membene; Milibangalala and Dobela and six community members were actively involved, two per camp. The study was undertaken during the months of October to February, from 1996 to 2001. Daily patrols on foot were carried out twice a day, one at night, one hour before high tide, and another early in the morning. All successful nests were marked and all signs left by the turtles were concealed to disrupt the egg collectors and to avoid double counting.

From 1996 to 1999 data were collected on the number of nests of both species, without differentiation by species. However from the nesting season of 1999/2000, we started collecting data on number of nests per species and on their temporal (monthly) and spatial distribution. On that purpose the surveyed area was divided in five zones, Chimucane-Mucombo (CHMU); Membene-Chimucane (MECH); Milibangalala-Membene (MBME); Milibangalala-Dobela (MBDB) and Dobela-Matondo (DBMT). Special data sheets were designed for this purpose, based on Eckert at al (1999).

To estimate the number of nesting seas turtle per season, a number of methods could be used, such as through the ratio between the total number of nests laid on a beach per species in the season and the mean number of nests laid per turtle of the same species in a season (Barata 1997). This requires data gathered by tagging the turtles found on the beach. However, considering that the tagging programme is not yet in place in MSR we based our calculations of the nesting sea turtle on the information obtained from Tongaland, South Africa, where Hughes (1974) suggests that loggerhead lay a mean of 4 to 5 nests per season, with intervals of about 12-15 days during its breeding season, while leatherback lays a mean of 8 nests per season with intervals of 9-10 days. The assumption was that since geographically Tongaland and MSR are in close proximity the turtle populations of the two sites might exhibit similar ecological characteristics.

RESULTS AND DISCUSSION

Number of nests. The total number of nests of both species from 1996/97 to 2000/01 nesting season is showed on table 1. The lowest and highest number of nests were observed in 1998/99 and 1999/00, respectively. The reason for that fluctuation is not known, but it may be attributed to the fact that sea turtles do not nest on consecutive years. For instance (Hughes 1979) reported a remigration interval in Tongaland of 2-3 years for leatherback, and an irregular remigration pattern for loggerhead.

Number of nesting females per species and per season. The estimated number of nesting female that nested in MSR during the seasons 1999/00 and 2000/01 showed that between 79 and 82% of the females belongs to loggerhead (Table 2). The reason for this disparity is partly due to the fact that loggerhead is the most common species of the East Africa Coast (Hughes 1974). By other hand, Hughes (1974) point out that the apparent scarcity of leatherback in the sub-tropic may be a result of their avoiding the coral reef areas, were most fishermen are active.

Spacial distribution of nests. In terms of spatial distribution, both loggerhead and leatherback seem to prefer Dobela-Matondo (DBMT). Other important sites include Milibangalala-Dobela (MBDB) and Membene-Chimucane (MECH) for loggerhead and Membene-Chimucane (MECH) and Chimucane – Mucombo (CHMU) for leatherback (Table 3). DNFFB (1997) in the Management Plan for MSR also noted that the southern portion of the Ponta Dobela constitute one of the most important nesting sites of the sea turtles. Preference of the same sites implies that there is less competition for breeding sites by the two species.

Nesting period. Tello (1973), reports that the nesting season in MSR goes from end of October to end of January. Our study showed that the nesting season in MSR for both species starts on second half of October and goes up to the first half of February. The nesting peak occurs between November to January (Fig. 1). Hughes (1974) noted that there is a correlation between temperature and inter-nesting interval. The increase in seawater temperature on the nesting beach reduces the internesting intervals. The months of November, December and January are the hottest in Mozambique, an this coincides with high number nesting activities in the MSR's, with a peak in December, when the summer solstice is in the south hemisphere.

CONCLUSION AND RECOMMENDATIONS

It is important to recognise that to have a clear picture on status of sea turtles in the MSR, it requires many years of monitoring, due the fact that sea turtle do not lay eggs in consecutive years. We need to determine the remigration rate, the internesting interval and the average number of nests per species. Furthermore, as sea turtle take decades to reach maturity, the effort for turtle management cannot be seen in a short term, especially if the adverse impacts affect the populations in their early stage of life. Consider all the above-mentioned aspects and the fact that the beach-monitoring program in MSR only started in 19996, it would be premature to make conclusions about the size, structure, tendency and other aspects of the nesting population in MSR. Our immediate priority is to start a tagging programme of sea turtles in order to determine remigration rate, the inter-nesting interval and the average number of nests per species.

Acknowledgements. We would like to thanks all people who directly or indirectly contributed in one way or another to make this work possible. More especially we thank the community members that were directly involved in the survey of the beaches, the National Directorate for Forestry and Wildlife and the Warden of MSR for their collaboration and assistance, Dr. Simon Munthali for helpful comments and English correction; Chico Carneiro for the photos; and Sérgio Tique for suggestions and help with poster assembling. Thanks are also due to David and Lucile Packard Foundation, Sea Turtle Symposium, IUCN-Mozambique and WWF-Mozambique for funding this work and our participation in the symposium.

LITERATURE CITED

Barata, P.C.R. 1997. Estimation of the number of sea turtles nesting on a beach in a season. In: S.P. Epperly and J. Braun, comps. Proceedings of the Seventeenth Annual Sea Turtle Symposium. NOAA Tech. Memo. NMFS-SEFSC-415. p. 133

Direcção Nacional de Florestas e Fauna Bravia. 1997. Plano de Maneio da Reserva Especial de Maputo. Volume 1: Programa de Maneio. Maputo, Moçambique

DNFFB (unpubl.). GEF transfrontier conservation areas and institution strengthening project. Direcção Nacional de Florestas e Fauna Bravia; Maputo, Mozambique. p. 297.

Eckert, K.L., K.A. Bjorndal, F.A. Abreu-Grobois, and M. Donnelly, eds. 1999. Research and Management Techniques for the Conservation of Sea Turtles. IUCN/SSC Marine Turtle Specialist Group Publication Nº 4

Hughes, G.R. 1974. The sea turtles of South-East Africa, II. The biology of the Tongaland loggerhead turtle *Caretta caretta* L. with comments on the leatherback turtle *Dermochelys coriacea* L. and the Green Turtle *Chelonia mydas* L. in the study region. Investigational Report No. 36. Oceanographic Research Institute. p. 34-46.

Hughes, G.R. 1982. Nesting cycles in sea turtles-typical or atypical. In: K.A. Bjorndal, ed. Biology and Conservation of Sea Turtles, Smithsonian Insitution Press. Wash. p. 81-89.

Tello, J.L. 1973. Reconhecimento Ecológico da Reserva dos Elefantes do Maputo. Veterinária de Moçambique. Volume 6 Nº 1, p. 19-76, Lourenço Marques

Table 1. Number of nest of the two sea turtle species, *Caretta caretta* and *Dermochelys coriacea.*

Year	Combined number of nests
1996/97	190
1997/98	279
1998/99	149
1999/00	347
2000/01	325

Table 2. Estimated number of nesting loggerhead (CC) and leatherback (DC) turtles on MSR beach by season.

Season	Number of nests		Estimation of females	
	CC	DC	CC	DC
99/00	255	92	51-65	12
00/01	220	105	44-55	13

Table 3. Number of nests counted for loggerhead (CC) and leatherback (DC) by sampling zone from 1999 to 2001.

Sampling zones	1999/2000		2000/2001		Mean	
	CC	DC	CC	DC	CC	DC
CHMU	0	0	42	33	21	17
MECH	50	23	35	18	43	21
MBME	13	2	43	18	28	10
MBDB	50	9	38	14	44	12
DBMT	142	58	62	22	102	40

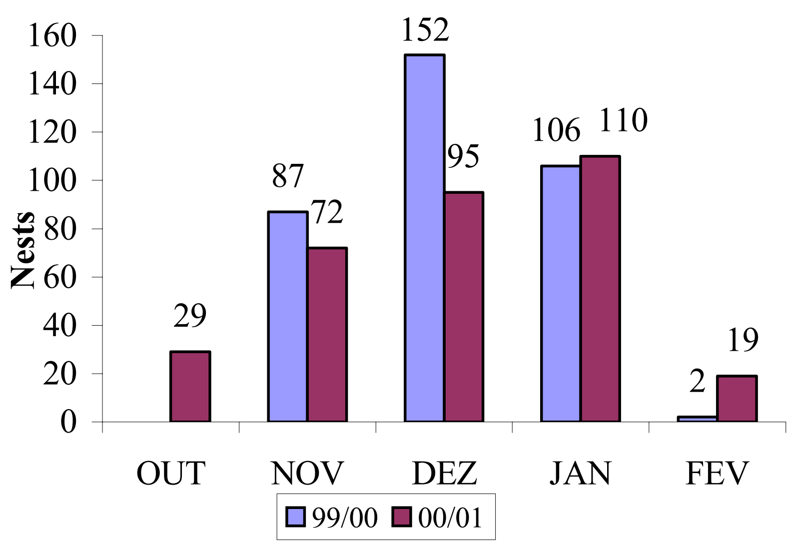

Fig. 1. Monthly distribution of nests for both species.

Community-based coastal resource management: success factors and the sea turtle reserve in Estero Banderitas, BCS, Mexico

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Estero Banderitas, Baja California Sur, Mexico is an important developmental and feeding ground for the endangered East Pacific green sea turtle (*Chelonia mydas*). However, it is also a place often frequented by tortugueros, or turtle fishermen. A proposal has been developed to designate Estero Banderitas as a sea turtle reserve; local community members would be involved in the management and monitoring of this community-based reserve. Community-based coastal resource management projects are being developed globally as innovative environmental policy tools to balance resource protection with resource use. Such a project is especially important in Estero Banderitas, as the consumption of sea turtles is a tradition in many Baja California Sur communities. In August 2001 we interviewed 29 fishermen from Puerto San Carlos, the largest coastal community near Estero Banderitas, to determine the level of community support for the proposed reserve. In addition, we considered six 'success factors' defined by Pollnac and Crawford (2000) in order to determine the potential success of the sea turtle reserve: relatively small geographic area and small population size; concern about declining fish populations before the marine protected area is started; successful alternative income projects; relatively high level of community participation in decision making; continuing advice from the implementing organization; and inputs from the municipal government. Based on this research project, we conclude that Estero Banderitas has the potential to be a successful site for a community-based sea turtle reserve.

Estero Banderitas and the Green Turtle. Estero Banderitas is a sub-estuary of Bahia Magdalena, which is located approximately 500 miles south of the U.S.-Mexico border in Baja California Sur, Mexico (Young and Dedina 1993). The green turtle is the most common sea turtle species in Estero Banderitas, and uses this protected arm of Bahia Magdalena as a feeding and developmental area (Brooks et al., in press, Garcia-Martinez and Nichols 2000). In addition, Estero Banderitas boasts a high density of sea turtles compared to other areas in Bahia Magdalena (L. Brooks, pers. comm.).

A Community-based Sea Turtle Reserve in Estero Banderitas. Community-based conservation projects are an integral part of the local peoples' sovereignty over their own resources; the success of such projects affects the ability of local peoples to manage their resources. The reserve in Estero Banderitas would be a no-take sanctuary for sea turtles; however, other fishing activities would be permitted. A fundamental aspect of the reserve's success is the support of the local community. Over the past eight years, WJN and his associates at WildCoast, an international conservation team working in the Californias, have worked with locals in the Bahia Magdalena region to foster relationships between community members and scientific researchers. Local fishermen are an integral part of the data collecting process, and a key to understanding the complex relationship between sea turtles and humans in Baja California.

METHODS

Our survey was designed specifically to obtain fishermen's perceptions, opinions, and beliefs towards the establishment of a sea turtle reserve and the use of eco-tourism in Estero Banderitas. Surveys were conducted in Puerto San Carlos from August 8, 2001 to August 24, 2001. We surveyed 29 participants; after conducting seven face-to-face interviews, written surveys were distributed to decrease possible biases due to the sensitive nature of the survey topic. Participants were identified using the snowball sampling and on-site, intercept methods. Survey results were used to evaluate the level of success to be expected if Estero Banderitas were designated as a sea turtle reserve. For this case study, success is defined as achieving the conservation goals of the reserve.

RESULTS

Respondents were Mexican males, ranging in age from 17 to 65, and the mean number of years lived in Puerto San Carlos was 18 years. Ninety-three percent of the respondents were fishermen, while the remaining six percent were pangueros (boat drivers/guides). When asked specific questions concerning the proposal to designate Estero Banderitas as a sea turtle reserve, 37.9% of the respondents indicated that they were aware of the proposal, and 70% of respondents were interested in participating in eco-tourism activities in Estero Banderitas if it becomes a sea turtle reserve. Approximately 72% of respondents felt that Estero Banderitas should be a sea turtle reserve, and 86.2% of respondents felt that they would not be affected if Estero Banderitas were a turtle reserve. When asked about the potential effectiveness of the reserve in protecting sea turtles, 89.7% of respondents believed that it would be effective.

Community Support and Estero Banderitas. Although Estero Banderitas has physical characteristics that make it an ideal location for a reserve, local community support will be essential to the reserve's success. Local residents, particularly fishermen, are critical stakeholders in the process of developing Estero Banderitas as a sea turtle reserve. The establishment of such a reserve should contribute to several outcomes: involving local fishermen in the planning process; protecting sea turtles and their habitat; and attracting more eco-tourists to the area. Facilitating the success of any eco-tourism project depends on involving local peoples in the planning and implementation process (Whelan 1991). The project in Estero Banderitas will receive more community support if locals are involved from the beginning, as opposed to having an outside agency develop and implement the project. In Estero Banderitas, fishermen have been working closely with Wildcoast to collect data, and have contributed their opinions to the concept of the eco-tourism project.

Success Factors and the Sea Turtle Reserve. Pollnac and Crawford's (2000) work with community-based marine protected areas in the Philippines identified six factors that appear to be the most important involved in the overall success of the community-based marine protected areas in their sample: (1) relatively small geographic areas and small population size; (2) concern about declining fish populations before the MPA project is started; (3) successful alternative income projects; (4) relatively high level of community participation in decision making; (5) continuing advice from the implementing organization; and (6) inputs from the municipal government (Pollnac and Crawford 2000). The application of these factors to the sea turtle reserve in Estero Banderitas demonstrates that the proposed reserve is likely to be successful, based on the above criteria and the survey results: (1) the towns surrounding Estero Banderitas are small fishing communities; (2) survey results indicate that respondents believe sea turtles ought to be protected; (3) alternative income projects have yet to be developed; (4) Puerto San Carlos is a community where there has been a tradition of participatory and democratic decision-making; (5) advice will continue to be given from the implementing organizations; (6) enforcement schemes are already in place within the local, state and federal governments.

CONCLUSIONS

Our results indicate great potential for a successful community-based sea turtle reserve in Estero Banderitas, as it is supported by the local community. This support is likely to result in the effective implementation and enforcement of the reserve. As the first such turtle reserve in Baja California, Estero Banderitas has the potential to set a precedent for sea turtle conservation in other local communities.

Acknowledgements. We would like to thank everyone who offered their support and assistance to this project, particularly the Wildcoast team, the summer session 2001 students and staff of the SFS Center for Coastal Studies, and those fishermen who contributed their time and effort to further this project within the community. Pam Rubinoff and Serge Dedina provided valuable guidance on the development of this project, and numerous individuals assisted in the editing process. We are especially grateful to those fishermen who shared their opinions by participating in the study. This research was funded by The Duke University Latin American and Caribbean Studies Travel Grant Program and the Oceanic Resource Foundation. Participation at the Symposium was funded by the David and Lucile Packard Foundation and by The 22nd Annual Sea Turtle Symposium.

LITERATURE CITED

Brooks, L.B., W.J. Nichols, V. Koch, and A. Hernandez. In press. Preliminary results on the distribution and movement of green turtles (*Chelonia mydas*) in Estero Banderitas, Baja California Sur, Mexico. In: M. Coyne, comp. Proceedings of the 21st Annual Symposium on Sea Turtle Biology and Conservation. Philadelphia, Pennsylvania.

Garcia-Martinez, S. and W.J. Nichols. 2000. Sea turtles of Bahia Magdalena, Baja California Sur, Mexico: Demand and supply of an endangered species. Proceedings of the Tenth Biennial Conference of the International Institute of Fisheries Economics and Trade. Oregon State University, Corvallis.

Pollnac, R.B. and B.R. Crawford. 2000. Discovering factors that influence the success of community-based marine protected areas in the Visayas, Philippines. Coastal Management Report #2229. PCAMRD Book Series No. 33. Coastal Resources Center, University of Rhode Island, Narragansett, RI, USA, and Philippine Council for Aquatic and Marine Research and Development, Los Banos, Laguna, Philippines.

Whelan, T., ed. 1991. Nature Tourism: Managing for the Environment. Island Press: Washington DC.

Young, E. and S. Dedina. 1993. Magdalena Bay: the last stop in Baja. California Coast and Ocean. Winter/Spring. p. 24-28.

The Turtle Conservation Fund – The Marine Conservation Society supporting marine turtle conservation worldwide

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The Marine Conservation Society (MCS) is the UK charity dedicated to the protection of the marine environment and its wildlife. For over 20 years MCS has campaigned for the protection of our marine environment for this and future generations. In 2000, the UK government appointed MCS as the joint lead partner for the Marine Turtle Grouped Species Action Plan and in 2001, MCS launched the Marine Turtle Conservation Project (MTCP) supported by Cheltenham and Gloucester plc. MCS has recognised the importance of providing practical and financial support for marine turtle conservation and research worldwide and has therefore set up the MCS Turtle Conservation Fund. Fund income will be generated by a number of fundraising initiatives designed to involve members of the UK public including schools and students. The first fundraising programme, MCS Adopt-a-Turtle was launched in May 2001.

Priority funding criteria. MCS will award grants to non-profit organisations and individuals who are significantly contributing to the conservation of the leatherback (*Dermochelys coriacea*), hawksbill (*Eretmochelys imbricata*), loggerhead (*Caretta caretta*), green (*Chelonia mydas*), Kemp's ridley (*Lepidochelys kempii*) and olive ridley (*Lepidochelys olivacea*) marine turtles and their terrestrial and marine habitat worldwide. All applications will be considered, although the MCS will prioritise applications from projects that satisfy one or more of the following criteria: (1) Projects that contribute to the UK Marine Turtles Grouped Species Action Plan; (2) Projects that benefit local communities and promote their participation in conservation; (3) Research projects that contribute to the knowledge of marine turtles in a way that will enhance their conservation; (4) Projects that involve collaboration with one or more national government agencies; (5) Projects that contribute to the development of progressive approaches to environmental education and community involvement; (6) Projects that involve a mechanism of sustainability; and (7) Projects where MCS will either meet fully or make a substantial contribution to the project's total expenditure.

Application availability. Application forms are available from the MCS online at www.mcsuk.org or by e-mail from info@mcsuk.org

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Estimated tag retention rates for PIT and inconel tags in juvenile loggerhead (*Caretta caretta*) sea turtles

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Estimates of survival rates, migratory movements, population trends, growth rates and other demographic parameters are often obtained through mark-recapture studies and are influenced by the ability to accurately identify specific individuals in a given population over time. Identification of individual sea turtles is generally accomplished through the use of flipper tags and, more recently, Passive Integrated Transponder (PIT) tags. Previous studies (Alvarado et al. 1988, Bjorndal et al. 1996, Gorham et al. 1998, Henwood 1986, Limpus 1992, Parmenter 1993, van Dam and Diez 1999) have found that these and other tag types exhibit a degree of failure which, if not accounted for, may lead to biased parameter estimates. We calculated retention rates of Inconel and PIT tags applied to juvenile loggerhead (*Caretta caretta*) sea turtles. Sea turtles, incidentally captured by fishing gear (pound nets, channel nets, trawls) in Core and Pamlico Sounds, NC, were tagged June-December from 1989-2001. Inconel size 681 self piercing tags manufactured by National Brand and Tag Company (U.S.A.) were applied to the trailing edge of one or both rear flippers, just anterior to the first large scale (Balazs 1999). Passive Integrated Transponder (PIT) tags (Destron-Fearing 125 KHZ) were injected subcutaneously into the shoulder region of the left or right front flipper, approximately 1 cm anterior to the second most proximal scute. Tag loss of Inconel tags applied to front flippers of turtles in other studies ranged from 18% after 3 years (- hawksbills (*Eretmochelys imbricata*); van Dam and Diez 1999) to >50% after 440 days (- loggerheads; Gorham et al. 1998). In contrast, we estimated 11% single tag loss (9% double tag loss) for loggerheads at large for 3 years, which suggests that tagging in rear flippers might increase tag retention. The cumulative probability of losing both Inconel tags (3%) along with the probability of failure of a PIT tag (2%) resulted in a 1 in 1,667 probability (0.005%) of a turtle losing all 3 tags and not being identified. Therefore, we recommend using PIT tags in conjunction with one or more external tags (such as Inconel) to maximize the probability of identifying a recaptured turtle, and reducing the impact of tag loss on population parameter estimates.

LITERATURE CITED

Alvarado, J., A. Figueroa, and P. Alarcon. 1988. Black turtle project in Michoacan, Mexico: plastic vs. metal tags. Marine Turtle Newsletter 42:5-6.

Balazs,G.H. 1999. Factors to consider in the tagging of sea turtles. In: K.L. Eckert, K.A. Bjorndal, F.A. Abreu-Grobois, and M. Donnelly, eds. Research and Management Techniques for the Conservation of Sea Turtles. IUCN/SSC Marine Turtle Specialist Group Publication No. 4.

Bjorndal, K.A., A.B. Bolten, C.J. Lagueux, and A. Chaves. 1996. Probability of tag loss in green turtles nesting at Tortuguero, Costa Rica. J. Herpetol. 30:567-571.

Gorham, J.C., M.J. Bresette, and B.D. Peery. 1998. Comparative tag retention rates for two styles of flipper tags. In: S.P. Epperly and J. Braun, comps. Proceedings of the Seventeenth Annual Sea Turtle Symposium. NOAA Tech. Memo. NMFS-SEFSC-415. p. 179-182.

Henwood, T.A. 1986. Losses of Monel flipper tags from loggerhead sea turtles, *Caretta caretta*. J. Herp. 20:276-279.

Limpus, C.J. 1992. Estimation of tag loss in marine turtle research. Wildl. Res. 19:457-469.

Parmenter, C.J. 1993. A preliminary evaluation of the performance of Passive Integrated Transponders and metal tags in a population study of the flatback sea turtle (*Natator depressus*). Wildl. Res. 20:375-381.

van Dam, R.P. and C.E. Diez. 1999. Differential tag retention in Caribbean hawksbill turtles. Chelonian Conservation and Biology 3:225-229.

Managing multiple uses of Florida's sea turtle nesting beaches

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Florida's sandy beaches provide important nesting habitat for loggerhead, green, and leatherback sea turtles. These beaches also host many human activities, including beach restoration, beach cleaning, coastal armoring, and recreation. Current state and federal law mandates that human activities be managed to minimize negative impacts to marine turtles, their nests, hatchlings, and nesting habitat. Staff in the Florida Fish and Wildlife Conservation Commission, Florida's wildlife management agency, cooperates with regulatory entities at the federal, state, and local level to ensure that marine turtle protection is achieved. Each activity must minimize impacts due to either construction at the landward edge of the beach or activities on the beach itself. Standard conditions implemented to ensure protection of turtles and their habitat during construction include working outside the nesting season and landward of nesting habitat when possible. Lights that are visible from or illuminate the beach are prohibited, and FWC staff works closely with planners and consultants for approval of appropriate lighting. Other activities, such as beach nourishment, beach furniture, beach cleaning and special events, must also be designed and implemented so as to minimize impacts to marine turtles. The major activities authorized on Florida's sea turtle nesting beaches and the restrictions required to protect sea turtles, their nests, hatchlings, and nesting habitat, will be summarized.

Marine Turtle Research and Discovery Centre in Reunion Island

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The Marine Turtles Research and Discovery Centre was established in January 1998, on Region Reunions initiative, came within the framework of Ferme Corail reconversion. This centre is an original project devoted to sea turtles, and is one of the most visited places in Reunion Island. Since his discovery, Reunion Island was nicknamed turtle island because of his relief and the high number of turtles. At present time, on account of human activities development marine turtles, still present in Reunions waters, exceptionally lay on beach. The centre task is to promote sea turtles conservation by the way of theirs habitats conservation and recovery. The centre develops conservation and educational programs on natural sites in the region and on Ferme Corail installations. In the next months, infrastructures will be totally rebuilt using recent know-how for marine ecosystems reconstruction and presentation.

The recovery of nesting habitat: a proactive approach for conservation of the hawksbill sea turtle, *Eretmochelys imbricata*, Long Island, Antigua, West Indies

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INTRODUCTION

Throughout most Caribbean countries, threats exist for hawksbill populations and affect every stage of their life cycle. In particular, tourism and tourism-related development have critically altered many nesting beaches by increasing erosion and disrupting reproductive behavior, including nest-site selection and the nocturnal sea-finding behavior of both hatchlings and nesting females. Herein lies the conflict between man's vision of beautiful beaches, and the life-needs and instinct of the sea turtles.

Among the many factors affecting hawksbill survival, beach (habitat) health remains a critical influence. The reproductive success of adult turtles and the survival of their offspring are often diminished by adverse environmental conditions at the nesting beach. Stressing beach health are both human induced (i.e. tourism, invasive species) and natural occurrences (i.e. hurricanes, wind, waves) that when paired, weaken beach structure, further intensifying the struggle for turtle survival. Conservation efforts must focus on reducing these threatening human alterations, through effective preventative and restorative measures. The Jumby Bay project has recognized the need for these efforts and has answered the call through landowner education and habitat restoration.

The story of Pasture Bay Beach. Pasture Bay beach, located on Long Island, is a small privately owned island off the northeast coast of Antigua. Composed of aragonite sand, this windward facing beach (475 m in length) contains many shallow reef systems and marine grass beds offshore. Historically, a thick maritime forest of shrubs and trees such as button mangrove (*Conocarpus erectus*) and sea grape (*Coccoloba uvifera*) grew all the way to the high water line, stabilizing thick prevalent dunes with their roots. Turtles would immediately crawl up on the beach, attracted by the beach-edge vegetation, and enter almost 3-5 meters into these ancient forests to nest.

Within the past few decades, much of the forest on Long Island was cleared for the development of elegant homes and recreational access to the beach by resort guests and private landowners. Planted in place of the forest were non-native species such as the coconut palm, which do not provide adequate cover for nesting turtles, nor stability for the beach. In addition, marine grasses washing ashore were removed from the shore in an effort to create an environment that echoed of cleanliness. This action took away the rich supply of organics for the soil, critical for the establishment of native beach flora. The steep, vegetated berm has now been replaced by a highly eroded low, flat beach.

Vegetation Islands – 'Beach Gardens'. With all the knowledge of the nesting turtle population on the island, we have never been able to produce a beach management plan. The owners have been afraid that a plan would affect their choice of action and would infringe on the "environmental engineering" mode so many of them prefer to natural processes.

It was not until Darien Joseph, a worker for the Homeowners Parks Department on Long Island, helped to develop the beach in a way that encouraged turtles to nest on P.B. beach as well as appeal to the landowners. Thus, the creation of a friendly and unthreatening concept, "beach gardens", which conveyed an image that was beautiful and aesthetically pleasing. The gardens created an interface between the turtles and stakeholders of Jumby Bay. We could finally proceed with restoration and recovery.

The first islands were constructed in 1998, and were planted in an area of Pasture Bay beach that was predominately open and cleared of natural vegetation. More islands were built in the following years, ranging 9-16 meters from the water's edge. Marine grasses that wash ashore were collected and incorporated into the aragonite sand as compost for the islands. Plants such as Ink Berry, Sea Grape, Bay Cedar, Beach Pea, Morning glory, and Aloe were planted in patches along the beach to trap sand-preventing beach erosion while providing the preferred location for nesting turtles.

PROJECT BACKGROUND AND BEACH ZONATION

The Jumby Bay hawksbill project, located at Pasture Bay beach, has gathered superb data from its saturation tagging program begun in 1987, continuing each season through 2001. The patrolling season begins in early June through mid-November, identifying every nesting female, noting where they nested on the beach, the distance from the high water line, and other reproductive parameters disrupted by human presence.

Various habitat types comprise Pasture Bay beach, as well as different degrees and areas of modification. Zones were simply chosen according to the location of the established vegetation islands. Three zones were established and are described as follows: Zone 1- east of Zone 2, this area contains exposed outcrops of ancient limestone reef and an accumulation of flint nodules; Zone 2 - all of the vegetation island and dune restoration plantings reside within this zone; Zone 3 - west of Zone 2, this area contains a mixed-shrub thicket with a narrow berm.

PRELIMINARY IMPLICATIONS - DO VEGETATION ISLANDS WORK?

Although the mean ratio of successful nests to false crawls over the duration of the study is roughly 1:1, slight shifts have occurred. False crawls begin to increase in proportion to successful nests in the early 1990's. It should be noted that this was the time period private development of beachfront homes began. Additionally, hurricanes occurred annually from 1995-1999. However, proportional shifts are modest enough that these causes can only be speculated (Fig. 1).

The most significant change in nesting distribution has been observed in Zone 1, which receives the least sand build-up, and therefore has the highest erosion rate due to vegetation loss. Slight increases in Zones 2 and 3 suggest compensation for the loss of nesting opportunities in Zone 1 (Fig. 2).

The percentage of successful nests out of total observed activity is fairly consistent until the mid 1990's where Zone 1 decreases and Zone 2 increases. Once again, shifts could be attributed to annual hurricanes in the years 1995-1999 after which both Zones 2 and 3 nesting begin to increase. It cannot be determined if the increase in Zone 2 can be attributed to restoration efforts (Fig. 3).

The percentage of nests in this restored area (Zone 2) out of total successful nests for all zones from 1999-2001 has significantly increased (Fig. 4). The nesting increase observed in Zone 2 (Fig. 3), could be correlated with this increase (Fig. 4) due to vegetation islands.

Although it is premature to state that restoration efforts are successful, hawksbills are increasingly considering restored areas as suitable nesting habitat. Efforts from this monitoring project can be used in tropical beaches throughout the world. Many degraded beaches are waiting for this instrumental opportunity.

LITERATURE CITED

Limpus, C.J., P. Reed, and J.D. Miller. 1983. Islands and turtles: the influence of choice of nesting beach on sex ratio. In: J.T. Baker, R.M. Carter, P.W. Sammarco, and K.P. Stark, eds. Proc. Inaugural Great Barrier Reef Conference, Townsville. JCU, Townsville, p. 397-402.

Mortimer, J.A. 1995. Factors influencing beach selection by nesting sea turtles. In: K.A. Bjorndal, ed. Biology and Conservation of Sea Turtles. Revised edition. Smithsonian Institution Press, Washington, D.C. p. 45-51.

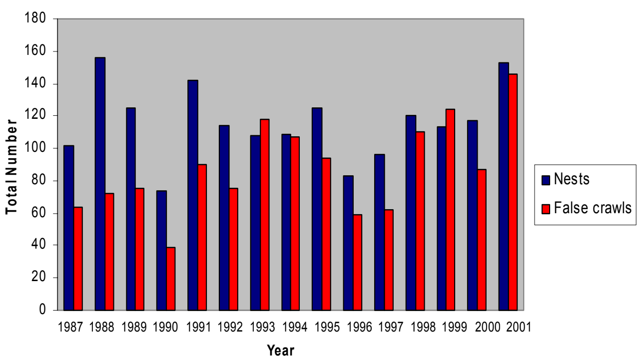

Fig. 1. Total number of nests and false crawls (1987-2001).

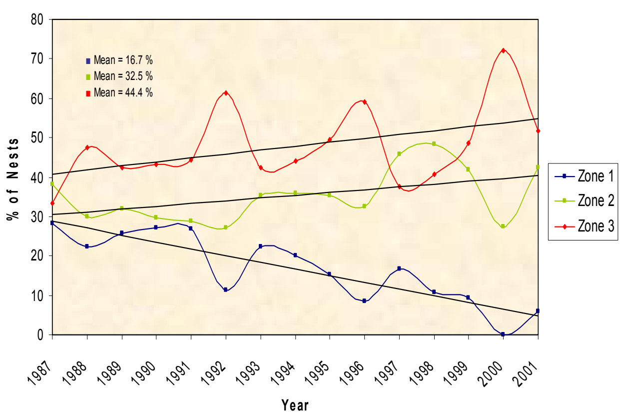

Fig. 2. Percentage of nests in Zones 1, 2, and 3 of total nests for Pasture Bay Beach (1987-2001).

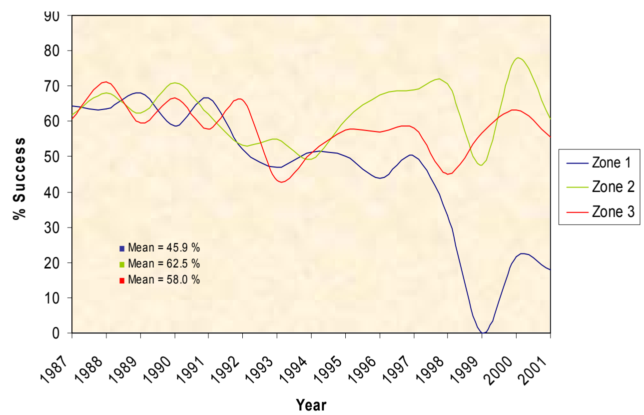

Fig. 3. Percent success of nests within each beach zone (1987-2001).

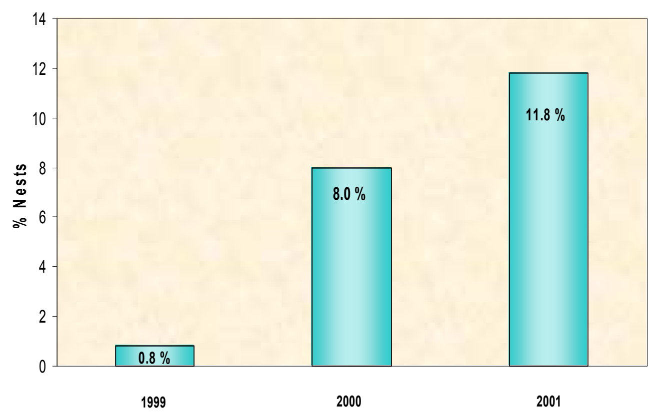

Fig. 4. Percentage of nests in vegetation islands of total nests for years 1999, 2000, and 2001.

Sea turtles in Egypt: sustainable conservation through partnerships and participatory approaches with fishermen

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INTRODUCTION

The fishing community near Alexandria is comprised primarily of the native Alexandrians; an ethnic society with their own language, accent, traditions, meals and personality. They were very keen to keep their culture unchanged and prevented the nearby villagers coming to work, socialize and marry amongst them. However, in the last thirty years many changes occurred with a flood of villagers from the countryside, looking for jobs and a new life in the city of Alexandria.

The fishermen were unable to do anything to protect their culture from the new immigrants and it slowly started to change. One feature that started to slowly disappear was the use of sea turtles for food, a popular meal in the past.

In a previous study by the author, it was found that despite being illegal more than 135 loggerhead and green turtles both loggerhead and green were killed in Alexandria fish market (El Anphoshi) during the period December 1998 to May 1999, the number increased toward the summer season. Most of the turtles were females, catastrophic for the sea turtle population.

PARTNERSHIP AND PARTICIPATION WITH THE FISHERMEN

Building a partnership with the fishermen is of crucial importance to provide a guideline for the planning process, decentralize the decision-making process, provide better communication with the fishermen, and enhance collaborative relationships with other local actors. At the same time helping to increase awareness, and motivating them to contribute in innovative ways that are characteristically of a social and economic nature.

Situation analysis. To ascertain the size of the fishery interaction problem, the reasons for the problem, who is involved, and any conflict of interests. The situation analysis involved three main steps: (1) collection of Secondary Data, including information on the fishermen's lifestyle, their financial status, social life, celebrations, and socio-cultural-economic problems; (2) collection of Primary data which determines the relationship between the fishermen and sea turtles and all the positive and negative influences affecting it; and (3) organize a Public Consultation Meeting including all the stakeholders in the area involved in the problem. The fishermen, the police department, the government, the scientific community, the churches and mosques in the area, NGO's involved in the sea turtle conservation, fishermen's organizations, etc. This aimed to create an interaction between the stakeholders' ideas, thoughts and beliefs regarding sea turtle conservation, giving us good ideas about the problem and the best way to overcome it.

Building trust and common objectives. These include (1) setting common objectives with the fishermen was a very important for a participatory approach, with agreement on the importance of law enforcement and effective sustainable development to improve the well being of communities that depend on coastal resources now and in the future and (2) finding a balance between satisfying competing present-day demands, without compromising the potential for future resource users.

Motivation of the fishermen. Fishermen as well as other individuals have many needs at any given time. Some needs are bioorganic; arising from physiological states of tension such as hunger, thirst and discomfort. Others are psychological; Arising from psychological states of tension such as the need for recognition, esteem, and to belong. A need becomes a motive when it is aroused to a sufficient level of intensity.

Fredrick Herzberg developed a two-factors theory that distinguishes dissatisfiers and satisfiers, the absence of dissatisifiers is not enough, satisfiers must be actively present in order to motivate. Two implications arise; first, we should avoid dissatisfiers for the fishermen, i.e. belittling their culture and life style, as this might easily de-motivate them. Secondly, to identify the satisfiers or motivators for the fishermen, and then supply them.

A theory by Abraham Maslow states that human needs are arranged in a hierarchy, from the most pressing to the least pressing. In order of importance, they are physiological, safety, social, esteem and self-actualisation needs. People will try to satisfy their most important need first, when a person succeeds in satisfying an important need, that need ceases to be a current motivator and he will try to satisfy the next-most-important need.

Maslow's theory has two implications; firstly, it becomes logical that fishermen with problems satisfying their physical needs will have no interest that sea turtles are listed in the IUCN red list. Therefore to motivate those fishermen to protect the sea turtle, we have to enforce the laws against the exploitation of endangered species. When fishermen know that killing a sea turtle is illegal and the penalty is prison that will negatively impact on their physical, safety, and social needs and their self-esteem, then they will be motivated to co-operate in sea turtle protection. Secondly, the fishermen come from a different socio-economic background to us, so we have to cherish the difference between them and us and realise that what motivates us will not necessary motivate them and vice versa.

Enforcement of local incentives. Most human behaviour is learned; this involves changes in behaviour arising from the interplay of drives, experience, stimuli, cues, responses and reinforcement. It is very important to go beyond the various influences on the learning process and develop an understanding of how fishermen actually learn.

In every society, different categories of people play different roles in changing behaviour and attitude. We can distinguish four roles people might play: *The initiator*: a person who first suggests the idea. *The influencer*: a person whose views or advice influence the decision. *The decider*: who decides whether, then how and when to change. *The recipient*: receives the perceptions and makes the behavioural change.

There are five different categories among the recipients: *Innovators*: people who are eager to try new ideas and willing to take risks. *Early adopters*: they are careful and successful innovators. *Early majority*: people that tend to deliberate before adopting a new idea. *Late majority*: that adopts ideas after public confidence has grown. *Laggards*: past oriented people who are suspicious to change.

Engaging the local opinion leaders and decision makers in local initiatives is the key to any successful sea turtles conservation effort. It is also important to understand that changing the fishermen socio-cultural-economic views on turtle conservation is related to what extent the opinion leaders are able to handle the educational aspect and assist in implementation by mobilising the fishing community's support and participation

Creating a special interest group (SIG). Active participation by the fishermen in a special interest group (SIG) is an essential precondition to their empowerment, which is the key to sustainability. This Special Interest Group (SIG) is an independent, not-for-profit, membership group organized by the fishermen themselves with an elected officer, to provide opportunity to exchange ideas and to keep themselves informed about current and discrete developments in their field. To develop, improve, and maintain their knowledge of sea turtle conservation issues by focusing on education at all levels.

The activities of a SIG include participation of the fishermen in data collection, like the sex of sea turtles in foraging habitats, population identification, population size estimation and tagging, also educational activities to sensitise the fishermen about the threats to sea turtles in the foraging habitats, like oil pollution, dynamite and chemical fishing, bottom trawling and other activities which directly or indirectly affect the health and physical integrity of sea grass, reefs, and related coastal ecosystems.

SUMMARY AND CONCLUSION

The social, cultural, traditional and economic potentials of the fishermen in El-Anphoshi area in Alexandria can be utilized in the conservation of the sea turtles. There is a growing interest amongst fishermen living in the area to establish their own conservation groups that will help in solving their local problems. Many fishermen have begun to understand what can be done to resolve the problems, and what tools can be used. A fishermen's Special Interest Group focusing on sea turtle conservation can help local people to better understanding the problem and to plan their own actions to address it.

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LITERATURE CITED

Gerosa, G. and P. Casale. 1999. Interaction of marine turtles with fisheries in the Mediterranean. MAP-UNEP-RAC/SPA. 59 p.

Gibson, J. and G. Smith. 1999. Reducing threats to foraging habitats. In: K.L. Eckert, K.A. Bjorndal, F.A. Abreu-Grobois and M. Donnelly, eds. Research and management techniques for the conservation of sea turtles. IUCN/SSC Marine Turtle Specialist Group Pub. No. 4. p. 184-188.

Herzberg, F. 1996. Work and the nature of man. William Collins, Cleveland.

Laurent, L., E.M. Abd El-Mawla, M.N. Bradai, F. Demirayak and A. Oruc. 1996. Reducing sea turtle mortality induced by Mediterranean fisheries. Trawling activity in Egypt, Tunisia and Turkey. Report for the WWF International Mediterranean Program. WWF project 9E0103. 32 p.

Laurent, L., P. Guglielmi, and E. Leonardi. 1998. Marine turtle conservation management in the Mediterranean. Recommendations for a new approach. WWF International. 17 p.

Maslow, A. 1954. Motivation and personality. Harper Row, N.Y.

Miranda, L. 2000. International and regional fisheries regulation of the Mediterranean.

Rudloe, A. and J. Rudloe 1994. Sea turtle in a race for survival. The National Geographic 185:104-120.

Venizelos, L. and M.A. Nada. 2000. The exploitation of loggerhead and green turtles continues in Egypt. Marine Turtle Newsletter 87:12-13

Venizelos, L. and M. Kallonas. 1999. The exploitation of sea turtles continues in Egypt. Testudo, The Journal of the British Chelonia Group 5:53-58.

Williams, S.B. 1999. The socio-economic potentials of women in Riverine small-scale fisheries in Nigeria. Proceedings of the 7th International Congress on Women. University of Tromso, Norway.

Five years of implementing management policies for the protection of sea turtles on Crete: an evaluation

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INTRODUCTION

Crete is the 5th largest island in the Mediterranean, hosting three important nesting sites for loggerhead sea turtles in Greece (Rethymno, Hania and the Bay of Messara). ARCHELON, the Sea Turtle Protection Society of Greece has been monitoring those sites since 1989 (Margaritoulis at al. 1992). Crete, with 2.9 million visitors per year, is also one of the three most important tourist destinations in the Mediterranean. Uncontrolled tourism development, which has replaced agriculture as the mainstay for the local economy is one of the main reasons why the nesting sites of the island are under pressure. With the conclusion in 1997 of a LIFE-Nature Programme, co-funded by the European Union, a Management Plan was compiled to address the threats sea turtles face in the area using techniques that can ensure their coexistence with human activities (Irvine 1997). Since that time ARCHELON has proceeded with its implementation, aiming to ensure the long-term viability of the nesting sites. This presentation analyses the strategy and results of the implementation of the Management Plan on Crete, and evaluates its successes.

OBJECTIVES

The intense tourist development has had an impact on the nesting habitats of Crete. Erosion caused by illegal constructions and beach armoring, the ever-increasing number of beach furniture and the use of heavy machinery for beach cleaning purposes reduce the area available for sea turtles to nest and may be detrimental to the safe incubation of the eggs. Furthermore, light pollution affects nesting activity and causes hatchling disorientation (Witherington and Martin 2000). The main objectives of the Management Plan include on one hand mitigating the effects of the current state of the beaches on sea turtle nesting and on the other preventing all future developments from having a negative impact on the beach, thus ensuring their viability as nesting sites. Another important objective is the achievement of the above with the active participation and support of the local community.

IMPLEMENTATION

Implementation of the Management Plan includes monitoring a total of 33 km of nesting beach on Crete where 400-800 nests are laid annually. All beaches require special management interventions so as to maintain the present levels of nesting. Nest protection includes caging, relocating to the back of the beach or to natural beach hatcheries, and shading in order to prevent hatchling disorientation. Due to the above measures, the incubation of the eggs is ensured while hatchling loss due to disorientation is minimised. ARCHELON also runs a public awareness and environmental education programme addressed to tourists and the local community aiming to communicate with them and gain their support.

The Management Plan is also implemented through lobbying, cooperations and partnerships with the authorities, the tourism industry, and other NGO's, who become active participants in the effort to protect the sea turtle nesting habitats on a long-term basis. More specifically: (1) The Ministry of Environment was the authority that determined that the nesting sites of Crete are to be included in the proposed NATURA 2000 Network based on the fact that *Caretta caretta* is included in Annex II (priority species) and Annex IV of the Habitats Directive (92/43/EEC). As obliged by the directive, NATURA 2000 sites should come under a special protection status and all activities have to comply with specific management proposals. (2) In Greece, the area within a set distance from the sea is considered public land and is regulated by the Public Land Department, which is answerable to the Ministry of Finances. In cooperation with ARCHELON, they have issued a set of instructions regulating the use of the sea turtle nesting beaches on Crete. It is also the authority dealing with any illegal constructions within that zone. (3) ARCHELON co-operates with all the major tour operator companies. They contribute to raising awareness, by providing information to tourists before or upon arrival to the island. During 2001, information about the Society and sea turtles on Crete was included in 107,000,000 brochures distributed to the companies' prospective clients. Additionally, tour operators apply pressure on hotel owners and local authorities in order for them to enforce protection measures for the sea turtles of Crete. (4) The Hellenic Society for the Protection of Nature is an NGO coordinating the Blue Flag Awards in Greece. The Blue Flag is awarded to beaches meeting a set of criteria, concerning the environment as well as the facilities available to beach users. ARCHELON cooperates with HSPN. At the nesting sites of Crete, one must comply with specific regulations concerning the protection of sea turtles in order to receive the Blue Flag.

RESULTS

Mitigation of existing beach status on the nesting activity. According to the Management Plan, regulated use of beach furniture may reduce sea turtle nesting activity. It is suggested that no more than 50% of the beach should be covered in beach furniture and umbrellas should be set in straight rows and columns, leaving a 5-metre zone at the back of the beach for sea turtles to nest. Sunbeds should be collected at night and stored away from the beach to be replaced the following morning. In 2001, all the major hotels on the nesting sites of Crete complied fully with these regulations. As a result, 2,063 sunbeds were collected at night, representing 17.7% of the total. The Public Land Department and the port authorities fined owners who did not abide to the existing regulations. According to regulations issued by the Public Land Department and the port authorities, The use of heavy vehicles on the beach is not allowed between the 31st of May and the 31st of October. Beach cleaning during the nesting/hatching season should be conducted either manually or using light machinery and under the supervision of an ARCHELON representative. The prefecture of Rethymno was the first to establish a company responsible for beach cleaning in 1998, with ARCHELON being a shareholder and a member of the Board of Directors. 2001 was the first year that no heavy vehicles were used on the beach during the nesting/hatching season.

Light Pollution is one of the most difficult problems to tackle, due to the large number of lights used on buildings directly behind the beach. ARCHELON first focused on floodlights, which were assessed to have the most detrimental effect. In 2001, 90% of the floodlights was switched off, shaded or directed away from the beach. This helped to reduce the amount of light pollution, although, ARCHELON still needs to resort to nest protection measures like nest shading in order to prevent hatchling disorientation.

Thanks to ARCHELON's cooperation with the Public Land and Town Planning Departments, 1000 m² of illegal constructions were removed from the beach and $130,000 were paid in fines during 2001. Most of the new constructions were stopped after the relevant authorities were informed.

Controlling developments on the nesting sites. Plans for large-scale works have been blocked by the authorities because of the impact they would have on the sea turtle nesting sites. These include constructions of beach roads, a fishing harbor and a motorway extension. The Public Land Department have agreed not to sell any of the land within the sea turtle nesting sites. The Ministry of Environment has stipulated regulations concerning future developments on the nesting habitats of Crete. These fully agree with the management plan. In order to obtain permission to be built, a construction must among be at a set distance from the beach, do not alter the dune area and ensure that there is no light spillage on the beach. Furthermore, the local community of Rethymno is planning to establish a Management Body for the protection of the sea turtle nesting sites. The main partners include besides ARCHELON and a local NGO, The Prefecture of Rethymno, the municipalities involved, the General Tourism Office, The Hoteliers Association and the port authorities. The management proposals put forward will be submitted to the Ministry of Environment in order to achieve a ministerial decision regulating beach use and development on the coastal zone.

CONCLUSIONS

In the years that followed the compilation of the Management Plan, ARCHELON has managed to: (1) maintain the levels of nesting activity; (2) mitigate the condition of the nesting habitats by improving the conditions under which sea turtles nest; and (3) prepare the grounds for effective legislation to be enforced on the nesting sites of Crete without opposing the needs of the local community. While it is obvious that a lot of effort is still required, especially in matters concerning beach use, ARCHELON will continue to work actively for the implementation of the management plan.

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LITERATURE CITED

Irvine, C. 1997. Management Policies for the Conservation of the Nesting Habitats of the Loggerhead Sea Turtle (*Caretta caretta*) on the Island of Crete. Prepared for the Sea Turtle Protection Society of Greece, under the auspices of E.U. LIFE Project

Margaritoulis, D., M. Dretakis, and A. Kotitsas. 1992. Discovering new nesting areas of *Caretta caretta* in Greece. In: J.I. Richardson and T.H. Richardson, comps. Proceedings of the Twelfth Annual Workshop on Sea Turtle Biology and Conservation. NOAA Tech. Memo. NMFS-SEFSC-361. p. 214-217.

Witherington, B.E. and R.E. Martin. 2000. Understanding, assessing and resolving light pollution problems on sea turtle nesting beaches. 2nd ed. Florida Marine Research Institute Technical Report TR-2. 73 p.

Conservation and investigation activities for sea turtles in the Columbian Pacific WIDECAST-Columbian Association (WCA) period 2000-2001

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With the objective of uniting efforts directed to the conservation of the sea turtles in Colombia, the Colombian WIDECAST association (WCA) achieved in October of 2000 with the support of World Wildlife Fund (WWF), the workshop in biology, conservation of the sea turtles and the third international seminar of the Colombian Network (RETOMAR). The objectives of this encounter of national and international specialists were to update scientific knowledge; to facilitate spaces of investigation between governmental establishments, universities and communities, and to generate tools for the update and execution of the National Action Plan for the Management and Conservation of the Sea Turtles in Colombia. On the other hand, in May of 2001, the Comisión Permanente del Pacífico Sur (CPPS), the Ministerio del medio Ambiente, WCA, WWF and the Corporación Regional del Valle del Cauca realized at Cali, Colombia; the workshop called "Definition of the Action Lines for a Program of Conservation of the Southeast Pacific Sea Turtles". The main objective of this event was to analyze the actual state of conservation of the sea turtles in Colombia. This meeting complemented a series of regional workshops realized previously in Peru and Ecuador, and advanced in design and the implementation of a regional program for investigation and conservation of the Southeast Pacific sea turtles. The mean results obtained were the compilation of scientific information about sea turtles, as soon as the determination of actual state of knowledge, the national reality, the principal researches to do and the local management threats were established.

Partnership for protection: the UK Marine Turtles Grouped Species Action Plan

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INTRODUCTION

Five species of marine turtle have been recorded in UK waters including the leatherback turtle (*Dermochelys coriacea*), loggerhead turtle (*Caretta caretta*), Kemp's ridley turtle (*Lepidochelys kempii*), green turtle (*Chelonia mydas*) and the hawksbill turtle (*Eretmochelys imbricata*). Little is known about marine turtles in UK waters, although the number of reported sightings has increased over recent years (Pierpoint 2000). This is most likely due to improvements in reporting mechanisms. With the exception of the loggerhead, which may be at the far edge of its range, the Cheloniid marine turtle species generally occur in UK waters as cold-stunned strays and are associated with adverse weather conditions (Pierpoint 2000). Leatherback turtles appear seasonally with the majority of sightings occurring between August and October and the occurrence of this species in UK waters is part of a deliberate migratory movement (Davenport and Gaywood 1997).

Human impacts on marine turtles in UK waters include incidental capture in static fishing gear and marine pollution. In UK waters, marine turtles are protected by various British and international legislation including the Wildlife and Countryside Act (1981, as amended), Conservation (Natural Habitats) Regulations (1994), Control of Trade in Endangered Species (Enforcement) Regulations (1997), Council Regulations (EC) No. 338/97, EC Habitats Directive (1992)

'TURTLE', a database of marine turtle records in UK waters, was established in 1999. As of 05.02.02, TURTLE held 767 records, these are summarized as follows (including the percentage of all records); leatherback 502 (65%), loggerhead 97 (13%), Kemp's ridley 29 (4%), green and hawksbill 4 and 1 (<1%), Unidentified 134 (>17%) (Turtle Implementation Group 2002).

MARINE TURTLES GROUPED SPECIES ACTION PLAN

The Marine Turtles Grouped Species Action Plan (SAP) was published by the UK Government conservation Agency 'English Nature' in 1999 in response to commitments made at the Rio Earth Summit, 1992. The SAP aims to enhance the conservation of marine turtles in UK waters and the UK Overseas Territories. The broad objectives of the SAP are to 'Avoid accidental harm to, and bycatch of, marine turtles when present in UK waters' and to 'Contribute to international measures for the conservation of marine turtles'. The SAP includes 26 separate actions and can be viewed at www.ukbap.org.uk

PROGRESS TOWARDS PROTECTION

In 1999 the Marine Conservation Society (MCS) was appointed joint lead partner in the implementation of the UK Marine Turtles Grouped Species Action Plan along with the Herpetological Conservation Trust and Scottish Natural Heritage. In 2000, MCS secured funding from Cheltenham and Gloucester plc, the UK's third largest mortgage lender who became the first 'Champion' for a marine species under the UK Biodiversity Action Plan. In 2001, the UK Environment Minister, Hon. Michael Meacher, launched the MCS Marine Turtle Conservation Programme.

THE PARTNERSHIP APPROACH

In 2001 the Turtle Implementation Group (TIG) was established. This coalition represents a partnership between government and NGO's, which meets on a regular basis to drive forward the implementation of the Species Action Plan. The coalition has strong links with other organisations and individuals who frequently contribute and are integral to many aspects of the work. These include the Institute of Zoology, Scottish Agricultural College, Sea Fisheries Committees, Fish Producing Organisations and fishermen. The Turtle Implementation Group has prioritised research into leatherback turtles in UK waters.

CURRENT OUTPUTS

The UK Turtle Code and Advisory Note. In 2002 the new UK Marine Turtle Code and Advisory Note were published. These documents were produced by the Marine Conservation Society in consultation with the TIG and UK fishing industry representatives with support from English Nature, the Environment and Heritage Service and Cheltenham and Gloucester plc. The documents aim to engage sea-users in developing a greater understanding of marine turtles in UK waters by reporting all sightings and following guidelines for the safe rehabilitation and/or release of stranded or entangled marine turtles. The UK

Turtle Code is currently being distributed widely among fishermen and other sea users in the UK. The Advisory Note is for use by those who may be called upon to deal with injured, sick or dead animals and is being made available to all aquaria and local authorities around the coast.

Turtles/ Fisheries Interactions Workshop. On the 2nd of March 2002 a Turtle/ Fisheries Interactions Workshop was held at the University of Wales, Swansea. This workshop brought together fishermen, NGO's, government departments, fisheries organisations and academics with the aim of producing a national leatherback turtle research plan. The draft proceedings from this workshop are currently being reviewed by participants and will be finalised by June 2002.

Fisheries surveys. Preliminary surveys of marine turtle/ fisheries interactions in South West England have been conducted in collaboration with the Cornish Sea Fisheries Committee and the Cornish Fish Producers Organisation. Status and exploitation of marine turtles in Caribbean

Turtles in the Caribbean Overseas Territories (TCOT). In October 2001 the UK Department for Environment, Food and Rural Affairs (DEFRA) contracted a 3-year participatory research, socio-economic survey and training programme in the Caribbean UK Overseas Territories of Anguilla, Bermuda, British Virgin Islands, Cayman Islands, Montserrat and the Turks and Caicos Islands to assess the status and exploitation of marine turtle populations found there. This project is coordinated by the Marine Turtle Research Group, University of Wales, Swansea in association with the MCS. Other project partners include the Cayman Turtle Farm, Cayman Islands Department of Environment, University of Western Ontario and the University of Wales, Cardiff.

The specific aims of TCOT are to (1) Identify project partners and initiate monitoring projects incorporating an initial training programme, (2) Assemble quantitative and socio-economic data on the harvest and uses of marine turtle populations, (3) Assess current conservation status of, and trends in, marine turtle populations and their habitat, (4) Determine by DNA analysis the genetic profile of the turtle populations in OT's and the origin of harvested animals, (5) Provide an assessment of the sustainability of any harvest and (6) Provide recommendations for the future conservation, monitoring and management of marine turtles in the OT's

PARTNERSHIPS FOR THE FUTURE

Future participatory programmes will include a participatory UK leatherback research and bycatch monitoring programme, the opportunistic tagging of a leatherback turtle in UK waters for satellite telemetry, genetic stock analysis of leatherback turtles in UK waters, participatory monitoring of litter at sea (including potential cooperative lobbying by stakeholders to reduce marine litter) and a national education and outreach programme.

Acknowledgements. We would like to acknowledge the support of all participants in this process including Cheltenham and Gloucester plc, and all the members of the TIG; The Herpetological Conservation Trust, Scottish Natural Heritage, English Nature, The Environment and Heritage Service, Countryside Council for Wales, Marine Turtle Research Group, Marine Environmental Monitoring, Euroturtle, The Wildlife Trusts and University College of Cork. We would also like to acknowledge the support of the Symposium Travel Committee.

LITERATURE CITED

Davenport, J. and M. Gaywood. 1997. Advice on live stranded or fouled marine turtles in Scottish waters. Scottish Natural Heritage Information and Advisory Note, No. 91.

Pierpoint, C. 2000. Bycatch of marine turtles in UK and Irish waters. JNCC Report No. 301.

Turtle Implementation Group. 2002. Advisory Note: Marine Turtles in the United Kingdom. Marine Conservation Society.

Swimming against the tide: a survey of exploitation, trade, and management of marine turtles in the northern Caribbean

Adrian Reuter and Elizabeth H. Fleming

TRAFFIC North America

Marine Turtles have been exploited in the Caribbean for centuries. Caribbean peoples are thought to have used turtles for thousands of years without overexploiting the resource, which according to historical accounts was extremely abundant prior to European colonization in the region. Turtle eggs and most turtle body parts-meat, shell, skin, and viscera-have been valued for one attribute or another, and they have provided everything from basic sustenance to luxury items. Direct exploitation has had a particularly strong impact on marine turtle populations in the Caribbean. Six species of marine turtles occur in the region: the loggerhead turtle (*Caretta caretta*), green turtle (*Chelonia mydas*), hawksbill turtle (*Eretmochelys imbricata*), Kemp's ridley turtle (*Lepidochelys kempii*), olive ridley turtle (*Lepidochelys olivacea*), and leatherback turtle (*Dermochelys coriacea*). Each of these species is classified by the World Conservation Union (IUCN) as either critically endangered (hawksbill, Kemp's ridley, and leatherback turtles) or endangered (green, loggerhead, and olive ridley turtles). The once vast green turtle rookery in the Cayman Islands was rendered virtually extinct by the late 1700s after a century of intensive exploitation o nesting turtles, which were traded mostly for their meat. This population remains on the verge of extinction. The more recent exploitation of hawksbill turtle shell saw huge quantities exported to Japan up until the early 1990's. In 1999, TRAFFIC North America initiated a review of the exploitation, trade, and management of marine turtles in 11 countries and territories in the Northern Caribbean. This review, which combined desk research and field surveys, was undertaken to gather and synthesize information about harvest of marine turtles, use of and trade in their products, and the effects these activities may be having on marine turtle populations. Updated information of this nature had been lacking, and it was felt that an overview of current exploitation of marine turtles would be essential to the success of ongoing efforts to manage and conserve marine turtles in the region. The overall picture revealed by TRAFFIC's study is one of extremes and contrasts that coincide roughly with the levels of development that separate the countries. Some countries have allocated significant resources to manage and conserve marine turtles, while next to nothing has been done in others. Marine turtle populations have stabilized or increased in some parts of the Caribbean, while virtual extirpation and catastrophic declines have occurred in others. A few countries/territories have made enforcement of relevant regulations an important part of their conservation efforts; in others, enforcement is virtually absent. Legislation is comprehensive in some countries while incomplete and outdated in others. Marine turtles are afforded complete protection in some countries, and there are conscious policies to regulate fisheries in others; at the same time, all countries are confronted with a latent market for marine turtle meat and eggs, and opportunistic take is reported throughout the region.

Exploitation and trade of marine turtles and their products appear to be in decline throughout the Northern Caribbean, perhaps due largely to the fact that past overharvesting reduced some populations to the point where their exploitation was no longer profitable. In addition, improved legal protection and law enforcement, education, decreased national and international demand, and changing cultural values are all thought to have contributed to a reduction in the use of marine turtles in the region. Most current exploitation of marine turtles appears to have become opportunistic rather than targeted. Nevertheless, many populations have not yet rebounded from past exploitation, and they continue to be affected by current levels of exploitation. Though several range states in the region are apparently experiencing increases in nesting of certain marine turtles at some important nesting sites, most of these increases appear to be directly related to increased monitoring and enforcement, rather than a reduction in demand for meat and eggs. All of the countries and territories reviewed have enacted legislation to regulate the harvest and trade of marine turtles; however, these have been national in scope, and vary widely in terms of the protection afforded to various species, penalties set for infractions, and enforcement thereof. Research, management, and protection are not, in most cases, coordinated among countries, despite the existence of shared turtle populations; bilateral and multilateral cooperation would be an enormous step forward. It is widely acknowledged that cooperation among range states is critical to ensure the conservation of marine turtles in the Caribbean region.

CONCLUSIONS

TRAFFIC's general conclusion from this research is that of eight major areas of action need to be addressed by the countries/territories surveyed and the Wider Caribbean region. These are: (1) filling information gaps and increasing information exchange; (2) expanding public education and awareness; (3) building national and regional cooperation; (4) increasing participation in international and regional conventions; (5) strengthening national legislation; (6) supporting training and capacity building; (7) enforcing laws that affect local and tourist markets; and (8) documenting and monitoring existing stocks of marine turtle products in the region. Marine turtles feature among the priority species and taxonomic groups on which the TRAFFIC Network will focus its efforts in the coming years. WWF's Latin America ad Caribbean Program recently identified marine turtles as flagship species group and will focus greater efforts on their conservation. With this report, TRAFFIC North America offers an informational foundation and a set of recommended actions that can help support the in-depth work that must be done to rebuild and conserve Northern Caribbean marine turtle populations.

The first year of the Spanish River Park Embedded Roadway Lighting Project: response of sea turtle hatchlings

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INTRODUCTION

When the beach in Spanish River Park was renourished in 1998, the wider beach resulted in the exposure of all streetlights along a 1.5 mile linear area to the beach. During the 1999 and 2000 nesting seasons, nest disorientations in the project area increased from an average 3.8 per year (before 1998) to 37 nest disorientations in 1999 and 33 nest disorientations in 2000. Because the nest disorientations were catastrophic to hatchlings in 1999, we requested the City of Boca Raton, the Florida Department of Transportation (FDOT) and the utility provider, Florida Power and Light (FPL) to turn off the streetlights in this area. This was rejected by the Boca Raton City Attorney for public safety reasons but resulted in the response of FPL personnel to reposition the Cobra-head streetlights towards the road and away from the beach late in 1999. Although this effort resulted in more hatchlings reaching the ocean, the number of nest disorientations was not significantly reduced. Ann Broadwell of the FDOT responded with grant funding to install a novel method of lighting the roadway with Light-Emitting Diode (LED) roadway markers on the paint in the middle of the road and High-Pressure Sodium bollards on either side of the road, which are only one foot in height. This project was lit on June 8, 2001 and the streetlights in a 0.65 mile area of Spanish River Park were extinguished at this time.

During the 2001 nesting season, no hatchling disorientations were recorded in the embedded lighting project area. Hatchling disorientations north and south of the project area where the streetlights remained on were consistent with disorientations recorded in the 1999 and 2000 nesting seasons. These data indicate that the embedded roadway lights are effective at preventing hatchling disorientations. Additionally, no complaints from the Public were received during the first year indicating that road users were happy with the new "runway" appearance of the highway. This may be a system that satisfies both Sea Turtles and drivers.

MATERIALS AND METHODS

All nests in the embedded roadway lighting project area were followed from deposition to emergence according to the Florida Fish and Wildlife Conservation Commission (FWC) Guidelines (1999). From 1997 to 2000, hatchling disorientations were recorded on a form developed by the Boca Raton Sea Turtle Program which included a drawing area to show where the hatchlings traveled in their quest for the ocean. During the 2000 nesting season the FWC provided a form with a drawing area that was adopted by the Boca Raton Sea Turtle Program. Both of these forms focused on the number of disoriented hatchlings and the number of disoriented hatchlings that made it to water (the ocean). In the embedded roadway lighting project area, most emergent nests were reported on a disorientation form to differentiate nests with no disorientations from nests that had emerged but no tracks were seen due to rain or wind.

Each disoriented nest required the surveyor to estimate the number of hatchlings disoriented (not heading east) and their direction of travel, the number of hatchlings not disoriented, and the number of disoriented hatchlings that eventually reached the ocean. Additionally, if the disoriented hatchlings moved to a light source, the light source was identified on the drawing and the disorientation form.

RESULTS

The five miles of beach in Boca Raton are divided into ten ½ mile zones to monitor sea turtle nesting activity. The beach renourishment project of 1998 included zones A, B, and C and the Embedded Roadway Lighting Project is fully contained in zone B. A portion of the Lighting Project extends north 1/10th of a mile and since there is generally little nesting activity in this small area, the Lighting Project area will be defined as all of zone B.

The number of nest disorientations reported in zone A, B, and C since 1996 are shown in Fig. 1. In 1998, nesting in the renourished zones dropped by more than 50% for an unknown reason, at the same time the number of false crawls per nest in these zones increased from 1:1 to 6:1 (Rusenko, Echiverra, and Pfistner 2002). Because of the reduced nesting in this year, significant increases in nest disorientations were not recorded in the renourished project area. In the 1999 through 2001 nesting seasons the nesting had returned to normal levels (Fig. 2) and the number of nest disorientations in these zone increased dramatically due entirely to the exposed streetlights along Highway A1A.

In 1999, 1,671 hatchlings disoriented in zones A, B, and C and only 26% of these hatchlings (436) eventually made it to the ocean. In late August of 1999 our local Power Company, Florida Power and Light, adjusted the High-Pressure Sodium (HPS) "Cobra-head" streetlights downward or away from the beach. This adjustment resulted in a similar number of nest disorientations during the 2000 nesting season, but of the 1,407 hatchlings disoriented, 60.9% (858) eventually reached the ocean, more than twice as many survivors from the previous season. This shows that directional streetlights such as the "Cobra-heads" can reduce the number of hatchling deaths but may not reduce the total number of nest disorientations.

The Florida Department of Transportation's Embedded Roadway Lighting Project was lit on June 8, 2001; before any nest in the lighting project area had emerged. The single nest disorientation recorded in the lighting project area (zone B) occurred on a night when the streetlights were on for research purposes. Had the streetlights been off during this season, no nest disorientations would have been recorded.

DISCUSSION

Following a beach renourishment project in the extreme northern section of Boca Raton (zones A, B, and C), approximately 28 streetlights were exposed to the beaches in this area in 1998. The exposure of these streetlights to the beach along A1A clearly had a large negative impact on emerging sea turtle nests. Because of low nesting in the renourishment project area in 1998, higher than average nest disorientations were not observed that year. In 1999 and 2000 an average of 31% of the nests were disoriented on emergence. These disorientations were catastrophic in 1999 with only 26% of 1,671 disoriented hatchlings reaching the ocean, some of the disoriented hatchlings even made it onto the surface of AIA where they died. A request to turn off the streetlights was denied due to public safety, however; after our local electrical utility company, Florida Power and Light, repositioned the directional "Cobra-head" streetlights late in 1999, 61% of the disoriented hatchlings reached the ocean in the 2000 nesting season. Although, light was reaching the beach, the percentage of nests disoriented actually increased slightly to 36% indicating that the directional streetlights increase hatchling survival but not the number of nest disorientations.

On June 8, 2001, the FL DOT embedded roadway lighting project was lit and the streetlights were turned off in zone B. The only nest disorientation recorded in this zone occurred on a night that the streetlights were on for a separate research project. When the streetlights were off, no nest disorientations were recorded indicating the embedded roadway lighting project is effective at keeping light off the beach. This is reinforced by the fact that zones A and C, which remained exposed to the streetlights, continued to record significant nest disorientations. In effect, these zones are control areas for the lighting project.

Another benefit of the embedded roadway lighting project may be a future increase in nesting due to the darkness of the beach. In zone C one condominium trimmed 900 linear feet of sea grapes according to State guidelines. This action early in 1999 resulted in a drop in nesting in this area from an average of 10.2 nests from 1989 to 1999 to 4 nests in 2000 and 1 nest in 2001. The even exposure of the streetlights in this area apparently discourages female sea turtles from nesting in this area. If the embedded roadway lighting project remains active for more than another year, we may expect to see increased nesting activity in zone B. The lighting project is clearly beneficial to sea turtles but the effects on the public are less clear. Anecdotally, we have received no complaints about the project even though there have been many inquiries about the project which may indicate public acceptance. Other investigations will hopefully answer these questions after this nesting season.

Acknowledgements. We would like to thank Ann Broadwell of the Florida Department of Transportation for conceiving, funding, and managing this project. Her efforts have made this section of beach safer for nesting sea turtles and their hatchlings. We would also like to thank Scott Stevens and Leonard Attai of Florida Power and Light for their quick response to reposition the streetlight heads to direct more light away from the beach in 1999.

LITERATURE CITED

Rusenko, K.W., J. Echiverra, and C. Pfistner. 2002. Unusual nesting patterns on a renourished beach. In: A. Mosier, A. Foley, and B. Brost, comps. Proceedings of the Twentieth Annual Symposium on Biology and Conservation. NOAA Tech. Memo. NMFS-SEFSC-477. p. 321-322.

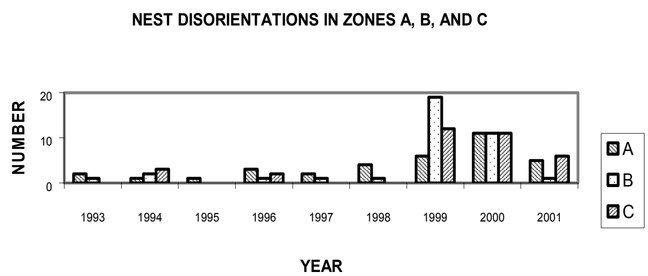

Fig. 1. The number of nest disorientations recorded in zones A, B, and C from 1993 to 2001. Zone B, the lighting project area, had the highest number of disorientations in 1999 and 2000. The single disorientation recorded in 2001 occurred while the streetlights were on. No disorientations were recorded in this zone when the embedded roadway lights were on in 2001. Zones A and C recorded significant disorientations due to exposed streetlights from 1999 through 2001.

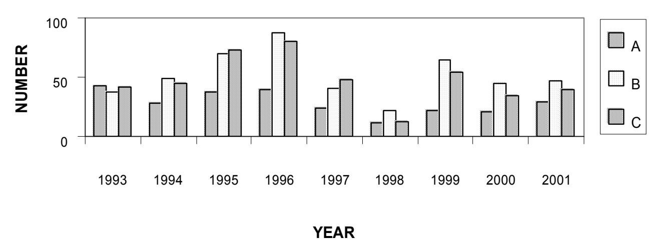

Fig. 2. The number of nests recorded in zones A, B, and C. Zone B is the Embedded Roadway Lighting Project area. 1998 was the first nesting season after the renourishment project nesting dropped more than half while 6 to 7 false crawls were observed for each nest. After that unusual season, normal nesting appeared to return from 1999 to 2001.

The use of hot pepper extract and ipecac to control mammalian predators: the year of the fox

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INTRODUCTION

Since 1976, cages have routinely been used in Boca Raton to protect sea turtle nests from mammalian predators. In 1997, this practice was discontinued when a 1996 study demonstrated that the cages actually attracted predators (Mroziak 1997, Salmon 2000). Since this time, cages were randomly utilized on less than 1/3 of the loggerhead nests giving the predators time to apparently relearn how to locate in situ sea turtle nests. As attacks by predators increased during the 2000 and 2001 nesting seasons, alternative deterrents to caging were sought. Chicken eggs or infertile turtle eggs from excavated nests were injected with extract of habenero pepper from a commercially available product or with Syrup of Ipecac. These "egg bombs" were placed in sham-nests located in areas of high predator traffic on the beach, in areas of high predator traffic from the dunes, or in previously excavated sea turtle nests.

Initial results indicate that the hot sauce and ipecac deployment in combination with caging resulted in a lower ratio of successful predatory attacks to overall attacks. A complicating factor was that loggerhead nesting was nearly half of average in the zone with highest predator activity (zone D) while the predator population was apparently unchanged. As a result an increased number of attacks per nest were observed in areas of high predator activity. Foxes south of the inlet (where little garbage is present) apparently learned to avoid sham nests laced with hot pepper sauce whereas raccoon attacks began to appear outside of zones D, E, and F (City Parks) indicating possible movement away from city parks to condominium areas. During the 2001 nesting season foxes were responsible for the majority of successful attacks on nests although they rarely completely destroyed a nest. Raccoons were most often responsible for total depredations possibly as they forage in groups whereas foxes tend to be solitary foragers. One large raccoon in zone D apparently figured out that a cage means dinner and destroyed several caged nests directly without foraging. In this case, spiked eggs were ineffective against this one raccoon although others in the group apparently took the eggs. Because spiked eggs do not directly protect a nest, as does a cage, caging and the use of spiked eggs were used concurrently. This combination appeared to help control successful predatory attacks in areas of high raccoon activity.

MATERIALS AND METHODS

Infertile sea turtle eggs or chicken eggs were injected with 0.5 ml of "Da Bomb- The Final Answer" (Original Juan, Kansas City, Kansas; www.originaljuan.com) or 1.5 ml of Syrup of Ipecac (local pharmacy). These eggs (referred to as "spiked eggs") were sealed with wax and were set in sham nests in areas of high fox and raccoon activity. From mid-July, spiked eggs were also placed in the egg chambers of excavated or totally predated nests. After this time all excavated nest contents were scattered in the dune or buried below the high tide line to prevent predators from learning how to find incubating nests by smell. Additionally, sand from the excavated nests was used to create the sham nests with spiked eggs and excess sand was spread in areas where no nests were incubating in an effort to encourage predatory digging away from nest sites. These techniques were utilized throughout Boca Raton where higher than average attacks were recorded.

Caging was performed according to the Florida Fish and Wildlife Conservation Commission's Guidelines (FWC 1999). Since mid-June, all nests in zone D (Red Reef Park) were caged due to extremely high mammalian predator activity. Throughout Boca Raton, all nests that suffered successful partial predations (nests with most eggs intact after the attack) were caged in an attempt to prevent subsequent attacks. Since no section of beach was specifically set aside to investigate the effectiveness of spiked eggs, this study may show the effects of spiked eggs and caging in Boca Raton. We felt it would be unnecessarily wasteful, from experience, to not give each nest all the protection possible.

All unsuccessful predatory attacks with significant digging are referred to as DNP's (dig no pred), these attacks typically compromise more than 80% of the attacks on nests. Successful predatory attacks are divided into two types, partial predation, where more than 50 viable eggs remain in the egg chamber; and total predation, which the entire nest contents are destroyed. To determine the type of attack, a predated nest is carefully excavated to remove debris until whole eggs are felt. Clean, wet sand is replaced into the egg chamber without disturbing the remaining eggs and the nest is caged. Because loggerhead nesting was more plentiful and evenly spread throughout Boca Raton, only loggerhead predations are reported in this study.

RESULTS

The beaches of Boca Raton are divided into ten ½-mile zones (A through J). Typically the highest number of predatory attacks occur in zones D, E, and F which totally includes Red Reef Park, the Golf Course, and South Beach Park; all of which are located east of Highway A1A. Zone B is Spanish River Park that is located west of Highway A1A. Zones A and C are composed largely of condominiums west of A1A, and zones G, H, I, and J are composed of condominiums east of A1A (beachfront condos).

In 2001, the gray fox (*Urocyon argenteus*) was responsible for 68% of all predatory attacks whereas the Raccoon (*Procyon lotor*) was responsible for 32% of these attacks, which are percentages consistent with data collected from 1997 to 2001. Although 72% of the successful attacks are caused by the Gray Fox in 2001, over 77% of the total predations (total nest destruction) are caused by raccoons. In 2001, an unusually high number of attacks was recorded in zones D and E by all predator species on loggerhead nests (5.9 and 6.4 attacks per nest in each zone respectively). In contrast, the average number of predatory attacks per nest in the other eight zones was 1.5. Despite the high number of attacks in zones D and E in 2001, the numbers of successful attacks were kept in line with previous years, an average of 0.43 attacks per nest in 1998 through 2000 versus 0.6 attacks per nest in 2001. The reason for the high number of attacks in zones D and E may be explained the fact that Loggerhead nests in zone D were 48% of the 1998 to 2000 average and in zone E nest were 74% of the 1998 to 2000 average. This decrease in loggerhead nesting occurred with no apparent decrease in the populations of mammalian predators. Fig. 1 shows the total number of fox attacks on loggerhead nests and Fig. 2 shows the decreased attack success in zones B, C, D, and F. Despite the significant increase in successful attacks in zones I and J in 2001, only 3 cases of total nest destruction occurred in zone I (0.04 total predations per nest). This demonstrates that foxes generally take only a few eggs from the nest during a successful attack and leave the majority to eventually hatch.

Fig. 3 shows the total number of raccoon attacks on loggerhead nests and Fig. 4 shows the increased number of successful attacks in zones D, E, and I. In zone D, raccoons are responsible for 0.31 successful attacks per nest and 80% of those attacks result in the total destruction of the nest. This shows that if a raccoon finds an egg chamber, it will most likely destroy the whole nest. It should be noted that raccoon attacks occur primarily in zones D, E, and F (City parks east of A1A) where garbage is plentiful and beach access is easy without crossing the road. In areas where garbage is less accessible (all other zones), Raccoon activity on the beach is almost negligible (Figs. 3, 4). Fox attacks are more evenly spread over the entire beach area of Boca Raton (Figs. 1, 2) as these mammalian predators appear to rely more on hunting skills rather than feed on garbage provided by humans, hence their range is not restricted to areas where garbage forage is available. High raccoon predatory activity in Boca Raton is apparently associated with areas of the beach containing abundant garbage, such as the city parks; outside of the park areas, raccoon activity is dramatically decreased.

DISCUSSION

These data indicate that a combination of caging in areas of high predatory activity and deployment of spiked eggs in sham or excavated nests may help control the number of successful predatory attacks by foxes and raccoons. The large drop in Loggerhead nesting in zones D, E, and F during the 2001 nesting season did not result in excessive losses of incubating nests in these zones as would be expected. Raccoons continue to dominate in city parks east of Highway A1A where garbage is plentiful and feeding by the public is not officially discouraged. Recently, one inland city park began trapping raccoons that were regularly being fed by humans. In the nine-acre area, 76 Raccoons were removed, far more than expected in a wild area of the same acreage. Hopefully trapping will begin in Red Reef Park (zone D) before the peak of sea turtle nesting season in 2002 as similar numbers of raccoons can be expected per acre. Another factor that may have influenced the increased number of attacks in 2001 is the installation of raccoon-proof covers on the city parks garbage cans. This reduction of available food may have encouraged hungry predators onto the beach in search of sea turtle nests. Zones I and J have shown significant increases in gray fox activity. One small county park exists at the north end of zone I and appears to provide these foxes with a home base. There is little or no garbage available in the park or the beachfront condos that compromise the majority of the area of zones I and J. The foxes in these zones may subsist more by wild foraging than by garbage or human feeding and, hence; reject objects with human scent such as the spiked eggs. In these zones, we have noted that the spiked sham and excavated nests were often ignored by the foxes in favor of incubating nests with no human scent. Luckily, foxes that found egg chambers took less than ten eggs on average and the protective cage prevented further attacks. The increase of successful raccoon attacks in zone D and E may be due to one large raccoon that apparently remembered that cages mean dinner (Mroziak et al. 1997, Salmon et al. 2000). In mid-August of 2001, a large raccoon successfully attacked several cages and the nests were totally destroyed leading us to abandon cages in favor of screens and spiked eggs in these zones. The success of using hot pepper sauce in 2001 appears to rely on the dependence of the predators on wild-foraged food versus human provided food. Predators used to scavenging garbage or being fed cat and dog food seem more susceptible to the effects of spiked eggs, using the deployment methods of this study, than populations of predators that rely on wild-type foraging.

LITERATURE CITED

Mroziak, M.L., M. Salmon, and K.W. Rusenko. 1997. The effects of mammalian predation and human impact on sea turtle nests on Boca Raton's beaches: A re-evaluation of nest caging as a management strategy. In: S.P. Epperly and J. Braun, comps. Proceedings of the Seventeenth Annual Workshop on Sea Turtle Biology and Conservation, NOAA Tech. Memo. NFMFS-SEFSC-415.

Salmon, M., M.L. Mroziak, and K.W. Rusenko. 2000. Do wire cages protect sea turtle nests from foot traffic and mammalian predators? Chelonian Conservation and Biology 3:693-698

Rusenko, K.W., E. de Maye, A. Cammack, and H. Harder. In press. The use of hot pepper extract to control mammalian predators: A preliminary study. In: M. Coyne, comp. Proceedings of the Twenty-first International Sea Turtle Symposium. Philadephia, PA.

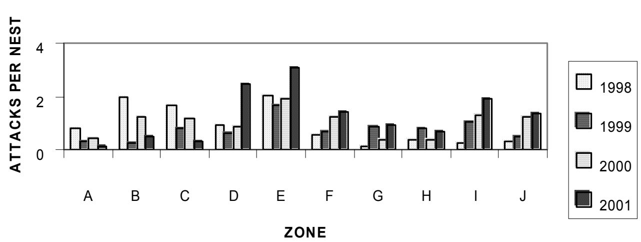

Fig. 1. All attacks by the gray fox on loggerhead nests. Despite caging and the deployment of spiked eggs, attacks in 2001 increased in zones D, E, F, G, H, I, and J. This may be due to an overall decrease in Loggerhead nesting during the 2001 season.

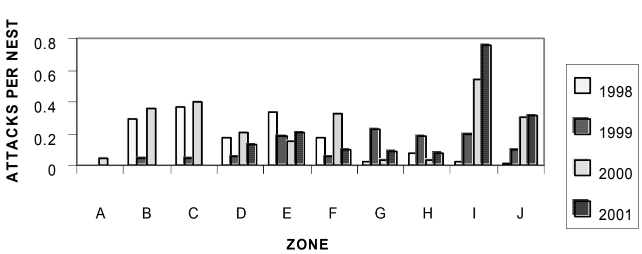

Fig. 2. Successful attacks by the gray fox on loggerhead nests. Despite increased attacks by predators during the 2001 nesting season, the numbers of successful attacks were reduced in zones A, B, C, D and F. Successful attacks in zone E were increased but near previous successful attack levels. Successful attacks in zones B and C were apparently reduced by the deployment of spiked eggs and caging. Spiked eggs and caging were less effective in zones I and J where feral foxes roam.

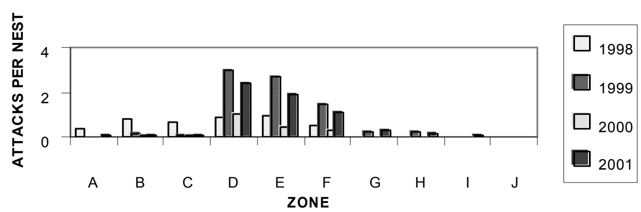

Fig. 3. All attacks by raccoons on loggerhead nests. Despite caging and the deployment of spiked eggs, attacks in 2001 increased in zones D, E, F, G, H, and I. This may be due to an overall decrease in loggerhead nesting during the 2001 season. Additionally, this may represent a migration of raccoons outside of zone D, E, and F in order to find more food.

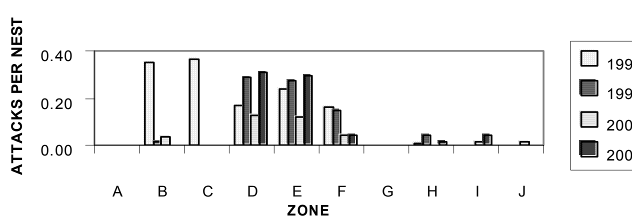

Fig. 4. Successful attacks by raccoons on loggerhead nests. Despite increased attacks by predators during the 2001 nesting season, the number of successful attacks by Raccoons were reduced in zones B, C, and F. Successful attacks in zones D, E, and I were increased but near previous successful attack levels. Successful attacks in zones B and C may have been reduced by the deployment of spiked eggs and caging. Raccoon attacks are rarely recorded in zones I and J. This may be due to the lack of parks where humans can feed them and provide them with garbage.

Making the most of hatchling production in peninsular Malaysia: an urgent need to increase egg protection in marine parks

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Despite decades of sea turtle conservation measures in Peninsula Malaysia, the nesting population at least one species of sea turtle is nearly extinct. Of the other three species nesting on these shores, green turtle (*Chelonia mydas*) populations are under significant decline, and little data exist for the less common hawksbills (*Eretmochelys imbricata*) and olive ridleys (*Lepidochelys olivacea*). Green turtle nesting is widespread around Peninsula Malaysia, but the majority of nesting and the largest rookeries exist in the eastern states of Terengganu and Pahang. Despite historically large mainland nesting rookeries, much of the green turtle nesting activity presently occurs on offshore islands. An ongoing contributor to declining sea turtle numbers is a continued legal egg harvest. Only leatherback turtle (*Dermochelys coriacea*) eggs are 100% protected. Most green turtle egg clutches bought by the Department of Fisheries, or otherwise protected, for hatchling production are incubated either in-situ on natural beaches (two small beaches on an island within a marine park), or in hatcheries at/near major nesting beaches. This paper compares the number of green turtle eggs laid and the proportion of those that have been protected each year over the last 18 years in the state of Terengganu (plus Chendor beach just across the state border in Pahang). We focus particularly on the Marine Park Islands of Terengganu (MPIT) and their importance as nesting sites.

Staggeringly, almost half of all eggs laid annually are laid on Pulau Redang and are deposited almost exclusively on three small beaches. The beaches of the nearby Perhentian islands are another regionally important nesting area, receiving around a fifth of all eggs. A small proportion of green turtle eggs are laid on Pulau Kapas, located further south. All three island locations fall within Marine Park areas. In total, almost 66% of all green turtle eggs laid in east coast Peninsula Malaysia are laid on islands within current Terengganu Marine Parks. Unfortunately, the Marine Park status of the waters around the islands does not afford protection to turtle eggs laid on the beaches. The level of realised egg protection varies between years but, disturbingly, an average of less than 40% of green turtle eggs laid in Terengganu (plus Chendor beach) go to conservation. Total sea turtle egg protection is highly recommended for Peninsula Malaysia. However, there is a clear and particular urgency to increase egg protection on the MPIT since they currently receive a very important portion of the total green turtle nesting in east coast Peninsula Malaysia. At present, the Fisheries Department is hindered in this aim by lack of financial and political support for their acquisition and/or legislative protection of several important beaches - particularly in light of rapid tourism development in the area.

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Monitoring hatchery success – What's worthwhile?

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Hatcheries are an integral part of sea turtle conservation in Peninsula Malaysia - especially for green turtles (*Chelonia mydas*). We summarize three years of data from a collaborative study of nest success and hatchling quality for multiple hatcheries and one in-situ beach. Between-season changes in levels of nest success and hatchling quality within hatcheries are highlighted and we discuss management alterations that potentially contributed to these changes. We make several general recommendations for future hatchery management in Peninsula Malaysia.

NEST CHARACTERISTICS, HATCHLING QUALITY AND MONITORING EFFICIENCY

1) High rates of abnormal scale counts were correlated with overly high sand temperatures. 2) Body condition differed between sites (perhaps this is influenced by nest depth). 3) The monitoring program revealed poaching of whole/part nests from Chendor hatchery. 4) Relatively low effort and skill was needed to effectively determine nest success and scale counts. 5) Excessive person-hours were required to make multiple morphological measurements on hatchlings and to conduct performance trials (running and swimming) – these measures may not be practical unless many volunteers/workers are available. 6) Data across multiple years is necessary to understand annual variation in hatchling and nest parameters and to efficiently monitor the ability of a hatchery, or nesting beach, to produce healthy hatchlings. 7) Recommend expansion of monitoring program to include other Peninsula Malaysian hatcheries using reduced set of parameters i.e. emergence success (nests to be dug by persons other than those responsible for planting eggs), body size (straight carapace length only), weight, and scale counts. 8) Recommend additional experiments on the effects of nest crowding on nest success and hatchling quality, and of nest depth on hatchling body condition

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Plan for sea turtle conservation in Togo

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Togo is a small country of western Africa, situated along the coast of the Gulf of Guinea, between Benin and Ghana. Its southern part, 50 km wide, is open to the Atlantic Ocean. This coast welcomes every year from October to January, *D. coriacea* and *L. olivacea* for nesting. The nesting of *C. mydas* is also probable, but not confirmed. The examination of *C. mydas* and *E. imbricata* juvenile carapaces proves the existence of development areas of these species along the Togolese coast. The sea turtles, badly protected by the present legislation, are strongly exploited by the coastal human populations. The grease of the leatherback turtle, in particular, is used in the traditional pharmacopeia. Very few data were known about the sea turtles in Togo before this study, consisting of a preliminary assessment through interviews with the fishers, recovering the shells on sale and inventorying the nesting beaches. Togo is part of the regional west African Kudu, network instituted by CMS and the IUCN - France. The ministry of the environment of Togo spread in November 1999 the Memorandum of CM Abidjan. In this context a Plan of action for sea turtle conservation is being prepared currently by the Science Faculty of Lomé and the Agbo-Zegue NGO.

The status of sea turtle nesting and threats to nesting populations in Grenada, West Indies

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Four species of sea turtle are found in Grenada: *Caretta caretta*, *Chelonia mydas*, *Eretmochelys imbricata* and *Dermochelys coriacea*; there are occasional sightings of *Lepidochelys olivacea*. Land-based threats to nesting populations in Grenada include egg harvest, slaughter of nesting females, sand mining, hotel development, beach lighting and beach compaction. Consumption of sea turtle meat, including leatherback, is widespread; egg harvest exceeds 50% of production. New 2001 Fisheries Regulations afford both leatherback turtles and sea turtle eggs full protection, but enforcement is casual. Other species of sea turtle are subject to an open hunting season (31 August - 1 May) with a minimum size limit of 25 lb. Sand mining occurs widely along the East Coast, resulting in nesting beach loss. Legislation allows for sand mining to occur under a licensing system, but many operators act outside of the law. Beachfront lighting is currently a limited hazard, but with a major hotel development beginning proximate to the key leatherback nesting beaches, the potential impacts must be considered. Community-based conservation programs are paramount in reducing land-based threats to the leatherback turtle and other sea turtles in Grenada. Ocean Spirits, with valued assistance from the Wider Caribbean Sea Turtle Conservation Network (WIDECAST), proposes intensification in its research, education and community empowerment programs for 2002.

Volunteer loggerhead patrol and nest protection program on Fripp Island, South Carolina, USA

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The beaches of South Carolina, USA, are important nesting areas for the loggerhead sea turtle (*Caretta caretta*). Seventy percent of turtle nests in the state are protected by 20 independent projects. Over 700 people participate in these projects, 97 percent of whom take part in a voluntary capacity. The active participation of these volunteers is crucial to sea turtle conservation in South Carolina. The Fripp Island Turtle Nest Protection Program is one of 10 voluntary turtle projects in the state.

Location. Fripp Island is located along the east coast of South Carolina. It is primarily a private residential community, but is also a popular resort island during the summer months. Over 800 residents and 3000 visitors use the island each year. The island has been subjected to high erosion. Due to rock revetments there is currently only one mile of useable beachfront where sea turtle nesting takes place.

Nesting activity. As with other projects in the state, nest numbers on Fripp have been declining through the years. In recent years an average of 40 loggerhead turtle nests are laid on Fripp each year during the nesting period (May to August). The average hatch success on the island is 80 percent. Approximately 3000 hatchlings emerge from the protected nests each year between July and September. Tidal erosion and over-wash due to low-lying areas along the beach, hatchling disorientation due to beachfront lighting, and depredation by ghost crabs are the only direct impacts on turtle nests in recent years.

During the 2001 nesting season 43 nests were laid on Fripp, 12 percent of which were completely eroded away and 47 percent of which were over-washed. Of this nest total 23 percent were left "in situ" and 65 percent were relocated. The average hatch success of the nests that survived through incubation was 82 percent, with the hatch success for "in situ" nests being 74 percent and for relocated nests being 85 percent. The average clutch size was 116 eggs (range 79-164 eggs).

Turtle volunteers. Volunteer turtle conservation activities began on Fripp in 1979. Currently about 20 volunteers participate each year, a majority of whom are permanent residents of the island. College interns who work with Fripp's Nature Center have also contributed to sea turtle project activities. Volunteers participate in a variety of tasks from daily patrols to education.

The leaders of the project conduct an intensive training program at the beginning of each season to ensure standardized methodologies and to maintain state guidelines for sea turtle nest management. Volunteers carry letters of authorization under the permit held by the project leader, which allow them to carry out approved activities. On average, volunteers have at least two years of experience working with turtle nest protection activities. Awareness, enthusiasm and dedication of volunteers are maintained through group meetings, information and slide presentations, and potluck dinners.

Beach patrol and nest protection. Each morning a rostered group of volunteers patrol the beach on foot to locate, identify, and record any turtle crawls from the previous night. Each crawl is evaluated for the presence of a clutch of eggs by carefully probing the nest area. Each nest, when found, is marked off with flagging-tape so as to identify locations for future reference and to alert beach-goers of areas that are protected and therefore to be avoided. While nests are left "in situ" as much as possible, nests that may be in danger of tidal erosion or inundation are relocated to the next best available site closest to the original nest location. (During the 2001 season 65 percent of all nests laid on Fripp were relocated.) All nests are monitored during daily patrols, and information including depredation and tidal over-wash are recorded through the use of a centrally located logbook.

Hatchling emergence and nest inventories. During daily patrols nests are also monitored for signs of hatchling emergence. Once emergence is complete, nest contents are inventoried to determine hatch success rates by comparing empty eggshells with unhatched eggs. If any hatchlings are trapped within the egg chamber they are released with great care and least disturbance. The emergence of these trapped hatchlings provide invaluable education opportunities and are often viewed by many volunteers and visitors.

Strandings. Unfortunately live or dead strandings of sea turtles happen on occasion, and when they do, measurements and other information are recorded. Live, yet hurt or weak strandings are handed over to state biologists, veterinarians, and aquariums for care and subsequent release. Selected volunteers on Fripp and neighboring islands are members of the Sea Turtle Stranding Network that assist state and federal agencies with managing strandings that appear on the island.

Education. Education is viewed as a critical part of the project activities, and the project's philosophy has been to provide the public with any available information on sea turtles and nests found on Fripp. Guests are regularly engaged in discussion during the daily patrols and other nest management activities. Children are especially encouraged to participate in discussions and to observe turtle activities, as they are vital to present and future conservation of the sea turtle and all other wildlife. The Nature Center on Fripp has also provided educational activities for a variety of ages, including several sea turtle and beach related programs. Crowd control or disturbance by the public has not been a problem on Fripp.

As a result of the education and publicity developed by the project, the volunteers, beyond their regular patrols, can rely on the observations of the public at large for information on nesting loggerheads and nest emergences. The turtle project participates in a variety of community activities as well, and as a result is well known on the island. Ongoing collaborations with international initiatives have brought a range of sea turtle presentations and discussions, which have benefited project volunteers and island residents in understanding sea turtle and conservation related issues beyond Fripp Island.

Visitor logbook. At a central point along the beach, a logbook is maintained for comments and observations from volunteers and visitors. Volunteers log daily records and visitors write in comments about their sea turtle related experiences. Visitors view such notes in the logbook as an opportunity to become a part of what is happening on Fripp by being able to contribute with their experiences while on the island. Volunteers encourage visitor input as it assists volunteers to know what is happening on the beach when they are unable to be there. Adults and children alike have written many heart-warming stories, thus increasing the appreciation for the work done by the volunteers as well as the need to conserve the turtles.

Project website and volunteer e-mail network. The Fripp Island Loggerhead Protection Program maintains an active website , which was developed to share data with anyone who might have any interest in the loggerhead turtle. The website includes information about nests laid on Fripp, a turtle related photo-gallery, as well as other turtle links. Many from around the world have visited the website. Through the website requests have been received from people from other locations interested in becoming part of the Fripp turtle project. Website recruits have traveled over 100 miles on a weekly basis to be a part of the turtle program on Fripp. In addition to the website, active volunteers and other close associates are interconnected through an e-mail network which assists with daily communication, keeping everyone informed of nest activity and news.

Lights-out campaign. Beachfront lighting, as a result of houses along the entire beach, has contributed to some disorientation of hatchlings during emergence. To address this problem, a "Lights Out For Sea Turtles" Campaign was initiated. Volunteers visit house residents, explain the disorientation issue, and request their cooperation in turning off their beachfront lights. Information flyers are also issued at guest check in, at a central post on the beach, and in resident mailboxes. The Fripp information TV channel carries a public service announcement for the entire turtle season on the issue.

Despite these education efforts, light pollution on the beach and the disorientation of hatchlings is a concern. Previous challenges to reducing beach lighting include voluntary compliance and a high turnover of visitors using rental properties. A recent Barrier Island Beach-Dune Lighting Standard, which restricts beachfront lighting, will hopefully give the project's Lights-Out Campaign more validity and assist in reducing disorientation. Information on this new ordinance and on window-film used to reduce the visibility of indoor lighting is provided to residents and the public through the Nature Center on the island.

Support and funding. The Fripp turtle project is maintained entirely by the personal contributions and time of the volunteers. Often small donations have been received for purchasing vital supplies and materials. In recent years community organizations and local businesses, some of which are associated with individual volunteers, such as the Creek View Studio, Fripp Island Audubon Club, and ISLC (a local internet provider), have been of great assistance to the project. The project has also begun the production and sale of turtle t-shirts to fund some expenses in order to avoid the burden falling on volunteers who are already giving of their time. Tax-deductible donations to the project have been facilitated through the Fripp Island Audubon Club.

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An overview of Projeto TAMAR-IBAMA's activities in relation to the incidental capture of sea turtles in Brazilian fisheries

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Projeto TAMAR-IBAMA, the Brazilian Sea Turtle Conservation Program, is a network of 20 conservation stations that together protect over 1,000 km of Brazilian coastline on the mainland and on three oceanic islands. TAMAR was created in 1980, and initially focused its efforts on nesting beaches. Since 1990, a significant proportion of TAMAR's field activities have been focused on sea turtle feeding areas.

Five species of sea turtles are found and nest in Brazil: the green turtle (*Chelonia mydas*, CM), the loggerhead (*Caretta caretta*, CC), the hawksbill (*Eretmochelys imbricata*, EI), the olive ridley (*Lepidochelys olivacea*, LO) and the leatherback (*Dermochelys coriacea*, DC). Several nesting beaches and feeding areas are located near important fishing and/or shrimping grounds, where sizeable industrial fishing fleets operate. Moreover, artisanal fishing is a key livelihood for many coastal communities. Therefore, there is significant interaction between sea turtles and fishing gear around those areas, and the successful conservation of sea turtles by TAMAR must also involve actions to reduce incidental captures of sea turtles in fishing activities. Furthermore, since 1998 TAMAR has been collecting data on the level of sea turtle capture by the pelagic longline fishery off the Brazilian coast, which is a new frontier for conservation activities. Different actions have been implemented by TAMAR in each region in Brazil, depending on local conditions and available funds. Here, we present an overview of TAMAR's activities regarding the incidental capture of sea turtles by Brazilian fisheries.

COMMUNITY INVOLVEMENT / EDUCATIONAL ACTIVITIES

The involvement of local people into the conservation program and environmental educational activities have long been hallmarks of TAMAR. Close, frequent personal contacts with local communities and educational campaigns make possible to present to local people different aspects of sea turtle conservation and of marine conservation in general. This way, the incidental capture of sea turtles in local fisheries has been dealt with by TAMAR in several forms: (1) Educational campaigns, like the one "Not everything caught in nets is fish", presents to local fishermen procedures for the rehabilitation of turtles incidentally caught in fishing nets. (2) Environmental education in a broad sense is also carried out at all TAMAR stations, by means of lectures to school students and groups of local residents, participation in local meetings, exhibition of videos, etc. (3) Development of alternative sources of income for fishermen. TAMAR looks for activities that, besides allowing the fishermen to earn money, have a low or null impact on sea turtles: mussel and oyster cultures, fish industrialization, analysis of adequate locations for setting gill nets, etc. (4) Development of alternative sources of income for the fishermen's families. This has the effect of lowering the local communities' dependence on fishing: craftsmanship, sewing, embroidery, paper recycling, etc.

DIRECT ACTIONS

Incidental captures of sea turtles are greatly reduced through TAMAR's direct actions at all stations. For example, in São Paulo (a feeding area), TAMAR works closely with artisanal fishermen who employ mainly floating weirs and gill nets. In the past, most turtles captured in São Paulo were consumed, but nowadays they are usually released alive and in good health back to the sea. In Ceará (another feeding area), fishermen employ mainly weirs and gill nets (targeting either fish or lobsters). Turtles captured in weirs are always released alive back to the sea, but those captured in gill nets still undergo a significant mortality. Both in São Paulo and Ceará TAMAR maintains tanks for the rehabilitation of turtles that have undergone forced submergence, or are diseased or wounded. In other stations located in nesting areas, TAMAR has worked mainly with local fishermen who operate near the nesting beaches, with the aim of suggesting proper locations for setting the nets and other measures to reduce the incidental capture of sea turtles.

Marine Surveys. TAMAR is conducting marine surveys at several areas in order to obtain data on the main types of fishing gear operating in each region, the size of fishing fleets, the different kinds of boats, the areas and periods of the year where the boats operate, and to assess the magnitude of incidental captures of sea turtles. These surveys are carried out by means of interviews with local fishermen, through the use of on-board observers on fishing boats and through boat trips by TAMAR personnel. Data obtained from governmental agencies are also being used to assess the level of incidental captures in those regions. In Bahia (a fishing area) and Sergipe (a shrimping area), sizeable fleets operate and a significant (if not yet adequately evaluated) mortality of sea turtles is known to occur. In São Paulo, a survey is being carried out regarding the capture of turtles in trawl nets - although these nets are a potential threat to sea turtles, the actual risk posed by them in São Paulo is as yet unknown.

Protected areas / law enforcement / orientation to fishermen. Protected areas, maintained by the federal government or by state governments, are located in many of the regions where TAMAR operates. These areas – a National Marine Park, Biological Reserves and Environmental Protection Areas - provide protection to sea turtles from fishing activities, although law enforcement is often lacking. In Bahia, boat trips, in cooperation with local governmental authorities, have been undertaken to verify reports of illegal captures of sea turtles or illegal fisheries. In Sergipe and Espírito Santo, boat trips around the state coasts have been undertaken by TAMAR personnel to orient trawl boats to operate outside 3 nautical mile exclusion zones around nesting beaches, in order to lower the impact of trawlers on sea turtles. In Sergipe and Espírito Santo, governmental legislation has established a minimum 3 nm distance from the coastline for the operation of trawl boats, as a means to protect local ecosystems and local artisanal fishing.

The open sea. Since 1998, TAMAR has obtained data on the capture of sea turtles by longline fisheries in the open sea. There are records of juvenile loggerheads and adult or subadult leatherbacks incidentally captured by longliners targeting tunas and sharks, both within Brazil's 200 mi Exclusive Economic Zone in the southern part of the country and in neighboring international waters. There are also some records of leatherbacks incidentally captured in drift nets targeting sharks around the coast of the state of São Paulo. The incidental capture of sea turtles in longlines and drift nets is a growing international concern. TAMAR has made agreements with universities and governmental agencies working on fishery matters, to obtain better data in order to assess the situation in the open sea.

A national plan / local vs. global actions in Brazil. While many successful results with regard to the incidental capture of sea turtles in fishing gear have been achieved in different Brazilian states, many specific questions remain in certain regions.

Furthermore, it has been increasingly clear that, previously, the problem of incidental capture was not well evaluated in Brazil as a whole. Thus, TAMAR's National Coordination has sought to integrate regional activities on a national scale, in order to better assess the overall situation. At the end of 2001, TAMAR began to develop a group of strategies to deal with the incidental captures, thus forming the "Action Plan for the Reduction of Incidental Sea Turtle Capture in Fisheries" (Marcovaldi et al. 2002, Brazilian plan for reduction of incidental sea turtle capture in fisheries, Marine Turtle Newsletter 96: 24-25).

The main objective of this action plan is the reduction of incidental captures of sea turtles in Brazil. The action plan includes the creation of a Coordination to deal specifically with that subject, and recognizes that achievements will only come as a result of the establishment of partnerships with several institutions, including governmental agencies, universities, NGOs, museums dedicated to marine research and the national fishery sector.

A SUMMARY OF THE SITUATION IN THE AREAS WHERE TAMAR OPERATES

Ceará. 40 km of coastline. 1 TAMAR station in the area. Artisanal fishing: weirs, gill nets for fish and lobsters. There are captures of sea turtles, a great proportion of the turtles are found dead (mostly juvenile and adult CM). DC have been captured in weirs. Before TAMAR operated in the area, dozens of sea turtles, whenever captured in weirs, were consumed by local fishermen. Nowadays, all turtles captured in weirs are released alive back to the sea, but there is significant mortality in gill nets.

Fernando de Noronha and Atol das Rocas. 2 TAMAR stations in the area. In Fernando de Noronha, hook and line. In oceanic waters around the archipelago, there are reports of drift nets, associated with longlines, but there has been no monitoring in the open sea. In Atol das Rocas, fishing is not allowed officially; clandestine fishing for lobsters occurs via diving and traps. In Fernando de Noronha, fishing is mainly for the local market, and does not pose a threat for sea turtles there. The existence of TAMAR and the existence of protected areas in/around the oceanic islands have kept sea turtles in the area safe from interactions with fishing gear.

Pernambuco and Rio Grande do Norte. 150 km of coastline. Pernambuco: gill nets, beach seines and weirs. Rio Grande do Norte: gill nets, hook and line, diving and fishing for lobsters. In Pernambuco, TAMAR does not operate directly. Information about turtles found dead comes mainly from institutional partners. In Rio Grande do Norte: there are large fishing communities, sea turtles are occasionally captured. However, fishing does not seem to pose a definite threat to sea turtles in those areas.

Sergipe. 125 km of coastline. 3 TAMAR stations in the area. Artisanal fishing: beach seines and fixed gill nets. Medium-scale commercial fishing: trawl nets, targeting shrimp. Mortality of adult LO; also some adult CC. Some mortality of juvenile CM. Juveniles are found stranded (dead) during the whole year. Adult turtles are usually found stranded, generally during the reproductive period (September-March), when trawl boats operate at less than 3 nm from the coastline.

Northern Bahia. 200 km of coastline. 5 TAMAR stations in the area. Artisanal fishing close to the coast, using boats without engines (canoes, sailboats, rafts); industrial fishing in deeper waters, targeting pelagic fish and lobsters; main fishing methods: gill nets, seines, longlines, hook and line, free diving and trawl nets (shrimping). Fishing is one of the main causes of sea turtle mortality in the area, mostly CM, but also CC and EI, mostly juveniles. Generally, records of deaths coincide with the presence of trawlers or gill nets operating at less than 3 nm from the coast.

Espírito Santo. 276 km of coastline. 6 TAMAR stations in the area. Artisanal fishing: gill nets, hook and line. Medium-scale commercial fishing: trawl nets, drift nets, bottom gill nets, hook and line. Large-scale commercial fishing: trawl nets, longlines, bottom gill nets. Some mortality of juvenile CM, throughout the year. Adult CC are usually found stranded, often during the reproductive period (September-March). DC have been captured in gill nets. Trawl boats from other Brazilian regions come to operate in the area; this causes an increased fishing effort in the area.

Trindade Island. Oceanic island, 1,100 km (600 nm) from the mainland; 1 TAMAR station there. Longline and hook and line fishing are known to occur in oceanic waters around the island, but there has been no monitoring there.

Rio de Janeiro. 140 km of coastline. 1 TAMAR station in the area. Artisanal and medium-scale commercial fishing. Gill nets, trawl nets, longlines. Some mortality of juvenile CM, mainly in gill nests. The impact of fishing on sea turtles in the area is not well understood.

São Paulo. 100 km of coastline. 1 TAMAR station in the area. Mostly artisanal fishing. There is a small-scale commercial trawling fleet, targeting shrimp. Main fishing methods that have captured sea turtles: floating weirs, fixed gill nets, bottom otter trawls, encircling gill nets. Main fishing method monitored by TAMAR: floating weirs, which capture mostly juvenile CM. Relatively low mortality in floating weirs, due to TAMAR's actions. Mortality in gill nets and trawl nets at a level not well understood.

CONCLUSIONS

TAMAR has already started work on many of the topics presented above, and gradually data are being gathered. However, conservation actions related to the incidental capture of sea turtles in the Brazilian fisheries is no simple task. Brazil has over 8,000 km (5,000 mi) of coastline, and the country has a 200 mi Exclusive Economic Zone. Furthermore, fishing is widespread, both in artisanal and industrial forms, and sea turtles abound in Brazil. So, there is a great deal of interaction between sea turtles and fisheries in Brazil, often in faraway locations, and often in the open sea. Passing the conservation message on to fishermen and other parties has taken (and will continue to take) a lot of work. We are confident that the actions now being implemented signal a brighter future for sea turtles regarding their incidental capture in the Brazilian fisheries. Through the actions herein described, we hope to further contribute to international efforts regarding sea turtle conservation.

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Comparison of Monel 49 and Inconel 681 flipper tag loss in green turtles, *Chelonia mydas*, nesting at Tortuguero, Costa Rica

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INTRODUCTION

Low tag loss is desirable for long-term studies of sea turtles because it will allow researchers to follow individual turtles for longer time periods (Balazs 1999). Green turtles have been tagged with flipper tags at Tortuguero, Costa Rica, since 1955 (Carr et al. 1978). The monitoring protocol for Tortuguero (CCC 1998) establishes that nesting sea turtles are tagged in order to: a) identify individual sea turtles for research purposes; b) monitor hunting pressures in feeding, migratory, and internesting habitats via tag returns; c) identify developmental habitats and migratory corridors for populations of sea turtles that nest at Tortuguero via tag returns; d) determine the longevity of sea turtles; e) determine how long female turtles are reproductively active; f) determine the retention time of tags.

The objective of the paper is to compare tag loss for Monel #49 and Inconel #681 flipper tags, both manufactured by National Band and Tag Company, KY, USA and used to tag green turtles at Tortuguero, Costa Rica.

METHODS

Since 1998, at least 1,000 new green turtles are tagged each year at Tortuguero (CCC 1998). This represents a sample of the green turtles that come ashore to nest. Tags are applied to each front flipper, axillary, inside the first scute on the trailing edge of the flipper.

Probability of tag loss was calculated for double tagged green turtles that were subsequently encountered with one or two tags (Wetherall 1982). Within-season tag loss was calculated from the first to last sighting and between season tag loss was calculated from the date of tagging to the first sighting two, three, four or five years later. The probability of tag loss is defined as:

$$1-K_i = 1-((2r_{di})/(r_{si}+2r_{di})), \text{ where}$$

K_i is the probability of retaining a tag during the interval i
r_{di} is the number of individuals encountered carrying two tags at interval i
r_{si} is the number of individuals encountered carrying one tag at interval i
Confidence limits (95%) were calculated according to the methodology presented by Bjorndal et al. (1996).

RESULTS

The probability of within-season tag loss varied between 0.019 and 0.169 (Table 1). Between season tag loss was consistently lower for Inconel #681 tags used during the 1998-1999 nesting seasons than for Monel #49 tags used in 1996-1997 (Fig. 1).

DISCUSSION

Explanations for the lower tag loss for Inconel #681 tags include less corrosion than for Monel tags, easier to check locking mechanism for Inconel #681 tags and thorough selection and training of Research Assistants during the 1998-2001 nesting seasons. Limpus (1992) concluded that tag loss was greater for the more distal tagging positions on the front flippers. The placement of tags (axillary, next to the first scale) may have contributed to the relatively low tag loss seen at Tortuguero. Passive integrated transponder (PIT) tags are being increasingly used in sea turtle tagging projects because of their perceived low tag loss. Godley et al. (1999) reported that 93% of PIT tags were detected within-season in renesting green turtles, which would suggest a 7% within-season tag loss. This is higher than the within-season tag loss observed for Inconel #681 at Tortuguero (Table 1). Metal flipper tags also have the added advantage of being externally visible so that non-experts can identify tags and provide tag return information. Parmenter (1993) reported 8% tag loss over two years for PIT tags used on the flatback turtle (*Natator depressus*). The tag loss is lower than the loss observed in Inconel #681 tags in this study. However, the sample size (n=37) was small and there may also be species differences that make comparisons between Parmenter's and this study inappropriate. Bjorndal et al. (1996) did not find a difference in tag loss for Monel #49 and Inconel #681 tags used in Tortuguero in 1989. It may be that the explanations mentioned above, especially the selection and training of Research Assistants may have confounded their or our study. Based on the difference in corrosion rates observed in removed Monel and Inconel tags (pers. obs.), we think that the advantage of the more resistant Inconel #681 tags will become more apparent as the study period increases to four or more years.

The most important consideration when choosing tag type should be to ensure that the tags employed will fulfill the research objectives of the study. Currently, we consider Inconel #681 tags to be adequate for the Tortuguero Green Turtle Program (CCC 1998).

Acknowledgements. All Research Assistants and participants taking part in the 1996-2001 Green Turtle Programs are gratefully acknowledged for their hard work and diligence in tagging turtles and checking them for old tags. Their dedicated efforts made this study possible. The CCC Scientific Advisory Committee members are thanked for their significant contributions to the new Tortuguero monitoring protocol.

LITERATURE CITED

Balazs, G.H. 1999. Factors to consider in the tagging of sea turtles. In: K.L. Eckert. K.A. Bjorndal, F.A. Abreu-Grobois, M. Donnelly, eds. Research and Management Techniques for the Conservation of Sea Turtles. IUCN/SSC Marine Turtle Specialist Group Publication No. 4. p. 101-109,

Bjorndal, K.A., A.B. Bolten, C.J. Lagueux, and A. Chaves. 1996. Probability of tag loss in green turtles nesting at Tortuguero, Costa Rica. J. Herp. 30:567-571.

Carr, A., M.H. Carr, and A.B. Meylan. 1978. The ecology and migrations of sea turtles, 7. The west Caribbean green turtle colony. Bull. Amer. Mus. Nat. Hist. 162:1-46.

CCC. 1998. Monitoring protocol for the green turtle program at Tortuguero. Unpublished protocol for the Caribbean Conservation Corporation. 13 p.

Godley, B.J., A.C. Broderick, and S. Moraghan. 1999. Short-term effectiveness of Passive Integrated Transponder (PIT) tags used in the study of Mediterranean marine turtles. Chel. Cons. Biol. 3:477-479.

Limpus, C.J. 1992. Estimation of tag loss in marine turtle research. Wildl. Res. 19:457-469.

Parmenter, C. 1993. A preliminary evaluation of the performance of passive integrated transponders and metal tags in a population study of the flatback sea turtle, *Natator depressus*. Wildl. Res. 20: 375-381.

Wetherall, J.A. 1982. Analysis of double-tagging experiments. Fish. Bull. 80:687-701.

Table 1. Probability of within-season tag loss from first-to-last encounter.

Nesting season	Tag type	Turtles with two tags	Turtles with one tag	Prob. of tag loss	Confidence limits (95%)
1996	Monel #49	332	135	0.169	± 0.029
1997	Monel #49	421	52	0.058	± 0.016
1998	Inconel #681	281	11	0.019	± 0.012
1999	Inconel #681	278	34	0.058	± 0.020
2000	Inconel #681	371	24	0.031	± 0.013
2001	Inconel #681	339	23	0.033	± 0.014

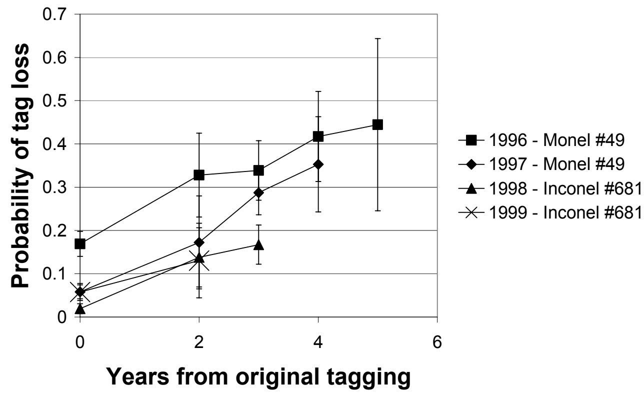

Fig. 1. Annual probability of tag loss for Monel and Inconel tags.

Sea turtle research and conservation: filling knowledge gaps, capacity building, and networking on the central Caribbean coast of Columbia. Phase II, 2001

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Some of the oldest and more important nesting areas for loggerheads (*Caretta caretta*) in Colombia are found within the Departments of Magdalena and la Guajira on the central Caribbean coast of the country. The nesting rookery that occurs in the beaches of Buritaca, Don Diego and Palomino has been assessed during 1999, 2000, and 2001. Biological data including reproductive behaviour, threats and hatchling success for nesting females has been collected during these three consecutive annual seasons. Collaborative networking involving government agencies, NGOs and local communities has improved research, protection and conservation activities along the coastal line that encompasses these beaches. Public awareness, a mass media campaign and follow up workshops have been carried out with all stakeholders of sea turtle conservation in the region. Results from the last three years demonstrate a decline in the number of females, although beach protection and nests relocation has been implemented and strengthened in this area. Comparative data from the beaches of Buritaca, Don Diego and Palomino surveyed during the 1999, 2000, 2001 nesting seasons will be presented in a poster at the symposium.

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Community-based marine turtle conservation at Punta Banco, Costa Rica

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The beaches along the Pacific coast of Costa Rica provide nesting habitat for various species of marine turtle. While harvesting marine turtles and eggs is illegal in most of Costa Rica, turtle eggs are part of the livelihoods of many coastal communities, where they are used in household consumption and/or for commercial selling. This paper draws on interviews, household surveys, and participant observation undertaken from July and August, 2001, during the olive ridley and green turtle nesting season in Punta Banco, Costa Rica. The research addresses the extent of community participation in and support for a marine turtle conservation project, promoted since 1996 by a local environmental NGO and the Sea Turtle Restoration Project. Community participation is critical for the success and continuation of marine turtle conservation projects, and results of this research may be applicable beyond the immediate case study.

Urgent conservation measures for *Caretta caretta* in the Pelagian Islands, Sicily, Italy (EU Life-Nature Project 99 NAT/IT/006271, 1999-2003)

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The project focuses on the conservation of sea turtles in the Pelagian Islands waters, through the reduction of mortality rates of adults and sub-adults, caused by the impact of fishing activities, and the reduction of current human disturbance levels on the nesting beaches. The project also aims at obtaining data about loggerhead spatial and temporal use of marine habitat, by use of an innovative satellite telemetry system. These objectives will be pursued by: (1) Actions at the local, regional and national level to enhance awareness and develop knowledge about the reasons why protective measures for sea turtles are required. Particular attention is dedicated to local fishermen; (2) The protection and conservation of nesting sites and nests by actions of cleaning, surveillance and monitoring of the beaches; (3) The protection of adult and sub-adult individuals by the setting up of a Rescue Center and the development of a network of collaborative fishermen working in the area in order to allow rapid intervention on turtles accidentally caught; and (4) The drawing up of a management plan for Loggerhead conservation in the Pelagian Islands Marine Reserve. The main results of the Project up to now are: (1) Starting-up of the Turtle Rescue Center on the Island of Linosa; (2) Production of several information materials (book, documentary, Internet site, public exhibit and information Center); (3) Involvement of local fishermen in the sea turtle's protection (operative workshop, sea turtle handling guidebook); and (4) Setting up of a satellite system and tracking activities of a few Loggerheads.

Community-based sea turtle conservation in the Pacific Coast of Costa Rica: Punta Banco, San Miguel, and Caña Blanca. 2001 Report

Edna Lopez, Cyndi Trip, Darren Childsworth, and Randall Arauz

Programa Restauración de Tortugas Marinas, Costa Rica

In 1996 PRETOMA began organizing community based sea turtle protection projects on the Pacific coast of Costa Rica in response to requests from the community leaders of Punta Banco, South Pacific Costa Rica. The people of Punta Banco have traditionally consumed sea turtle eggs, an activity that was controlled by the remoteness of the site. However, they have become increasingly concerned due to the excessive poaching of nests by members of neighboring communities, an activity facilitated by recent road access.

Community based conservation projects have proven to work as catalysts for other communities to initiate their own conservation projects. In 1996, the citizens of San Miguel, a small coastal community in the Northwestern province of Guanacaste contacted PRETOMA to begin a similar project. Simultaneously, Rafael Bejarano, a Guaymi Indigenous Chief, expressed interest to involve the coastal community of Caña Blanca in the Conte Burica Indigenous Territory, in a sea turtle conservation project as well. Both projects were driven by the same concern; the fate of the nesting sea turtle populations that visit their beaches.

Nesting activity at these three sites is described as "solitary" (a few hundred nests deposited per season). Olive ridley (*Lepidochelys olivacea*) sea turtles are the predominant species visiting these beaches, but other species are sporadically sighted as well. For example, Caña Blanca and Punta Banco both report sporadic Pacific green (*Chelonia mydas agassizi*) and hawksbill (*Eretmochelys imbricata*) sea turtle nesting activity. Leatherback (*Dermochelys coriacea*) nesting activity has only been reported in San Miguel.

Man-made hatcheries are mainly utilized to protect nests from poachers, although they also help avoid nest loss to erosion, a common natural factor of nest mortality due to the greatly varying tides of the Pacific coast of Costa Rica. Research assistants work together with community members not only in protection efforts, but also to create local awareness on the importance of conserving endangered sea turtles.

METHODS

The beaches that the project has chosen as study sites are divided into two or three sectors of 500 ms to 1 km each. Beach monitoring teams consist of student interns, local community members (local monitors) and occasional volunteers, who patrol their assigned sectors 4-6 hours each night, schedules based on tides. Upon finding a turtle, project personnel tag the fore flippers with inconel metal tags, measure the carapace length and width, and note whether she nests, makes a "false crawl", or if the nest was poached. When a nest is not poached, the eggs are counted and transferred to the hatchery. Eggs are protected in the hatchery until they hatch, at which point the number of hatchlings is counted and live newborns are released into the sea. The nest is then excavated in an attempt to investigate the cause of unhatched eggs and dead hatchlings (Arauz et al. 2000).

RESULTS AND DISCUSSION

Hatcheries have proven to be the most effective form of nest protection against poachers, thus most of the eggs are relocated into one. However, during the last month and a half of each project, all nests encountered on the beaches were strictly relocated on the beach, except in San Miguel where project work halted before the end of the season.

During the 2001 season there were 102 reports (total records) of turtle activity in Caña Blanca. 59 of the reports corresponded to successful nesting, with 53 nests for *L. olivacea*, 5 for *C. mydas* agassizi, and 1 for *E. imbricata*. In San Miguel there were 117 reports (total records) of turtle activity, 95 of which corresponded to successful nesting. In Punta Banco, of 240 reports (total records), 140 corresponded to successful nesting. In both San Miguel and Punta Banco, all successful nesting was performed by a single species, *L. olivacea*.

In Caña Blanca 71% of the nests were protected in the hatchery, 17% were relocated on the beach, and 12% were poached. In San Miguel 61% of the nests were protected in the hatchery and 39% were poached. In Punta Banco 65% of the nests were protected in the hatchery, 10% were relocated on the beach, and 25% were poached.

In 2001 more eggs were protected and more hatchlings released in Punta Banco than in the other two projects. This however, is most likely due to the fact that the project in Punta Banco began on July 15, whereas the projects in Caña Blanca and San Miguel began August 08 and September 15, respectively. Furthermore, monitoring in Punta Banco was more regular and consistent than at the other sites (Fig. 1). The number of eggs protected and hatchlings released has steadily increased since the project initiation.

The combined hatching success rate of the three beaches was greater than 64%. The highest hatching success rate attained was 85.6% in the Foundation Hatchery (Hatchery 2) of Punta Banco. These percentages surpass those reported in natural nests of *L. olivacea* (Buskirk and Crowder 1994) which indicates that use of hatcheries is beneficial in such protection programs (Fig. 2).

Low poaching rates in Caña Blanca are most likely due to the fact that this community is very remote. Furthermore, during high tide there is little, if any, accessible beach. High poaching rates in San Miguel this year are due to several factors. The sea turtle protection project didn't initiate until September 15, until which time there was no official protection. Furthermore, local monitors worked this year without the assistance of either student interns (research coordinators) or volunteers. Punta Banco usually experiences poaching rates between 20-30%. This rate has fallen to 10% when authorities patrol the beaches (such as the 2000 nesting season), as their official presence deters poachers from neighboring communities from even visiting the beaches. Unfortunately, this year the authorities were hardly present, and the poaching rate was only 25% even without the aid of the authorities (Fig. 3).

Nesting activity in Caña Blanca was greatest and peaked during the first two weeks of September. In spite of having initiated sea turtle monitoring activity late in San Miguel, a clear peak of nesting activity is evident during the first two weeks of October. In Punta Banco, September was the month with the greatest nesting activity, which also continued into the first two weeks of October (Fig. 4). The 2001 nesting season can be considered an average year, as it was definitely not the most active, yet neither was it the least.

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LITERATURE CITED

Arauz, R., A. Myers, S. Crossland, S. Dougan and G. Miller. 2000. Report: Sea Turtle Conservation and Research Using Coastal Community Organizations as the Cornerstone of Support. Submitted to the Sea Turtle Restoration Project and the Tiskita Foundation.

Mehta, S., A. Russell and R. Arauz. 2000. Solitary nesting activity in the Ostional Wildlife Refuge, Costa Rica and the Impact of Poaching (during solitary nesting) and harvesting (during arribadas) on olive ridley sea turtle nests (*Lepidochelys olivacea*). In: H.J. Kalb and T. Wibbels, comps. Proceedings of the Nineteenth Annual Symposium on Biology and Conservation. NOAA Tech. Memo. NMFS-SEFSC-443. p. 69-71.

Van Buskirk, J. and L.B. Crowder. 1994. Life-history variation in marine turtles. Copeia 1994:66-81.

Witherington, B.E. 1999. Reducing threats to nesting habitat In: K.L. Eckert, K.A. Bjorndal, F.A. Abreu-Grobois, and M. Donnelly, eds. Research and Management Techniques for the Conservation of Sea Turtles. IUCN/SSC Marine Turtle Specialist Group Publication No 4. p. 179.

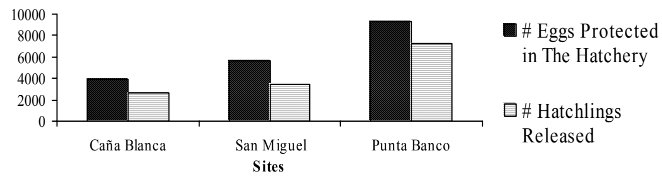

Fig. 1. Eggs protected in hatcheries versus number of hatchlings released 2001.

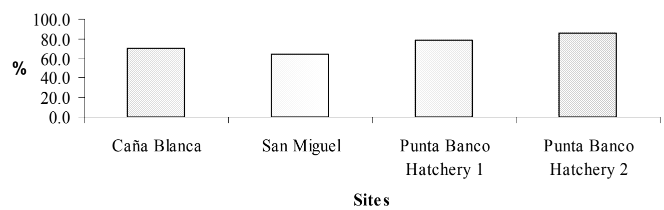

Fig. 2. Hatching success rate (%) 2001.

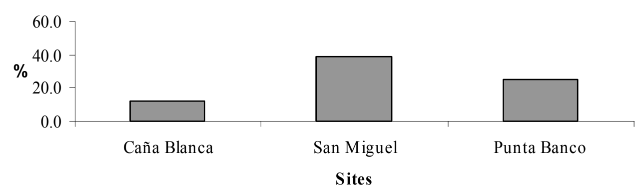

Fig. 3. Poaching percentages 2001.

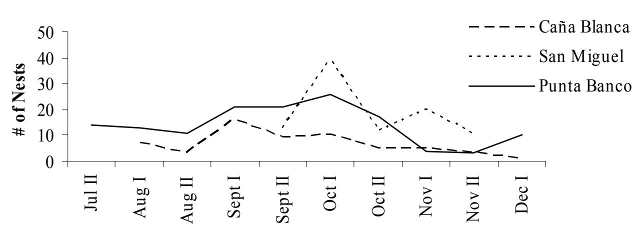

Fig. 4. Annual number of nests at each of three primary beaches.

Nesting loggerhead and green sea turtles in Quintana Roo, Mexico

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INTRODUCTION

The evaluation made by different institutions about the number of sea turtles nests along 200 km of the beaches (approximately) over 900 km of the coast of Quintana Roo are included in the documents of the SEMARNAP (2000) and the "Carta Pesquera" (Gobierno Federal 2000). These documents confirmed the importance of the nesting sites for the loggerhead *Caretta caretta* and green sea turtles *Chelonia mydas* in Mexico. The beaches of Aventuras DIF, Chemuyil, X´cacel and Xel-ha are always the areas with the highest density for these species. The objectives of this study were to determine the distribution and abundance of *C. caretta* and *C. mydas* nests.

METHODS

Study area. The beaches are located on the central coast of the state of Quintana Roo (Fig. 1), containing approximately 100 km of the coast and 36 km of nesting beaches, between Punta Venado (20°33´N,87°09´W) and Punta Allen (19°53´N,87°24´W).

Survey methods. The information used was generated from different sea turtle conservation programs from 1987 to 2001, with emphasis on beaches from the central part of the state, using only *C. caretta* and *C. mydas* nesting data. We compiled the information from the Centro Ecológico Akumal (2000), SEMARNAT (2000), Gobierno Federal (2000) and Parque Xcaret (2001) to find out the total number of protected nests in the state. The number of beaches varied from 8 to 15 during the 15 years of the study along the central coast. For the analysis of the nesting tendencies only data from seven beaches was used: Kantenah, Aventuras, X'cacel, Tankah, Kanzul, Cahpechen – Lirios, and San Juan.

RESULTS

Caretta caretta. The number of nests registered during a season ranged from 903 to 2331, with a noticeable increase in 1991, 1995, and 1999. The increase of the number of nests was statistically significant on the seven beaches ($r=0.57$, $p< 0.00$, $n=15$). From 1995 to 2000, the number of nests along the central coast represented 73% to 93% of the protected nests in Quintana Roo (Fig. 2). Table 1 indicates the number of nests on different beaches. The beaches Aventuras, Chemuyil, X´cacel, and Xel–ha have been the areas with the highest density.

Chelonia mydas. There was a biannual fluctuation in the number of nests in the 15 years of study. In "high" years (from 1988 to 2000), the number of nests varied from 338 to 2,560; the increase was significant ($r=0.78$, $p < 0.01$, $n=7$). In the "low" years (from 1987 to 2001), the number of nests varied from 247 to 384; there was a slight increase but it was not significant ($r=0.32$, $p < 0.43$, $n=8$). The number of nests along the central coast represented 51% to 87% of all the protected nests in Quintana Roo (Fig. 3).

DISCUSSION

The number of sea turtle nests varied on the different beaches along the central coast (see Tables 1 and 2). Some biotic and abiotic factors influence the nesting process. For example, the physical characteristics of the main nesting beaches and their level of conservation. The fluctuation in the number of nests of the green turtle in the "low" years reflects a critical situation for these species. The significant increase in the number of nests on the beaches during the 15 years should be considered with caution because these are the only important nesting areas for these species in Mexico. Ross (1996) examines the increase of *L. kempii* nests using 30 years of data from Rancho Nuevo, Tamaulipas. He indicates that there is not any evidence that the populations are decreasing, but it requires a long time before an evaluation can correctly estimate the variation of these groups. In addition, Meylan (1981) notes that these types of estimation of sea turtle populations are limited by the small portion of the life cycle observed. The census of the nesting females population only reflects the number of reproductively active females. Females and males that are not reproductively active may or may not reflect the same tendencies (Ross 1996). Without knowing the proportion of males to females and the age structure it is impossible to extrapolate the data from the nesting beaches to the entire population (Meylan 1982). Taking these opinions in consideration, we can conclude that in the study area, we don't know the situation of the nesting females of the two species, other than their nesting data. The number of nests being registered is relatively high, possibly due to the protection that has been in force for the last three decades in the region: legal protection, protection of eggs, protected areas, turtle camps and the implementation of environmental educational programs. The main problem for both species is the reduction of nesting habitat caused by tourist and urban developments along the coast (Zurita et al. 1993, Gobierno Federal 2000). Given the importance of these nesting beaches more efforts should be taken to protect them.

Acknowledgements. Thanks to all the people who are helping to protect the sea turtles in Quintana Roo.

LITERATURE CITED

Centro Ecológico Akumal. 2000. Minuta del taller de homologación de metodología y base de datos en la protección de las tortugas marinas en Quintana Roo. Akumal, Quintana Roo, México. 7 p.

Gobierno Federal. 2000. Decreto de la Carta Nacional Pesquera Diario Oficial del 28 de Agosto del 2000.

Meylan, A. 1981. Estimation of the population size in sea turtles. In: K.A. Bjorndal, ed. Biology and Conservation of Sea Turtles. Smithsonian Inst. Press. Wash. D.C. p. 135-138.

Meylan, A. 1982. Estimation of population size in sea turtle. In: K. Bjorndal, ed. Biology and Conservation of Sea Turtles. Smithsonian Inst. Press, Washington, D.C. p. 135-138.

Parque Xcaret. 2002. Informe de protección de tortugas marinas. Temporadas 1998 – 2001 Parque Eco-arqueológico Xcaret, Quintana Roo, México. 66 p.

Ross, J.P. 1996. Caution urged in the interpretation of trends at nesting beaches. Marine Turtle Newsletter 74: 9-10.

SEMARNAP. 2000. Programa Nacional de Protección, Conservación, Investigación y Manejo de Tortugas Marinas. Secretaría de Medio Ambiente, Recursos Naturales y Pesca, Instituto Nacional de Ecología. México DF,. 125 p.

Zurita, J.C., R. Herrera and B. Prezas. 1993 . Tortugas marinas del Caribe. In: S.I. Salazar-Vallejo and N.E. González, eds. Biodiversidad Marina y Costera de México Com. Nal. Biodiversidad y CIQRO, México, p. 735-751

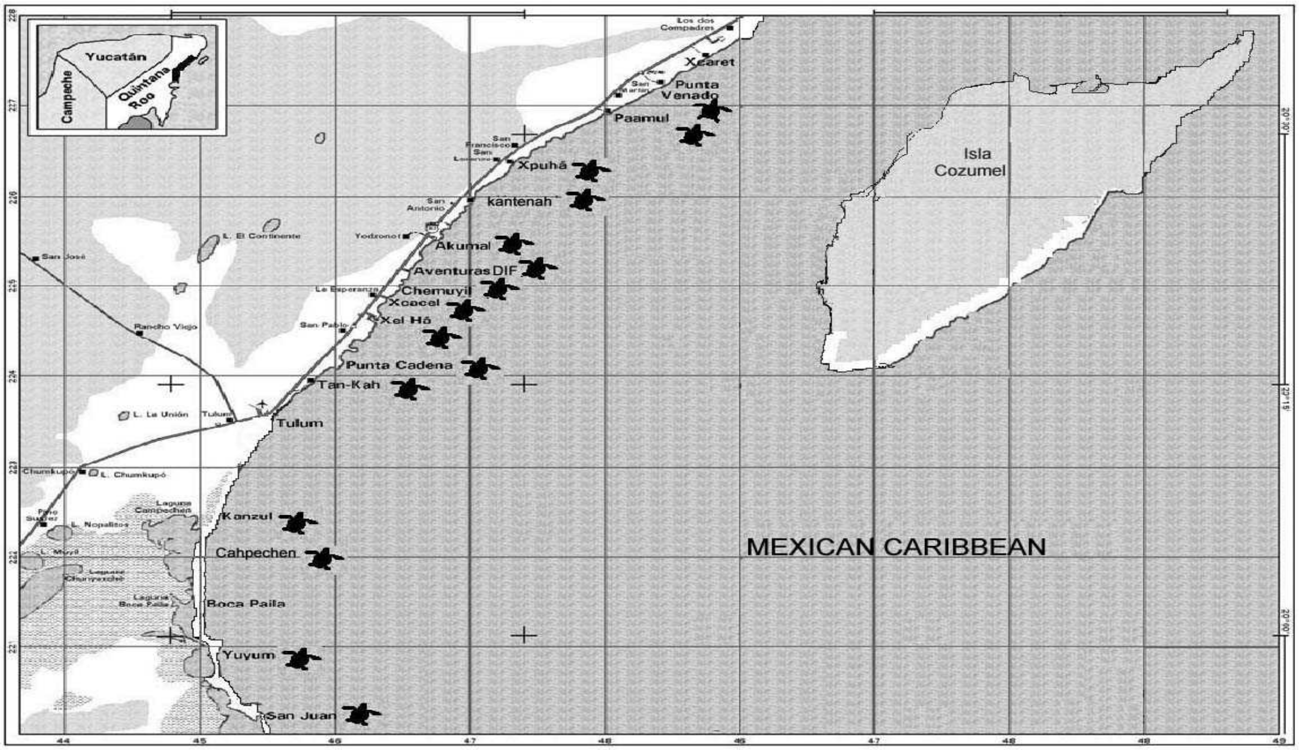

Fig. 1. Study area along coast of Quintana Roo, Mexico.

Table 1. Number of *Caretta caretta* nests in the central coast of Quintana Roo.

Beach	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	Σ
Pta. Venado										26	22	23	39	17		127
Paamul			7	6	10	26	46	43	79	43	27	45	83	52	8	475
Xpu-ha	40	36	45							39						160
Kantenah	129	56	53	13	84	112	151	123	213		113	180	145	130	158	1,660
Akumal							31		108	150	193		87	112	119	800
Aventuras	167	184	224	160	124	155	250	243	273	265	137	167	202	239	352	3,142
Chemuyil			44	38	50	89	93	106	130	110	67	95	144	66	90	1,122
X'cacel	186	240	220	233	345	324	345	232	465	307	301	339	310	219	301	4,367
Xel-ha					30	36	48	63	145	185	132	162	215	153	139	1,308
Enmascarado		31			3			31	52		84	24	132	72	79	508
Tankah	119	50	62	26	59	61	88	111	168	51	78	73	79	51	108	1,184
Kanzul	124	174	112	257	305	245	163	226	215	124	222	184	187	160	170	2,868
Cahp-Lirios	73	58	50	35	161	143	127	141	271	186	221	226	205	170	255	2,322
Yu-yum				11	13	5	26		60	21	29	21	32	20	36	274
San Juan	65	75	107	119	57	55	56	25	152	62	69	45	76	57	82	1,102
•TOTAL	903	904	924	898	1,241	1,251	1,424	1,344	2,331	1,569	1,695	1,584	1,936	1,518	1,897	21,419

Table 2. Number of *Chelonia mydas* nests in the central coast of Quintana Roo.

Beach	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	Σ
Pta. Venado										2	1	5	1	2		11
Paamul			0	4	0	36	4	8	7	10	1	4	5	8	0	87
Xpu-ha	1	0	6							6						13
Kantenah	12	17	1	0	13	42	12	63	22		33	45	8	108	9	385
Akumal							1		19	74	31		4	161	10	300
Aventuras	32	19	31	46	14	66	7	160	29	42	16	65	3	275	24	829
Chemuyil			7	7	1	66	11	81	19	36	49	104	1	73	7	462
X'cacel	84	76	48	221	38	287	49	348	71	197	101	424	67	597	94	2702
Xel-ha					7	22	2	29	11	72	34	120	28	168	13	506
Enmascarado		11			0			47	1		15	9	4	48	11	146
Tankah	45	50	23	50	16	90	21	79	30	44	43	98	15	136	33	773
Kanzul	42	125	153	229	38	212	43	194	25	93	71	244	48	360	57	1934
Cahp-Lirios	8	17	7	47	49	157	48	177	47	55	48	353	39	438	92	1582
Yu-yum				6	6	9	0		18	10	5	15	2	40	9	120
San Juan	25	23	10	71	27	75	33	58	33	19	32	62	7	146	25	646
ΣTOTAL	249	338	286	681	209	1062	231	1244	332	660	480	1548	232	2560	384	10496

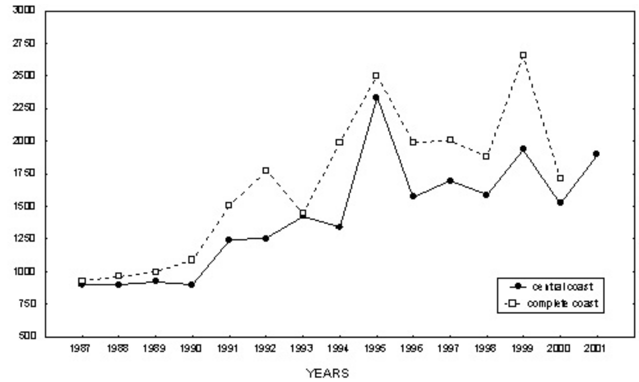

Fig. 2. Annual number of *Caretta caretta* nests.

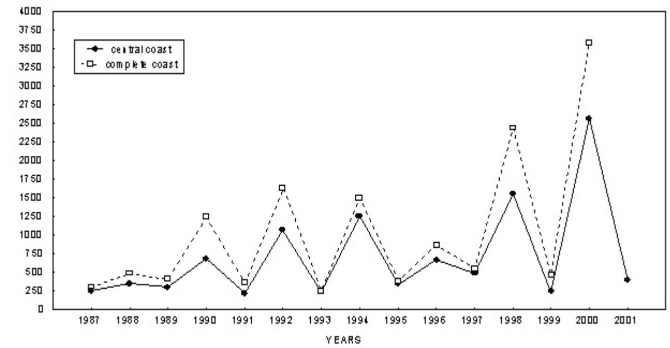

Fig 3. Annual number of *Chelonia mydas* nests.

Status survey of sea turtles and their nesting beaches along the Andhra Pradesh Coast, India

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INTRODUCTION

Five species of sea turtles have been reported from Indian waters, of which four species are known to nest on the mainland coast and offshore islands. These include the leatherback turtle (*Dermochelys coriacea*), hawksbill (*Eretmochelys imbricata*), green turtle (*Chelonia mydas*) and the olive ridley (*Lepidochelys olivacea*) (Kar and Bhaskar 1982). All these species, barring the loggerhead, have been reported from Andhra coast (Dutt 1976,1979, Kar 1983, Biswas 1982, Bhaskar 1983) but nesting of only olive ridley sea turtles has been confirmed (Kar 1983). Since the southernmost olive ridley rookery of Orissa (Rushikulya) is close to Andhra Pradesh border, it is possible that the Andhra coast may have significant nesting beaches for olive ridley turtles. While sporadic nesting is known to occur all along the Andhra coast, large nesting aggregations have been reported at a few sites along the northern Andhra coast (Priyadarshini 1998, Subba Rao et al. 1987, Raja Sekhar 2000). However, there is little information on the size, density or seasonality of these aggregations. Some information is available on sea turtle nesting along the northern Andhra coast, but there is currently no information on the status of sea turtles along the rest of the coast. In this context, an extensive survey of the Andhra coast was conducted to obtain detailed information on the status of sea turtles and their nesting habitats.

METHODS

Study area. Andhra Pradesh is located along the East Coast of India and is one of the largest maritime state of India with a coastline of 980 km (13º34.42'N and 80º16.03'E - 19º06.55'N and 84º47.19'E) (Fig. 1). The major rivers joining the Bay of Bengal are Vamsadhara, Nagavali, Godavari, Krishna, Pennaru and Swarnamukhi with several smaller rivers, tributaries, backwaters and lagoons. The Andhra coast also has good patches of mangroves in the Godavari and Krishna deltaic system. However the most dominate coastal vegetation along the rest of the coast are Palmyra and Casuarina plantations on the beach. It has a continental shelf area of 31,000-sq. km. with an annual fish production of 1,50,000 t. Andhra Pradesh, being the state with the second longest coastline in the country makes a major contribution to fisheries and ranks fifth in India in terms of marine fish production (Alagaraja et al. 1987).

Survey methodology. The entire coast was divided into three zones i.e. A - Northern Andhra coast, B - Central Andhra Pradesh and C - Southern Andhra coast. Each zone was divided into different sectors, based on coastal landmarks such as river mouth, bays, lagoons etc,. The survey was conducted in three phases namely pre-nesting survey, offshore survey and nesting/post nesting survey. An interview-based survey was conducted from May 2000 to September 2000 to collect secondary level of information from different sources. A standard questionnaire as suggested by Schroeder and Murphy (1999) was followed for these surveys. The offshore survey was conducted on board with a trawling vessel "Matsya Darshani" of Fishery Survey of India from November to December 2000 and the nesting survey was conducted from January to March 2001. Dead turtles washed ashore along the coast were also enumerated.

RESULTS

Pre-nesting survey. The interview results indicates that the olive ridley is the predominant turtle found all along the coast but no conservation effort has been initiated by any Forest, Fisheries organizations along the coast. It was also found that fish traders rarely sell turtle eggs in the market and meat trade is low but medicine is still extracted from sea turtle liver and bile in a few coastal villages. The fisherfolk identify the breeding and nesting seasons of ridleys as being between November and March in relation to local festivals.

Offshore survey. Sea turtle sightings were significant off the Northern Andhra Pradesh coast. During the experimental trawling (11/2 hr trawling effort each time for 60 trawl) a total of 30 and 32 olive ridley turtles were caught of which 97% were male in November and 98% females in December. The number of captures was more between Visakhapatnam and Kalingapatnam coast.

Nesting survey. Of the various nesting beaches of Andhra Pradesh, the Kapaskudi (Bahuda river mouth), Kalingapatnam (Vamsadhara and Nagavali river mouth), Sacramento (Goutami river mouth), Yellachitladibba (Krishna river mouth) and Sriharikota island (Pulicat mouth) had significant nesting intensity while in the rest of the beaches, nesting was sporadic to rare (Table 1). The nesting peaked in end January and February along the entire coast. Two green turtles (*Chelonia mydas*) were found dead along the coast during the survey. The number of dead turtles was less in central and southern Andhra Pradesh. During March and April, the mortality declined in all the zones. Almost all the sporadic nests of olive ridleys along the Andhra coast were predated by feral dogs, jackals and hyenas. The highest number of dead turtles was observed between Kalingapatnam and Visakhapatnam. The total number of dead turtles documented along the Andhra coast up to April was 806.

DISCUSSION

Several hundred thousand turtles migrate to Orissa coast to nest each winter at Gahirmatha and other rookeries. These turtles are known to migrate along the Tamil Nadu and Andhra coastlines prior to the nesting season in October and November and again after nesting in May and June (Dash and Kar 1990). Adjacent to the mass nesting beaches of Orissa, the Andhra coast has important sporadic nesting beaches for olive ridley sea turtles. Besides the northern AP coast, high nesting densities were also found along the Krishna and Pulicat beaches in southern Andhra Pradesh. Four river mouths had densities of nesting in excess of 50 / km / season, while densities averaged less than 5 nests / km / season along much of the coast. In conjunction with the fact that all mass nesting beaches in Orissa are at river mouths, it appears that river mouths are preferred nesting habitats for ridleys on the east coast of India. The density of nesting was clearly higher in northern and central Andhra Pradesh than in southern Andhra Pradesh. Ridleys tagged in Orissa have been recorded nesting in Chennai, Tamil Nadu, south of Andhra Pradesh (Pandav 2000). Hence, the possibility of these turtles using suitable beaches in Andhra Pradesh cannot be ruled out. In Orissa, turtles have also been known to use new mass nesting sites (Shanker and Mohanty 1999). This necessitates the need for the development of a dynamic strategy that can protect these turtles throughout their nesting and inter-nesting habitat on the east coast of India. Such a strategy would require high levels of coordination between governmental agencies such as the Forest and Fisheries Departments, Coast Guard and Navy as well as non-governmental agencies and local communities. Such a network requires a good communication network and awareness of the issues amongst all stakeholders.

Some management interventions to reduce fishery related mortality include the declaring No-Fishing zones during the nesting season in areas where sea turtle nesting concentration is high and enforcement of existing laws viz. the Andhra Pradesh marine fishing (Regulation) Rules, 1995. Turtle Excluder Devices would also be effective and is possible by convincing the trawler community about its use. Habitat degradation remains one of the biggest threats on the Andhra coast. Extensive shrimp seed collection along the coast and shrimp hatcheries and prawn farms close to the nesting beach pose a major threat, particularly along the central Andhra coast. Human disturbance and lighting from aquaculture industries was very high along much of the coast and pose a serious threat to turtle nesting habitats (Tripathy et al. 2001). Casuarina and Palmyra plantations close to the beach render the habitat unsuitable for nesting and also provide shelter to egg and hatchling predators, particularly jackals. With the introduction of new jetties and harbors, there will be an increase in fishing craft, gears and fishing operation and which will deter turtles from using the beach for nesting and will lead to larger incidental catch related mortality along the coast. Along with this, the sand mining near Kalingapatnam by Indian Rare Earth Limited (IREL) may also have adverse affect on the nesting beaches. Many major industrial projects are based near the coastal areas. Pollution from sea based industries, urban and military sewage from Visakhapatnam, Kakinada and Suryalanka and sand mining near Kalingapatnam, are likely to have detrimental effects to the coastal environment as well as the sea turtle population and therefore need detailed Environmental Impact Assessments.

Acknowledgements. We thank the Wildlife Institute of India, Dehradun and Government of India - United Nations Development Programme's Sea turtle project for funding support. We acknowledges the Forest Department, Govt. of Andhra Pradesh, for permits and logistic support and other Government and Non Government Organization for their information, help and support during the survey work. We also acknowledge the financial support provided to us from the David and Lucile Packard Foundation and the Sea Turtle Symposium for opportunity and as travel assistance to make it possible to attend the Symposium.

LITERATURE CITED

Alagaraja, K., K.C. Yahannan, P.L. Ammini and P.P. Pavitran. 1987. An appraisal of marine fisheries in Andhra Pradesh, Central Marine Fisheries Research Institute 33:1-52.

Bhaskar, S. 1983. Surveying of sea turtles, World Wildlife Fund – India 47:5

Biswas, S. 1982. A report on the olive ridley *Lepidochelys olivacea* (Eschscholtz) [Testudines: Cheloniidae] of Bay of Bengal. Record of Zoological Survey of India. p. 275-302

Dash, M.C. and C. Kar. 1990. The Turtle paradise- Gahirmatha, Interprint, New Delhi. 295 p.

Dutt, S. 1979. Sea turtle notes from Visakhapatnam, Hamadryad 4:14-15

Kar, C.S and S. Bhaskar. 1982. The status of sea turtles in the Eastern Indian Ocean. In: K.A. Bjorndal, ed. The Biology and Conservation of Sea Turtles. Smithsonian Institution Press, Washington, D.C. p. 365-372.

Kar., C.S. 1983. Notes on Marine turtles in Andhra coast, India. IUCN/SSC, Marine Turtle Newsletter.

Pandav, B. 2000. Conservation and management of olive ridley sea turtles on the Orissa coast. Ph.D. Thesis, Utkal University, Bhubaneshwar, India

Priyadarshini, K.V.R. 1998. Status and nesting of Olive ridley sea turtles (*Lepidochelys olivacea*) along the Northern Andhra coast. CAPART, WWF-India.

Raja Sekhar, P.S. 2000. Nesting activity of olive ridleys, *Lepidochelys olivacea* (Eschscholtz), at important breeding habitats of Andhra coastline, India. In: H.J. Kalb and T. Wibbels, comps. Proceedings of the Nineteenth Annual Symposium on Biology and Conservation. NOAA Tech. Memo. NMFS-SEFSC-443. p. 258-260.

Schroeder, B. and S. Murphy. 1999. Population survey (Ground and Aerial) on nesting beaches. In: K.L. Eckert, K.A. Bjorndal, F.A. Abreu-Grobois, and M. Donnelly, eds. Research and Management Technique for conservation of sea turtles. IUCN/SSC Marine Turtle Specialist Group, Pub. No. 4.

Subba Rao, M.V., P.S. Raja Rajasekhar and K. Kameswara Rao. 1987. Ecology and Management of Indian Sea turtles. UGC Final Report, New Delhi

Tripathy, B., B.C. Choudhury, and K. Shanker. 2001. Status survey of sea turtles along the Andhra coast: A report. GOI UNDP Sea Turtle Project, Wildlife Institute of India, Dehradun, India.

Shanker, K. and B. Mohanty. 1999. Operation Kachhapa: In search of a solution for the olive ridleys of Orissa (Guest Editorial). Marine Turtle Newsletter 86:1-3.

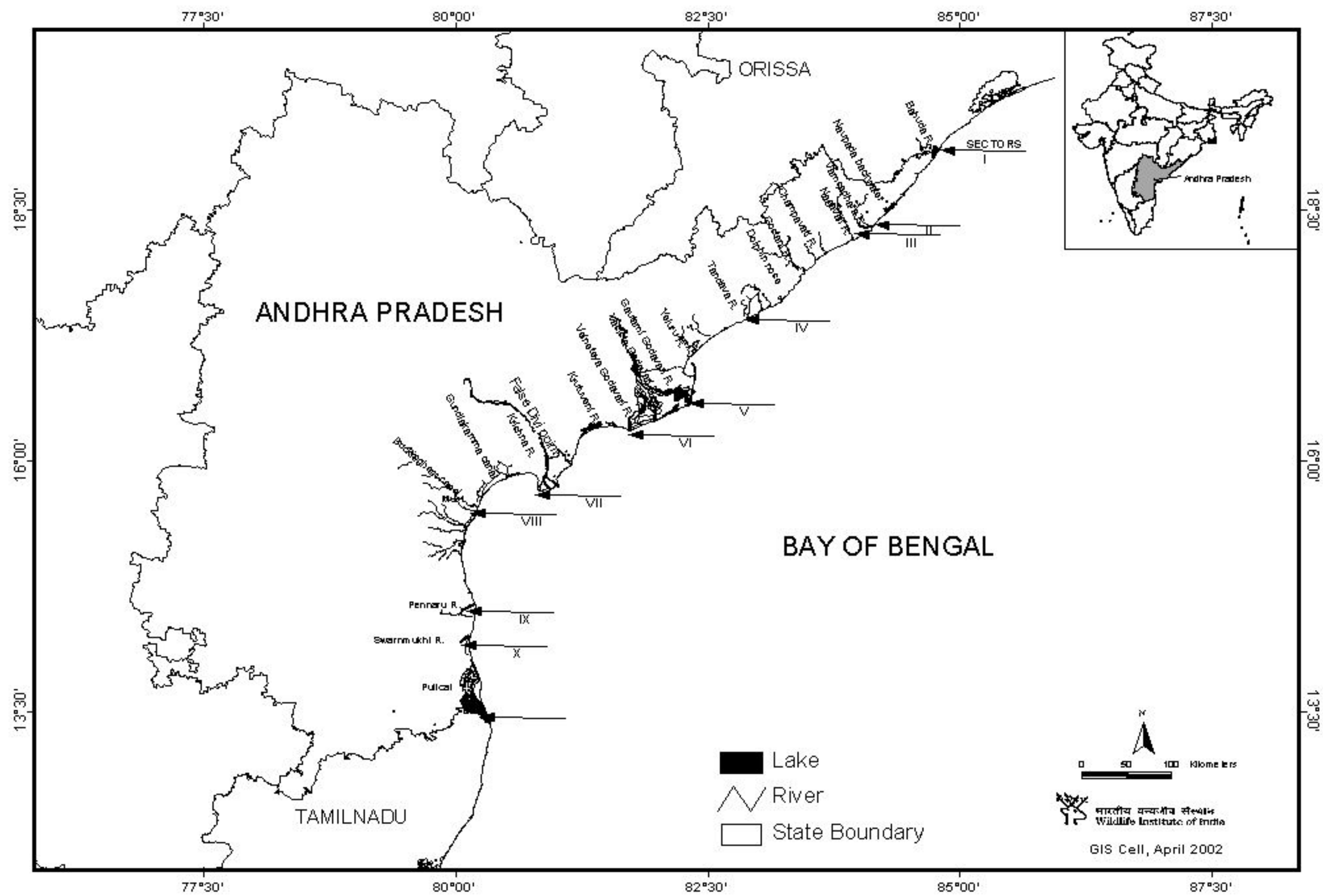

Fig. 1. Map of Andhra Pradesh Coast, India.

Table 1. Nesting of olive ridleys observed in intensified nesting location along the Andhra Coast.

Zone	Sector	Length (km)	Nesting area	No. of nests	Nests /km
A	I	10	Bahuda R – Kapaskudi	550	55
A	II	5	Vamsadhara R - Bandarvanipeta	200	40
B	II	3	Kunduvanipeta – Nagavali R	150	50
B	V	10	Goutami Godavari R - Neelarevu	685	68
C	VII	12	Krishna R – Lankevenidibba	125	10
C	VIII	5	Pennaru R – Mypadu	40	8
C	X	15	Sriharikota – Durgarajapalem	100	7

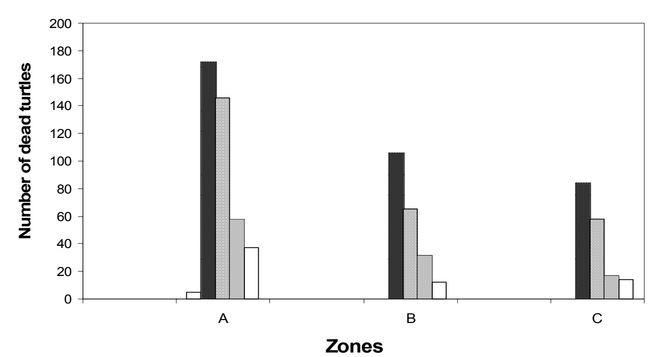

Fig. 2. Dead turtles counted along the Andhra Pradesh coast.

Sea turtle nesting and the effect of predation on the hatching success of the olive ridley (*Lepidochelys olivacea*) on Old Ningo Beach, Ghana, West Africa

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INTRODUCTION

Information about sea turtle populations and breeding success in Ghana is very scarce. Ghanas coastline stretches 539km (Fretey 2001) of which about 375 km (70%) are suitable for sea turtle nesting (Carr and Campbell 1995). Previous studies have identified 5 species of sea turtles on the coast of Ghana (Toth and Toth 1974): the leatherback turtle (*Dermochelys coriacea*), the green turtle (*Chelonia mydas*), the olive ridley (*Lepidochelys olivacea*), the hawksbill turtle (*Eretmochelys imbricata*) and the loggerhead turtle (*Caretta caretta*). However more recent studies (Carr and Campbell 1995) as well as this study have found only three species nesting there: the leatherback, the green turtle and the olive ridley. With the exception of the Ningo people who have a totemic belief in sea turtles (Armah and Amlalo 1998) most coastal communities pose threats to turtle populations by slaughtering adult turtles for food and trading and egg poaching. Other mortality sources are dogs, pigs and sand-winning activities. Aims of the study: (1) record species and numbers of sea turtle nests; (2) assess effects of predation on the hatching success of olive ridley turtles (*L. olivacea*); and (3) collect information on breeding and reproduction of olive ridley turtles.

METHODS

The study was carried out between September 2001 and February 2002. Morning surveys were done on 3km of beach and number of fresh nests and species recorded. Of the olive ridley 30 nests were randomly chosen for close investigation. These nests were excavated and immediately after egg deposition clutch size, egg weight and diameter of 30 randomly chosen eggs per nest were noted. The 30 nests were monitored daily from day 49 after egg deposition. When hatching was encountered the nest was excavated for estimation of hatching success. The study area, Old Ningo, is located 35 km east of Accra, the capital of Ghana, and within the prime sea turtle nesting area on the coast of Ghana (Toth and Toth 1974, Carr and Campbell 1995).

RESULTS

Three species of sea turtles were found in the study area (Fig. 1). The olive ridley (*L. olivacea*) was most abundant with highest numbers of 78 nests on the 13.12.2001 and 60 nests on the 24.10.2001. The green turtle (*C. mydas*) and the leatherback turtle (*D. coriacea*) were nesting in low numbers. 67% out of the observed nests did not hatch (Fig. 2). All of these nests showed clear signs of depredation by dogs. The average hatching success for all olive ridley nests in the study area is 30%. The hatching success of non-depredated nests with 90% is relatively high, indicating that egg handling did not considerably reduce hatching success. Table 1 shows some data that were collected on the olive ridley.

CONCLUSIONS

The olive ridley found to be the most abundant sea turtle on Old Ningo beach has also previously been found nesting in highest numbers of all occurring species (Carr and Campbell 1995). Extrapolating the hatching success of the 30 nests studied in detail, 393 out of a total of 586 nests were completely destroyed by dogs. Given an average clutch size of 130, 76180 eggs were laid in the study area. In an undisturbed situation 90% of these would hatch. Thus predation by dogs prevented 46698 eggs (61.3%) from hatching. With 67% of the studied nests attacked by dogs a higher number of nests suffered from depredation than during a study by Carr (1994). He found that out of a total of 359 sea turtle nests 56.6% were attacked. In Old Ningo the major mortality source of eggs could be eliminated and the hatching success considerably increased by preventing turtle nest depredation by dogs.

LITERATURE CITED

Armah, A.K. and D.S. Amlalo. 1998. Coastal Zone Profile of Ghana. Gulf of Guinea Large Marine Ecosystem Project. Ministry of Environment, Science and Technology, Accra, Ghana. vii + 111p.

Carr, T. and C.L. Campbell. 1995, A management strategy outline for marine turtle conservation in Ghana. Appendix 1: Survey of the Sea Turtles of Ghana. Report to the Wildlife Department, Republic of Ghana, mimeogr., 23 p.

Fretey, J. 2001. Biogeography and Conservation of Marine Turtles of the Atlantic Coast of Africa. CMS Technical Series Publication No.6, UNEP/CMS Secretariat, Bonn, Germany, 429 p.

Toth, E.F. and K.A. Toth. 1974. Coastal national park selection survey for Department of Game and Wildlife. Unpubl. Report.

Table 1: Data on the olive ridley (*Lepidochelys olivacea*).

	Average	St Dev.
Clutch Size	130	15.68
Incubation Period	51.4 days	2.01
Midnest Depth	36.03 cm	6.73

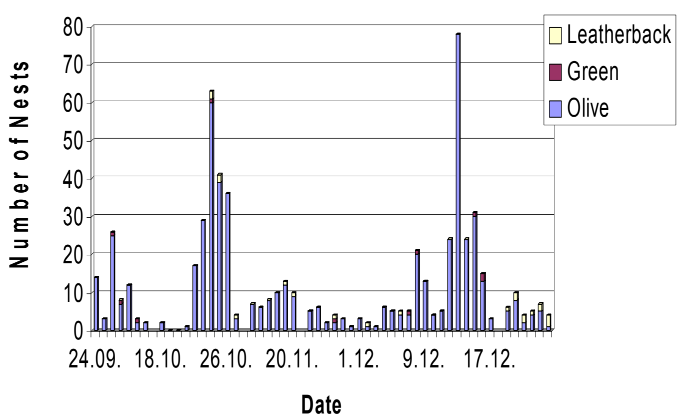

Fig. 1. Sea turtle nests per survey day.

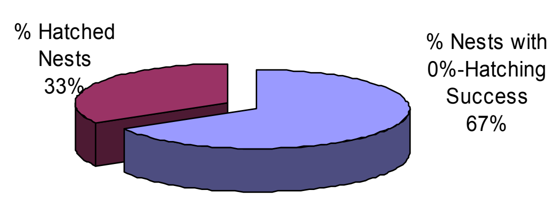

Fig. 2. Hatching success for 30 olive ridley nests.

Sea turtle nesting in black beach: a new nesting area in Costa Rica

Selene Bedoya, Brad Nahill, Henry Alguera, and Didiher Chacon

Associacion ANAI

The Playa Negra Sea Turtle Conservation Project began in March, 2001 as an effort of the conservation organizations working in Costa Rican's South Caribbean. Its objective is to improve the state of the turtles that nest, mate, and migrate in the region from March to October. The principal threats here are egg poaching, hunting, and coastal development. The protection, conservation, and education activities are focused on Playa Negra (9.39 N, 82.45 W), north of Puerto Viejo and the Puerto Vargas sector of Cahuita National Park and were based on patrols, tagging of females, collection and relocation of eggs, and data gathering. Within the results obtained, there were 436 nests, of which 80% were *Dermochelys coriacea*, 16% *Eretmochelys imbricata*, and 4% *Chelonia mydas*. We marked a total of 53 females with external tags and microchips, of which 49% were renesting *Dermochelys* females from the Northern Caribbean, Playa Negra, and Gandoca. This shows us that they are part of a colony that shares a portion of its females with other leatherback populations. We relocated 27% of nests, camouflaged 27%, and took 6% to the hatchery. About half of the nests survived the high tides and ghost crab (*Ocypode* sp.) depredation. At the beginning of the season, the poaching rate was estimated at 90%, which was reduced to 40% by the end of the season, a total reduction of 50%. The next steps are to expand in terms of personnel, investigation, and outreach, as well as creating economic alternatives for the community.

Marine turtle nesting in Machalilla National Park, Ecuador: comparing the monitoring made between 1996-2001

Maria-Jose Barragán

Jatun Sacha/CDC-Ecuador

Machalilla National Park is a protected area of Ecuador and is one of the primary marine turtle nesting areas in the country. From 1996 to 2001, a Marine Turtle Nesting Monitoring Program was carried out in the park and its surrounding areas. The research was conducted using a methodology in which we recorded all turtle activity on the beach. The recorded data included number of tracks/day/km and number of nests/day/km. The results show that there is very low nesting activity overall, with a slight peak from January to April. La Playita Beach had the highest number of tracks and nests during all periods of the year. Other beaches such as Los Frailes, Playa Dorada and Salango also had nesting activity, but at lower levels. Research about reproductive activities of marine turtles has been conducted in this zone, but the low amount of nests in this area are probably related with some threats which are affecting the turtles. The bycatch of marine turtles in artisanal fisheries nets could be one of the most important threats for sea turtles, however, this has yet to be evaluated. Fishermen and other local people have been involved in the monitoring program, in order to have local capability to maintain this monitoring in a long term.

Monitoring of leatherback turtles in Gabon

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Nesting sites. The Gabonese coast line stretches for nearly 950 km. The north of the country, where the coast consists of rocky parts, muddy beaches, coastal mudflats, mangroves and sandy islands, except some islets in the Baie of Corisco, is not often frequented by nesting leatherbacks. South of Libreville, apart from the Baie du Cap Lopez (one of the four main mangrove areas in Gabon) nesting sites are to be found all along the coast, especially south of Port Gentil where the littoral consists of long narrow sandy beaches, bordering lagoons of fresh and salt water, and interrupted by numerous outlets of lagoons and rivers.

Morphology and vegetation of the main nesting site. From the south of the town of Mayumba to the Congolese border, most of the length of the beaches is hemmed by the Atlantic ocean on one side and the relatively small Banio lagoon on the other side. The town Mayumba is situated near the outlet and the beaches south of the town are not much populated, apart from small camps. Those beaches consist of exposed, white leached sand; they are normally not wider than 80 m and are relatively steep (between 125 and 20%). Above the high water line (on 82 m width), we identified four formations of vegetation: in scattered vegetation: ground partially covered with herbaceous vegetation made up of low plants with long aerial or subterranean creeping stems (11 species in 8 families; *Canavalia rosea*, *Remirea maritima*, *Alternanthera maritima*, *Ipomoea stolonifera*) in low savanna: ground completely covered by dense herbaceous vegetation (26 species in 13 families) in thickets: mainly bushes and small trees lower than 2 m (23 species in 18 families; *Manilkara lacera*, *Ximenia americana*, *Dalbergia ecastaphyllum*) in groves: mainly trees and small trees higher than 2 m (26 species in 18 families)

Nesting frequency on Mayumba beaches. In 1999-2000 and 2000-2001, two extensive surveys named Nyamu Mission and financed by the European program ECOFAC (Ecosystemes forestiers di Afrique Centrale), allowed the monitoring of more than 85 km of beaches from the town of Mayumba to Congo.

Regular counts of nesting tracks were carried out during the nesting season and nesting females were tagged during nightly beach patrols. In 1999-2000, we estimated throughout the survey a nesting activity of 29700 nesting crawls of leatherbacks and, in 2000-2001 (Fig. 1), a nesting activity of 37150 nesting crawls. During the two nesting seasons, 209 leatherbacks were seen again once, 34 twice and 3 three times. The internesting interval was graphically estimated at 10 days (n=284) and we were able to provide an approximate estimation of clutch frequency of 4.736 (n=174, SD=2.137, range=2-11). By using this value of ECF and the estimations of the number of nests throughout the seasons, we have obtained an estimation of the breeding population of female leatherback turtles for the whole site of 6300 individuals in 1999-2000 and of 7800 in 2000-2001. The international interest of the whole site for the species is confirmed.

Biometry. During nightly beach patrols, 1930 leatherbacks were tagged in 1999-2000 and 2000-2001. The curved carapace length and width of 1874 females was measured. We calculated an average length of 151.6 cm (n=1874, SD=7.22, range=130-179) and an average width of 108.25 cm (n=1874, SD=4.62, range=86-132).

Threats to nesting females. This nesting season 2002-2003, the frequency of the logs lost on the beaches of the site is higher than the previous seasons and some females died, trapped in these blocks of woods. Slaughtering of nesting females is an important threat for leatherbacks on Mayumba beaches, but more worrying is industrial trawlnet fishing regularly practiced very near the coast without respect for the legislation in force. In 1999-2000, leatherback turtles which were victims to nets represented 5% of the carcasses counted, but, in 2000-2001, they represented 44% of the carcasses (see Fig. 2). Moreover, an extra 20% of the carcasses bore scars caused by propellers.

Monitoring of leatherback nesting beaches. An inventory of nesting sites all along the Gabonese coast will be carried out by combining in a GIS data from ground surveys, aerial and satellite photographs (SPOT or Landsat Thematic Mapper views). In regard to ground surveys, teams will be fitted out with cybertrackers (palmtop computer with a GPS receiver) to allow them to collect easily data with spatial components. Human data (group of dwellings, industrial concerns, farms, transport links, boats, logs) and environmental data (beach topography, coastal dynamics, coastal formations of vegetation, lagoons and rivers, rocks, mudflats) very useful for the monitoring of nesting habitats will be recorded thanks to these techniques.

Sea monitoring activities. During our field surveys on Mayumba beaches, we recognized incidental capture and mortality resulting from capture by fishing activities, as a threat to the leatherbacks' nesting on Gabonese beaches. The impact of local fishing practiced with nets along the length of the coast is not insignificant as regards the capture of marine turtles. In Gabon, 3500 people do local fishing; the fleet of pirogues is estimated at 1724 boats and among them, 73% are motorized (it is exceptional in all the Gulf of Guinea). In 1999, the captures of sea turtles were estimated at 32.1 metric tons (see Table 1). Industrial fishing activities (especially trawlnet fishing) are all the more worrying as some leatherback nesting populations have suffered an alarming decline due to this threat. In 1999, the industrial fleet of Gabon had 33 trawlers, 31 shrimp trawlers, 3 longline fishing vessels, 1 boat for lobster pots and 17 tuna boats. Reports on incidental captures currently come from ship owners through data sheets that they have to fill in for the national fishery services. Thus these data are not very reliable but are nevertheless pretty worrying: in 1999, captures of sea turtles were estimated at 391.6 metric tons (see Table 2). In order to know and restrain the impact of fishing activities on leatherbacks' nesting in Gabon, we recommend to carry out several studies. Observers fitted out with GPS receivers will participate in fishing campaigns on pirogues and on industrial boats. They will have to record data on fishing activities (date, fishing period, length, geographic location) and on possible incidental captures (turtle species, sex, biometry). At the same time, stranding data will be collected on nesting beaches by field teams, local residents, educators on standardized forms (date, turtle species, sex, biometry, geographic location...). Some leatherback females nesting on Mayumba beaches will be also equipped with satellite transmitters at the beginning of the nesting season. Thus we hope to know their geographical distribution at sea during the nesting season, a very important period of their life cycle, since a high number of breeding individuals is concentrated in a probably limited area. The previous data combined in a GIS should allow us to build connections between incidental captures, the geographic areas of fishing activities and the geographic distribution of nesting leatherbacks, and to identify the marine areas which are to be protected. We could also be able to propose a control on fishing activities in specific areas in certain periods of the year and to demonstrate the necessary use of TEDs to reduce incidental captures.

Acknowledgements. We are grateful to the people who have participated in the Nyamu campaign in 1999-2000 and 2000-2001, and to the organization ECOFAC that financed it. Thanks to the inhabitants of Mayumba who welcomed us. We especially thank Mr. Pambou Nyama, chief of the Cantonnement des Eaux et Forts de Mayumba. We thank the David and Lucile Packard Foundation and the Sea Turtle Symposium for accommodation and travel support.

Table 1. Captures of sea turtles (metric tons) by local fishing in 1999, by landing stages. A: Aviation; B: Coco beach; C: Port Nomba; D: Ombou¨; E: Gamba; F: Iguela; G: Port-Gentil; H: Mayumba.

Estuaire				Ogooué-Maritime					Nyanga		Total
A	B	C	total	D	E	F	G	total	H	total	
30.3	0	0	30.3	0	0	0	0.6	0.6	1.2	1.2	32.1

Table 2. Captures of fish, shellfish, mollusk and sea turtle by industrial fishing in Gabonese waters in 1999.

Species	Metric tons
Fish	6963.6
Shellfish	1330.3
Mollusc	93.3
Sea turtle	391.6
TOTAL	8778.8

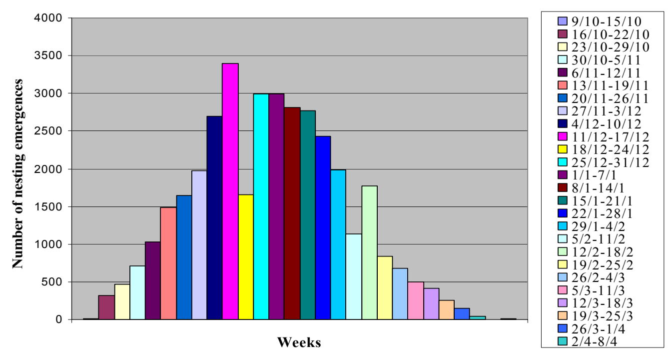

Fig. 1. Number of estimated leatherback nesting emergences per week on the whole site (85.5 km) from 9 October 2000 to 22 April 2001.

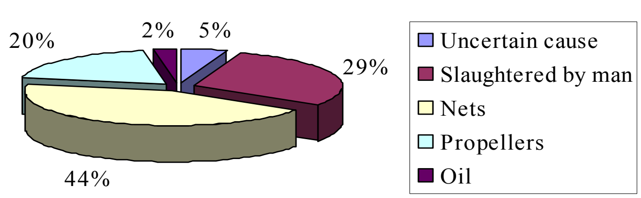

Fig. 2. Death cause frequency for the 41 carcasses of leatherbacks recorded on Mayumba beaches in 2000-2001.

The influence of nesting zone on the hatching and emergence success of green turtles (*Chelonia mydas*) in Tortuguero, Costa Rica

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INTRODUCTION

Favorable nest placement is important to the survival of sea turtle populations. Biotic and abiotic factors may influence offspring survival. The environment of the nest, including proximity to tidal zones and supralittoral vegetation, can influence the variables that affect nest success (Bustard and Greenham 1968). The location of nests in different zones may result in differential levels of mammalian predation or inundation rates or may expose nests to different sunlight levels, thereby affecting sand temperature and consequently sex ratios (Spotila et al. 1987). Consequently, the effects of these variables on the hatching and emergence success in relation to the location of the nests were evaluated

METHODS

Nests were marked between 10th June and 30th September 2001. All nests were classified into zones based on vegetation cover and exposure of the nest to sunlight (*Open* – complete exposure; *Border – Vegetation* - partial or no exposure). Data were collected on the northern 5 miles of the 22 mile beach from mile –2/8 to mile 5. Daily surveys of the marked nests were conducted from June to December 2001; poaching, predation, flooding by rainfall or seawater and other disturbances were noted. Nests were excavated after hatchlings had emerged or after the 70th day of the incubation period. The number of empty egg shells, pipped eggs, live and dead hatchlings, unhatched eggs without embryo, unhatched eggs with embryo, unhatched eggs with full embryo, depredated eggs, yolkless eggs, twins, deformed embryos and albinos were determined for each excavated nest. Only eggshells that were more than 50% of an egg were recorded as an empty eggshell. Additionally, sand temperature at 50cm was measured daily at the Caribbean Conservation Corporation field station.

To determine whether nest position on the beach had a significant effect on hatching survival the hatching and emergence success of the disturbed and undisturbed nests between the beach zones were estimated and compared using the Mann-Whitney U test. The sample size of the individual disturbance was too small to allow statistical analyses. Mann-Whitney U was also used to test the significance of the sand temperature between the zones. All tests were two-tailed and the cut off point for statistical significance was p=0.05.

Hatching success (HS) and Emergence success (ES) was calculated as:

$$HS = \frac{\text{no. of empty shells} \times 100}{\text{Total number of eggs}}$$

$$ES = \frac{\text{no. of empty shell - live hatchling} \times 100}{\text{Total number of eggs}}$$

RESULTS

Statistically there was no significant difference between hatching and emergence success of the disturbed nests in the open and border-vegetation. There was no significant difference between the hatching and emergence success of the undisturbed nest in the open and border- vegetation. Hatching and emergence success was significantly different in undisturbed and disturbed nests in the open zone, (hatching: W= 1002.5, p < 0.0001; emergence: W=950.0, p<0.0001). Hatching and emergence success was significantly different in the undisturbed and disturbed nests in the border-vegetation, (hatching: W=394.0, p <0.0001; emergence: W=419.5, p<0.0001). The average sand temperature at 50cm was significantly higher in the open than in the border-vegetation, W=52.5, p<0.05 (Table 1). Nests were found to be affected by both biotic and a biotic factors (Fig. 1). Nests in the open were affected more by washing over and washing out, due to high tides caused by heavy rainfall. While nests in the border-vegetation were affected more by biotic factors such as depredation, poaching and digging up by other turtles. However, inundation caused by a combination of flooding and heavy rainfall also affected nests in the border-vegetation. Although statistically there was no significant difference in hatching and emergence success between different zones, both were generally higher in the open (Figs. 2,3). An exception to this finding was found for washed over nests that had a high hatching and emergence success in the border-vegetation.

DISCUSSION

Nest position is important in the egg survivorship of *C. mydas*. Nests laid in the border-vegetation are disturbed more by biotic factors and inundation than nests in the open where they are greatly disturbed by heavy rains and high tides. In Tortuguero, inundation results from an interaction of the degree of water saturation on the beach and the height of the waves (Horiskoshi 1992). Disturbance reduces the number of eggs in the nest or removes them totally, as a result a reduction in the reproductive success of the turtle is caused. On average, the hatching and emergence success of the disturbed nests was less than one third of undisturbed nests. Although, not proven statistically, this lower hatching and emergence success of the disturbed nests appears to be directly related to the zones. Disturbance occurs in both zones but the type of disturbance varies with the location of the nests.

With respect to the undisturbed nest the hatching success is about the same in both zones but the emergence success is slightly higher in the open zone. The lower emergence success in the border-vegetation zone is partly due to hatchlings being trapped by the roots of vegetation thereby preventing them from emerging. Furthermore ants and other animals present in vegetation sometimes attacked hatchlings in the nests before they emerged. Hatching success may be affected by many factors, such as gas exchange with the incubation medium (sand) and between eggs within the nest, bacterial growth, sand particle size, sand and atmospheric temperature, as well as sand moisture. Though sand temperature was the only variable measured, the temperature in the open zone was significantly higher than in the border-vegetation in each month. This factor may partly explain the higher hatching success in the open. However, more factors have to be measured in order to prove this.

It appears that no particular zone is completely ideal for maximizing hatching and emergence success. Nests can be disturbed in both zones. Nevertheless, the type of disturbance differs with the zones. Also the severity of disturbance differs in the zones. Washed out nests have 0% hatching and emergence success, and most of the washed out nests occurred in the open zone which is closest to the high tide mark. It is therefore beneficial for a turtle to nest away from the high tide line. However, nesting too high up the beach leaves the nests vulnerable to predation and other biotic disturbances. It is likely that there is an optimal zone for nesting success that lies somewhere between these two extremes. More research is needed to evaluate this hypothesis.

Acknowledgements. This project was made possible through the corporation of the research coordinator and assistants of the CCC. The UWI Biological Society for financial support, and the bat crew for editing.

LITERATURE CITED

Bustard, H.R. and P. Greenham. 1968. Physical and Chemical factors affecting hatchlings in the green sea turtle, *Chelonia mydas*. Ecology 49:269-276.

Horikoshi, K. 1992. Egg survivorship and primary sex ratio of green turtles, *Chelonia mydas*, at Tortuguero, Costa Rica. Ph.D dissertation. University of Florida, Gainesville, Florida.

Lahanas, P.N., A. Bjorndal, A.B. Bolten, S. Encalada, M.M. Miyamoto, R.A. Valverde, and B.W. Bowen. 1998. Genetic composition of a green turtle *(Chelonia mydas)* feeding ground population: evidence for multiple origins. Marine Biology 130:345-352.

Spotila, J.R, E.A. Standora, S.J. Morreale and G.J. Ruiz. 1987. Temperature dependent sex determination in the green turtle *(Chelonia mydas)*: Effect on the sex ratio on a natural nesting beach. Herpetologica 43:74-81.

Table 1. Average sand temperature for the nesting season in open and border-vegetation zones.

Month (2001)	Open (°C)	Border-Vegetation (°C)
June	29.6	27.4
July	28.2	26.3
August	28.9	26.8
September	30.1	27.2
October	30.6	27.5
November	26.3	24.9

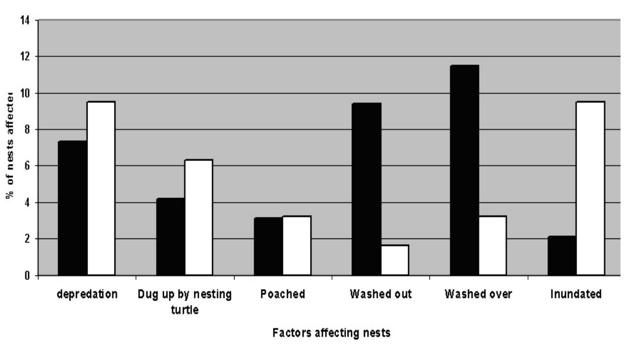

Fig. 1. Factors causing disturbance in nests.

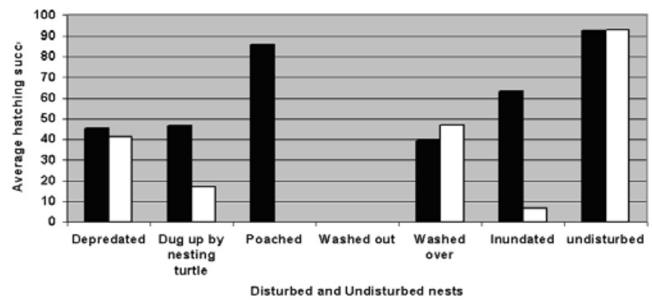

Fig. 2. Hatching success of disturbed and undisturbed nests in the open (black) and border-vegetation (white) zones.

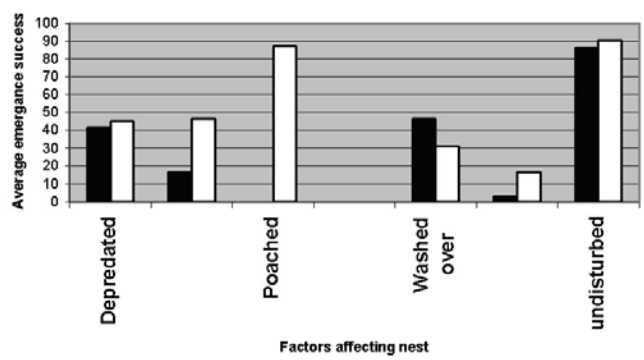

Fig. 3. Emergence success of disturbed and undisturbed nests in the open (black) and border-vegetation (white) zones.

Status of green turtle (*Chelonia mydas*) populations nesting in the French West Indies

Johan Chevalier[1] and participants to the Marine Turtle Conservation Program in the FWI[2]

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The French West Indies includes numerous islands located in the Lesser Antilles : Martinique, Guadeloupean Archipelago (Guadeloupe, Marie-Galante, Les Saintes), St Barthelemy and half of St Martin. A marine turtle conservation programs has recently started in all those islands. As in the initial stages of most new programs, one of the first objectives has been to review the population status of each nesting species. This work has brought attention to the case of the green turtle nesting populations. While most of the large nesting populations in the region (Aves, Tortuguero, Ascension) show an encouraging trend, the situation of this species on the beaches of the FWI is very critical. This poster presents a summary of the current and past status of the green turtle nesting populations of the French West Indies and emphasizes the importance of the nesting populations of this species in the marine turtle conservation programs of the Lesser Antilles.

Nesting of the hawksbill turtle in the southern Caribbean coast of Costa Rica

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INTRODUCTION

Palmer (1986), mentions that during the second half of the 18th Century, Afro-Caribbeans came to the Caribbean coast of Costa Rica from Bocas del Toro and the Nicaraguan coast, in search of turtles to catch, using harpoons. They arrived in March and left in September. They sold the carapaces in Bocas del-Toro, Panamá; to be exported to Germany and be used in the manufacturing of combs and buttons. Although there is little historical information before year 1950 and data is limited, Parsons (1962 mentioned in Groombridge and Luxmoore 1989) mentions that the annual catch of hawksbills around 1923 was 750 individuals. Groombridge and Luxmoore (1989) indicate that the area between Tortuguero and Matina, as well as the section between Cahuita and the Sixaola river host the greatest nesting of the species. There are three well-defined coral areas developed along the 212 km of coast between the borders to Nicaragua and Panamá: Uvita Island, Cahuita Point and the section Old Harbor-Monkey Point. Between the coral zones there are sandy beaches with varying stability (constantly eroding to very stable), rocky shores and mangroves (Fig. 1). The hawksbill sea turtle comes to shore for nesting and lay multiple clutches per season. Hawksbills turtles in the Caribbean typically produce 4 to 5 clutches at two weeks intervals. Males may breed annually, but females return to the nesting beach only after periods of 2 to 5 years. They begin feeding on benthic organisms and rare likely to remain sedentary for years or perhaps decades until reaching maturity an carapace lengths of 60 to 75 cm (van Dam 1997).

METHODS

Work began during the second week of February 1995. The Gandoca Beach, from the north side of Monkey Point to the mouth of the Sixaola River, was divided into 50 meter segments to facilitate mapping of the nests. The Black Beach, from the Cahuita Point to the Black Beach town, was divided into 90 meter segments. Each female encountered on the beach was tagged after oviposition, with a metal tag (monel 49). Tags were placed over the second axilar scale in the front flipper, following the methodology of Chacón et al. (1996). For each adult encountered on the beach some biometric parameters were taken according to the methodology in Eckert et al. (2000). When the monitors saw females, the nests encountered were examined directly digging the nest chamber and counting the eggs. Observations about the nests and nesting behavior were annotated. The monitors observed some nests around the season and check them after 60 days of incubation period.

RESULTS AND DISCUSSION

The hawksbill is rare in comparison with the abundance of green and leatherback turtles in Caribbean Costa Rica. At Gandoca Beach only over a hundred female nesters were counted during the period between 1995-2000 whilst on the same beach and period 1678 individual leatherback turtle were counted. It can be stated that the species nests inside, as well as outside of protected areas, that it likes to nest under vegetation and that nesting occurs from March to November. Since 1995 in Gandoca Beach and during the 2001 nesting season in Black Beach were collected the information of 148 nesting females, this data are presented in the Table 1. The CCL for Hawksbill Sea Turtles in Bay Islands and Cochinos Keys was 88,95 cm and the CCW was 79.28 (M. Arrone, pers. comm.); in Bocas del Toro region the Hawksbill Sea Turtles shows a CCL of 88,37 cm and a CCW of 73,43 cm (C. Ordoñez and I. Alvendas, pers. comm.). The nesting peak was placed in July. (Fig. 1). Meylan (1983) establishes the nesting season as May to November with a peak in May-June. Bjorndal et al. (1985) and Troëng et al. (2001) found that the species may show a nesting pattern with two reproductive peaks. The first in May to late July and the second around October.

The Hawksbill Sea Turtles in the Caribbean of Honduras (Bay Island and Cochinos Keys) shows a mean of 161 eggs/nest, in the case of Punta Manabique in Guatemala that data were 143 egg/nest and in Bocas del Toro region in Panama the clutch shows 121 eggs/nest. (M. Arrone, W. Katzs, C. Ordoñez and I. Alvendas, pers. comm.). Bjorndal et al. (1985) determined a mean of 158 eggs per nest (n=93, S.D.=29) with a range of 86-206 eggs, while Bravo (1983) determined the mean to 161 eggs/nest with a range of 56-206 eggs/nest. The range for nest size in the Caribbean is 101-161 eggs/nest (Meylan 1983). Hatching success has been documented by Chacón et al. (2001) as 91% for nests protected by REGAMA, whilst the success for natural nests from which hatchlings emerged was 58.3% with 91.6% of the nests producing hatchlings (Bjorndal et al. 1985). The nests in Utila Island, Honduras shows 81% of success rate (G. Pedersenn pers. comm.)

Tag returns from tags attached to nesting females in Gandoca shows a renesting interval of approximately 15 days for a maximum of three times, although the statistic mode is two times per season. The remigration range is between 2 and 3 years. On the other hand, Bjorndal et al. (1985) determined the period to be between 16 and 17 days for females nesting on the Tortuguero Beach. The last authors estimated that the mean number of days of incubation for the species is 58.5 days while this period was of 66.6 days for Gandoca Beach. Hawksbill nesting at REGAMA occurs with a mean of 5.5 nests per season for the period 1994-2000 (Chacón et al. 2001). Hawksbill nesting has been documented at Tortuguero National Park with a mean of 7.82 nests/season for the time period 1972-2000 (Meylan et al. 1997, S. Troëng, pers. comm.). Other areas such as Cahuita National Park, the beaches between Old Harbor and Monkey Point are areas where there exists nesting but where there has been no systematic or reliable nest data collection. Using data from Carr and Stancyk (1975), Bjorndal et al. (1993) and Unpublished Data from the Caribbean Conservation Corporation, Troëng (2001) concluded that the decline of the hawksbills along the north Caribbean coast of Costa Rica is -3.9%/year. With the information presented here the southern coast of Costa Rica confirmed that is the better region for the nesting Hawksbill Sea Turtle in the country, factor that is coincident with the kind of habitats present in the zone.

LITERATURE CITED

Bjorndal, K.A., A.B. Bolten, and C. Lagueux. 1993. Decline of the nesting population of hawksbill turtles at Tortuguero, Costa Rica. Conservation Biology 4:925-927.

Bjorndal K.A., A. Carr, A.B. Meylan, and J. Mortimer. 1985. Reproductive biology of the hawksbill *Eretmochelys imbricata* at Tortuguero, Costa Rica, with notes on the ecology of the species in the Caribbean. Biological Conservation 34: 353-368.

Bravo, E. 1983. The National Report. Western Atlantic Turtle Symposium. San José, Costa Rica. p. 131-142.

Carr, A. and S. Stancyk. 1975. Observations on the ecology and survival outlook of the hawksbill turtle. Biol. Conserv. 8: 161-172.

Chacón, D., W. McLarney, C. Ampie C. and B. Venegas. 1996. Reproduction and conservation of the leatherback turtle

Dermochelys coriacea (Testudines: Dermochelyidae) in Gandoca, Costa Rica. Rev. Biol. Trop. 44:853-860.

Chacón, D. 1999b. Informe de la temporada de anidación en playa Gandoca, temporada 1999. Asociación ANAI. Mi meografiado.

Chacón, D. 2001. Informe proyecto para la conservación de las tortugas marinas del Caribe Sur, Talamanca, Costa Rica. Asociación ANAI.

Eckert, K.A. et al. 2000. Técnicas de investigación y manejo para la conservación de las tortugas marinas. Grupo Especialista en TortugasMarinas UICN/CSE Publicación N° 4.

Groombridge, B. and R. Luxmoore. 1989. The green turtle and hawksbill (Reptilia: Cheloniidae): world status, exploitation and trade. Secretariat of the Convention on International Trade in Endangered Species of Wild Fauna and Flora.

Meylan, A. 1983. Biological synopsis on the hawksbill turtle (*Eretmochelys imbricata*). Proceedings of the Western Atlantic Turtle Symposium. STAO. San José, Costa Rica.

Meylan et al. 1997. Biology and status of the hawksbill in the Caribbean. IUCN/SSC Marine turtle Specialist Group, Washington, DC USA.

Meylan, A. 1997. Status of the hawksbill Turtle (*Eretmochelys imbricata*) in the Caribbean Region. Chelonian Conservation and Biology 3:177-184.

Palmer, P. 1986. "Wa happen man": la historia de la costa talamanqueña de Costa Rica, según sus protagonistas. San José. Instituto del libro. 402 p.

Troëng, S. 2001. Decline in the hawksbill turtle *Eretmochelys imbricata* in Caribbean Costa Rica. In: M. Coiné, comp. Proceedings of the Twenty-first Annual Symposium in Sea Turtle Biology and Conservation. Philadelphia, PA.

van Dam, R. 1997. Ecology of hawksbill turtles on feeding grounds at Mona and Monitor Island, Puerto Rico. Amsterdam. 118 p.

Table 1: Biometry of the hawksbill sea turtles in the southern coast of Costa Rica

n=148	CCL	CCW	Eggs
Value	85,9783	75,6818	152,921053
SD	5,57282	6,40042	36,3343197
Max	99	89	229
Min	77	65	95

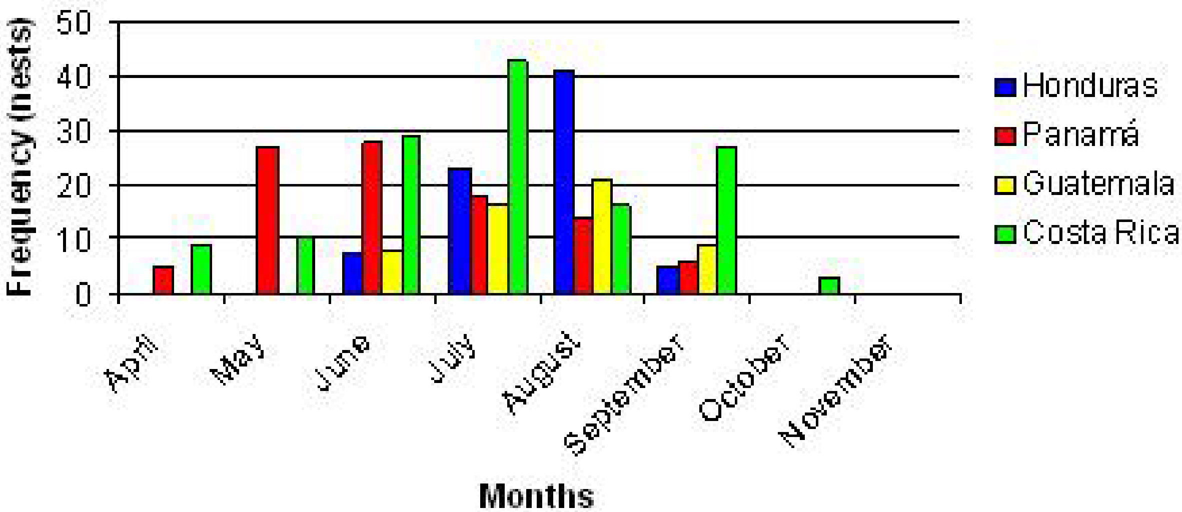

Fig. 1. Nesting season in the Southern Caribbean of Costa Rica and a comparison with others nesting rookeries in Caribbean coast of Central America.

Reproductive biology of the green turtle at the biological reserve of Atol Das Rocas off northeast Brazil

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The Biological Reserve Atol das Rocas (03° 45′S, 33° 37′W), 144 miles off northeast Brazil, is one of the nesting sites of *Chelonia mydas* in the West Atlantic. We analyzed reproductive data collected by the Projeto Tamar/IBAMA from 1990 to 2000. During the nesting season (December–June), 623 females were tagged reproducing in this area during the period. Reproductive activity peaked in March. The average of nests per female per season was 4,90 the most frequently recorded internesting period was eleven days (range 7-20 days). The clutch size ranged 50-193 (average=122.4 eggs) and the hatchling success was 73,39%. Incubation period ranged from 47 to 80 days (average 59 days). There was a clear preference for nesting in areas covered by vegetation and there was a statistically significant correlation between the size of the turtle and the nest site selection, larger turtles nesting mostly at vegetated sites. Half of the analysed females had a reproductive remigration interval of 3 years. The carapace length of green turtles nesting at the Atol das Rocas ranged from 1.0 to 1.34m (average 1.15m). Carapace length of reproductive turtles showed a statistically significant decrease (b=–0.003) from 1990 to 2000. We regard this length decrease as a possible recruitment of new reproductive females.

Factors disturbing leatherback turtles (*Dermochelys coriacea*) on two nesting beaches within Suriname's Galibi Nature Preserve

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Suriname, together with the surrounding Guianas, is host to the Atlantic's, and one of the world's largest nesting assemblages of the critically endangered Leatherback turtle, *Dermochelys coriacea* (Reichart and Fretey 1993, Godley and Broderick 2001). Up to half of the world's Leatherback turtles annually utilise Guianas beaches (WWF Guianas/ STINASU 2001).

In eastern Suriname, the Galibi Nature Reserve (GNR), located at the Marowijne River Estuary, encompasses Suriname's main nesting beaches (Reichart and Fretey 1993). During May-August of the 2001 nesting season, observations were made of factors likely to have a deleterious effect on Leatherback nesting activity and clutch development on two of Galibi's beaches, Samsambo and Baboensanti. This paper will describe the factors investigated.

FACTORS INFLUENCING NESTING BEHAVIOUR

Geomorphic factors. (a) Presence of coastal mudflats (Samsambo) restricted suitable nesting space and Leatherback activity (Mortimer 1979). Turtles became trapped in the mudflat during periods of low tide when they were arriving at or departing the beach. High tides enabled trapped turtles to swim free of the sticky mud. These turtles were often exhausted after enduring hours of sun exposure and bites from insects; (b) Flood cliff formation (Samsambo) often limited suitable nesting space to flood cliff bases during periods of high tide. Native vegetation made crawling over flood cliffs more difficult and many turtles could not nest; and (c) Periods of high tide (both sites) limited dry nesting space to higher beach regions, and prevented nesting on 4 evenings when tides were unusually high. Nest chambers were inundated during oviposition and eggs were dropped into the water.

Biotic factors. (a) *Ipomoea pes-caprae* vegetation (both sites) exists along much of the coastline, binding sand, making it difficult to uproot, which prevented Leatherbacks from nesting within vegetated areas. False crawls (aborted nesting efforts) were induced from vegetation presence unless sites free of vegetation were located.

Behavioral factors. (a) Intra-specific nest site competition (Baboensanti) can be problematic on high density nesting beaches, especially during peak nesting season when numbers of nesting females are high and nesting space is limited. Leatherbacks excavated developing clutches and oviposited within or beside existing nests.

Anthropogenic factors. (a) Photo-pollution (Baboensanti) from the "Warana Lodge" (tourist accommodation) attracted nesting females, which resulted in at least one false crawl when the turtle was unable to locate a suitable nesting site beside the lodge; (b) Dog disturbance (Baboensanti) came from a domestic dog attacking nesting females, biting their fore-flippers, especially during motion (beach entry/exit, body pitting and camouflaging). This dog may have induced false crawls.

NEST DEVELOPMENT

Geomorphic factors. (a) Beach erosion (Baboensanti) exposed eggs, increasing nest susceptibility to detection by egg predators, e.g., dogs. Low-lying nests were most affected; and (b) Tidal inundation (both sites) threatened nests deposited below the spring high tide line (SHTL). Eggs were submerged for extended periods (Horrocks 1992), leading to embryo suffocation and drowning. Increased salinity of high tides prevented normal egg metabolism and embryos in nests below the SHTL died at early develop-mental stages (Whitmore and Dutton 1985). Inundated nests did not eclose (hatch).

Biological factors. *I. pes-caprae* roots (both sites) influenced clutches in close proximity to the vegetation, through egg dehydration and/or encasement, which reduced hatch success. I. pes-caprae rapidly grows towards developing nests which provide nutrients to the plants otherwise leached substrate (Ruckdeschel et al. 2000).

Presence of bacteria's (black in colour) (Baboensanti) on and/or inside eggshells, made egg contents unrecognisable (contents had a thick, slimy appearance). Infested clutches contained small worms and nests did not eclose. Pink and purple bacteria's (both sites) on and/or inside eggshells, damaged but did not destroy clutches. Affected eggs (a proportion of the clutch) were 'clumped' together and did not hatch (Solomon and Baird 1979 Wyneken et al . 1988).

Insect depredation. Mole crickets (both sites) *Gryllotalpa* and *Scapteriscus* species (Reichart and Fretey 1993) are major egg predators in the GNR and depredated large numbers of eggs within the majority of nests. Fire ants (Baboensanti) were common in nests close to vegetation cover and preyed upon emerging hatchlings. Dead hatchlings formed 'plugs' blocking nest emergence to live hatchlings, increasing mortality rates. Dead hatchlings attracted dogs.

Behavioral factors. (a) *Nest-site selection.* Leatherbacks 'scatter nest' (Mrosovsky 1983), nesting at varying distances from the water. Many nests are deposited below the SHTL in the GNR and fail to hatch, whilst others deposited higher up the beach may hatch, unless buried too far from the water or too close to vegetation. Intra-specific nest site competition (Baboensanti). Later arrivals excavated developing nests, tearing open eggs, spilling their contents into nest chambers. This disturbance kills developing embryos through membrane dislodgement and the warm, damp environment encourages bacterial growth and may reduce hatching success; (b) *Inherent factors* - Low hatch rates. Suriname's Leatherback population naturally has a poorer hatch rate than other Leatherback populations and other turtle species nesting here (Whitmore and Dutton 1985), possibly due to the proportion of nests deposited below the SHTL. High rates of embryonic mortality were found.

Anthropogenic factors. (a) *Location and marking of nests* (both sites): The use of a metal 'probe stick' for locating nests pierced eggs, encouraging bacterial growth. Inserting data labels into nests disturbed them and many marked nests had low or zero hatch rates; (b) *Mammal depredation.* (1) Dogs (Baboensanti), both domestic and feral depredated turtle eggs and hatchlings. Eclosing nests were favoured (Fowler 1979). The opening of eggshells by emerging hatchlings releases potent odours for predator detection (D. Chacon, pers. comm.); (2) Egg poaching (both sites) by local Amerindians occurred throughout the nesting season, peaking during peak turtle activity. Army personnel stationed along the GNR deterred poaching but did not prevent it. Poaching was most common further away from settlements; (3) Fishing activities (both sites): drift and gill netting occurs within local waters. Dead Leatherbacks stranded on beaches and many showed evidence of having come into direct contact with fishermen. Mature females stranded with fishing ropes entangled around their limbs and/ or had holes in their carapace, where wooden sticks had been used to force them from fishing nets. Fore-flippers sported scars, possibly evidence for net entanglement.

CONCLUSIONS

This paper describes factors currently influencing Leatherback turtle breeding success in the GNR. Suriname's beaches are highly dynamic and their lifespan (suitability for nesting) is limited. Mudflat expansion may render Samsambo unsuitable for nesting during or beyond the 2002 nesting season. Baboensanti is more stable and may be suitable for longer. The shifting coastline provides alternative nesting sites for those lost. However, anthropogenic activities must be closely monitored and limited within the GNR to protect one of the world's most important nesting sites for the critically endangered Leatherback turtle.

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LITERATURE CITED

Fowler, L.E. 1979. Hatching success and nest predation in the green sea turtle, *Chelonia mydas*, at Tortuguero, Costa Rica. Ecology 60:946-955.

Godley, B. and A. Broderick. 2001. Recent change in the status listing of leatherback turtles (*Dermochelys coriacea*) and Mediterranean green turtles (*Chelonia mydas*). Marine Turtle Newsletter 93:34.

Horrocks, J.A. 1992. WIDECAST Sea turtle recovery action plan for Barbados. In: K.A. Eckert, ed. CEP Technical Report No. 12. UNEP Caribbean Environment Programme, Kingston, Jamaica.

Mrosovsky, N. 1983. Ecology and nest-site selection of leatherback turtles, *Dermochelys coriacea*. Biological Conservation 26:47-56.

Reichart, H.A. and J. Fretey. 1993. WIDECAST Sea turtle recovery action plan for Suriname In: K.L. Eckert, ed. CEP Technical Report No. 2. UNEP Caribbean Environment Programme, Kingston, Jamaica.

Ruckdeschel, C., C.R. Shoop, and G.R. Zug. 2000. Sea turtles of the Georgia coast (No. 1). Occasional Publications of the Cumberland Island Museum, Georgia, USA.

Solomon, S.E and T. Baird. 1979. The effects of fungal penetration on the eggshell of the green turtle. Electron Micro. 2:434-435.

Whitmore, C.P. and P.H. Dutton. 1985. Infertility, embryonic mortality and nest-site selection in leatherback and green sea turtles in Suriname. Biol. Cons. 34:251-272.

WWF Guianas/STINASU. 2001. Press Release: STINASU and WWF-Guianas host 5th Regional Marine Turtle Symposium. WWF Guianas/ STINASU, Suriname.

Wyneken, J., T.J. Burke, M. Salmon, and D.K. Pedersen. 1988. Egg failure in natural and relocated sea turtle nests. Journal of Herpetology 22:88-96.

Comparison of hatching success of *Caretta caretta* in 2000 and 2001 nesting seasons in the island of Boavista (Cape Verde, Western Africa)

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INTRODUCTION

Since 1998, a general study on the biology and conservation of the nesting population of *Caretta caretta* is being carried in the southeastern coast of Boavista island (Cape Verde, Fig. 1). During the 2000 season, up to 100 nests from the southeastern beaches of Ervatão and Ponta Cosme were incubated artificially to safeguard the survival of the eggs, because they were laid in non proper places as flooding areas or sand with roots of vegetation (García et al. 2000). However, in the 2001 season, no nest was incubated artificially. The nests from the closer beach of Calheta, have not been altered in any season, because previous experiences reported a high hatching success (Cejudo et al. 2000) and was used for comparisons.

The goal of this study is the general comparison of the hatching success of the nests incubated artificially in 2000 season, and those incubated in situ in 2000 and 2001 seasons, in the two beaches mentioned, and also the beach of Calheta.

MATERIAL AND METHODS

In July 2000, a hatchery of 225 m^2 was built in a beach closer to Ervatão and Ponta Cosme, as recommended by Mortimer (1999). Up to 100 clutches of *C. caretta* from those two beaches were reburied in the two following hours after they were laid by the female (Miller 1999), inside 45-cm-deep chambers, which was approximately the same depth as the ones observed in natural nests. Furthermore, 110 nests from Ervatão and Ponta Cosme, and 24 from Calheta, were tagged and monitored in their original places to compare with those incubated artificially. In the other hand, along the 2001 nesting season, 270 nests were tagged in the southeastern beaches of Ervatão (105), Ponta Cosme (141), and Calheta (24). After hatching, the nests were opened, and the number of empty shells and those not hatched were counted for further calculation of the hatching success as in Miller (1999).

RESULTS

If we compare the average hatching success in the three beaches studied, we see that in 2001 season, in the beach of Ponta Cosme there exists a low hatching success, while in Ervatão and Calheta this average is high (Fig. 2). The great majority of the females that emerge on the beaches studied, they do it on the beach of Ponta Cosme (Fig. 2), but only a small portion of them lays their eggs. In the beach of Calheta, this result is the opposite, where a small number of females emerge, but in a high percentage it finishes in nest.

The average hatching success is different also in the three beaches studied, with a higher value in Ervatão and Calheta (56.68% and 69.73% respectively) than in Ponta Cosme (22.98%, see Fig. 2). If we analyze now the beaches one by one, we see that in Ervatão there are no significant differences in hatching success in naturally incubated nests in 2000 and 2001 seasons, neither in those incubated artificially (Chi-square=1.8487, df=2, p=0.39), while there are significant differences in Ponta Cosme (Chi-square=56.4539, df=2, p<0.0001), due to the nests incubated artificially, which value is very similar to that obtained in Ervatão and Calheta (Fig. 3). As we can see in Fig. 2, while the beach of Ponta Cosme seems to be good for emerging the females, it appears to have not very good conditions for nesting neither for the incubation of the clutches, as the results of the nesting and hatching successes show. This was the reason why in 2000 season a hatchery was built. Those nests incubated artificially in 2000 season, from Ervatão and Ponta Cosme, show a relatively high percentage of hatching success, similar to that in Calheta (Fig. 3), where the nests were not relocated, and to those percentages we find in the literature (REFS).

DISCUSSION

The data from the 2001 season (with no nest incubated artificially), show how the hatching success in Ervatão and Calheta does not vary significantly from year to year, but in Ponta Cosme this value is even lower than in 2000 season. One explanation for this may be that in 2000 season, many of the nests from not proper locations were relocated (increasing the value of hatching success), and not in 2001, making the result of hatching success still lower.

The results of hatching success from Ponta Cosme, together with those in other works and the high numbers of females that emerge each year in this beach, make in some matter necessary the establishment of a program to incubate artificially as many nests as possible from this beach each year. This conservation effort could improve the hatching success. However, factors as the sex ratio resulted in the hatchery, the parasites and others, need to be beared in mind, in order to not alter important parameters of the sea turtles life cycle.

Acknowledgements. We thanks all the volunteers and people from Boavista who helped in this work, especially to Pedro López and Ana Pereira, and to Angelo Santana del Pino for statistical advice.

LITERATURE CITED

Broderick, A.C. and B.J. Godley 1996. Population and nesting ecology of the green turtle, *Chelonia mydas*, and the loggerhead turtle, *Caretta caretta*, in northern Cyprus. Zoology in the Middle East 13:27-46.

Cejudo, D., N. Varo-Cruz, I. Cabrera, and L.F. López-Jurado. 2000. Biology of nesting loggerheads in the island of Boavista (Cape Verde islands, Western Africa). In: H.J. Kalb and T. Wibbels, comps. Proceedings of the Nineteenth Annual Symposium on Biology and Conservation. NOAA Tech. Memo. NMFS-SEFSC-443. p. 244-245.

García, M., B. Peña, E. Abella, L. Ballell, B. Madariaga, M. Lozano, A. Díaz-Merry, S. Borrás, X. Ruiz, O. López, N. Nuez, J. Hidalgo, N. Pérez, N. Varo-Cruz, D. Cejudo, and L.F. López-Jurado. 2000. Hatching success in natural and relocated nests of loggerhead in the island of Boavista (Cape Verde islands, Western Africa). In: M. Coyne, comp. Proceedings of the Twenty-first Annual Symposium on Sea Turtle Conservation and Biology. Philadelphia, USA.

Miller J. D. 1999. Determining clutch size and hatching success. In: K.L. Eckert, K.A. Bjorndal, F. Abreu-Grobois, and M. Donnelly, eds. Research and Management Techniques for the Conservation of Sea Turtles. IUCN/SSC Marine Turtle Specialist Group Publication No. 4.

Mortimer J. A. 1999. Reducing threats to eggs and hatchlings: hatcheries. In: K.L. Eckert, K.A. Bjorndal, F. Abreu-Grobois, and M. Donnelly, eds. Research and Management Techniques for the Conservation of Sea Turtles. IUCN/SSC Marine Turtle Specialist Group Publication No. 4.

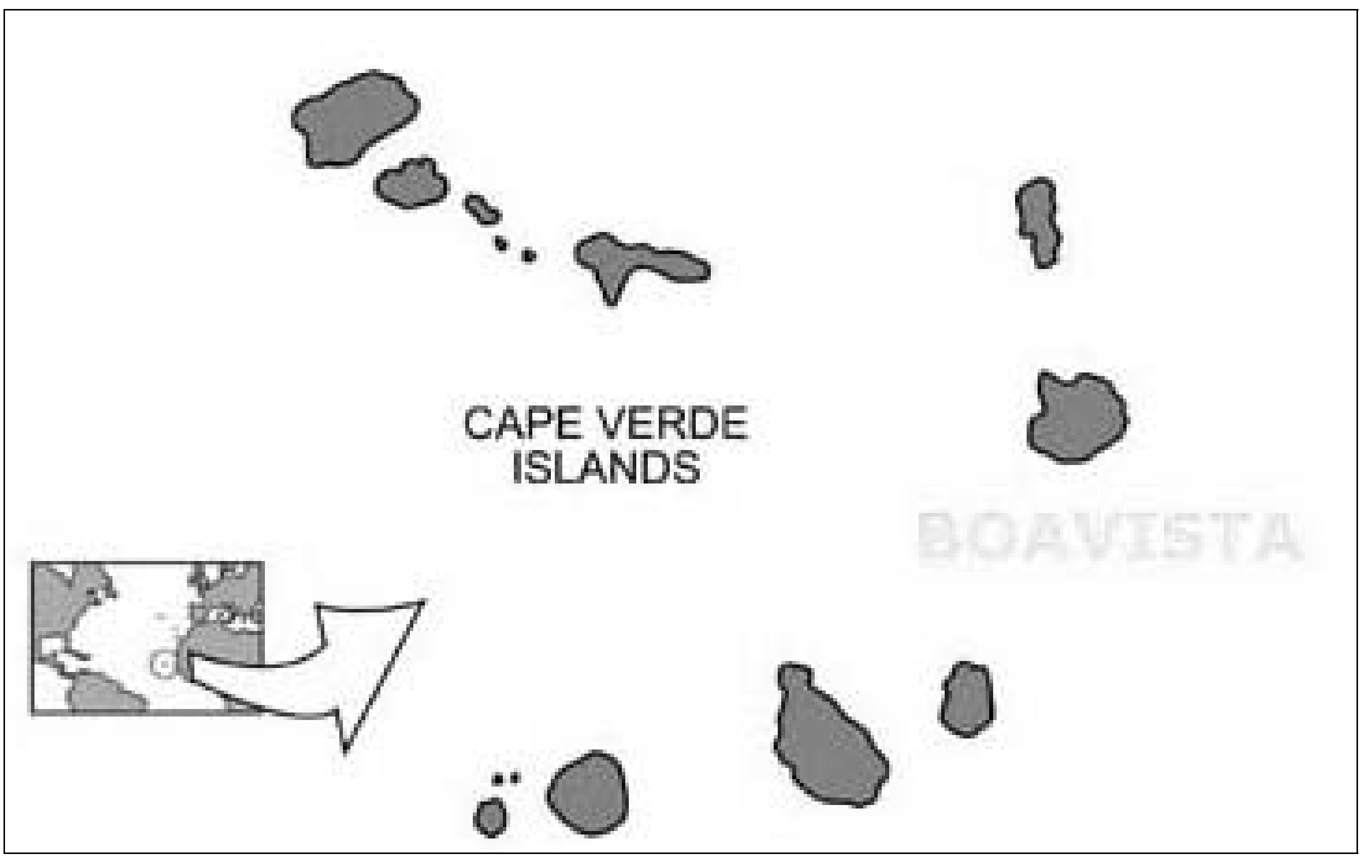

Fig. 1. Map showing the location of the Cape Verde archipelago and Boavista.

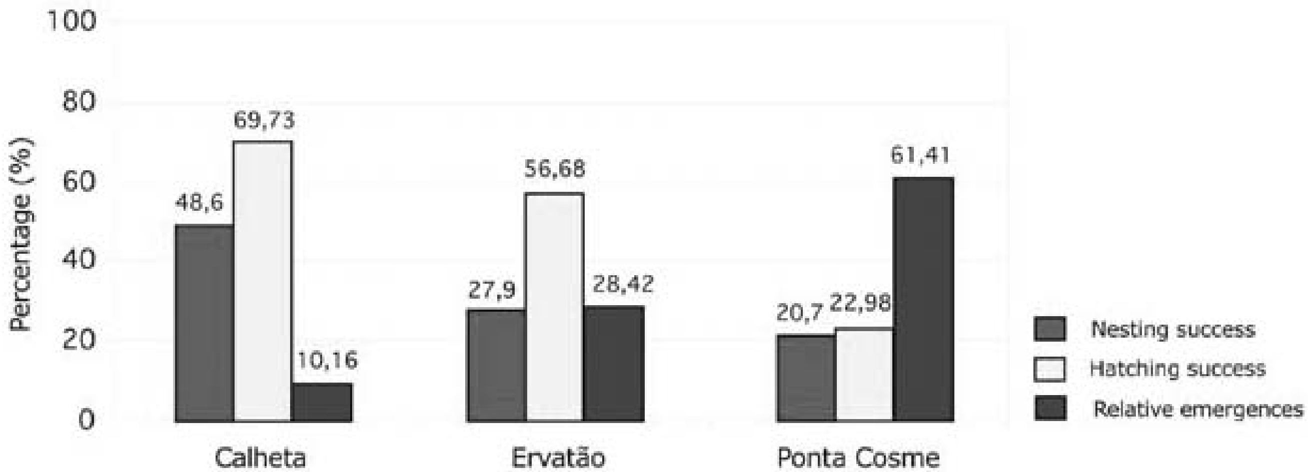

Fig. 2. Nesting success, hatching success and percentage of females emerged in the three beaches studied during the 2001 season.

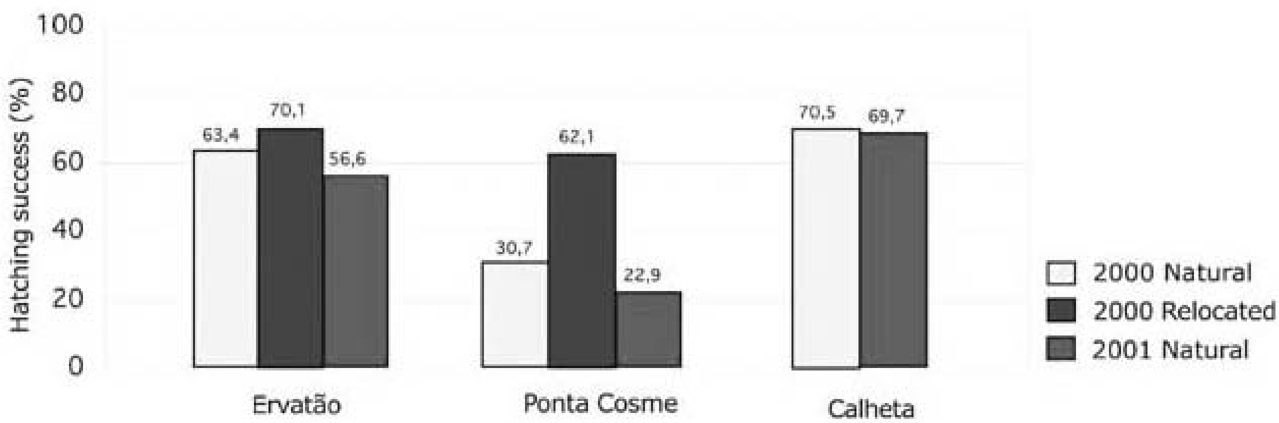

Fig. 3. Hatching success in nests incubated in situ in 2000, artificially incubated in 2000, and in situ in 2001 season, in the three beaches studied.

Comparison of five soil compaction measurement devices

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Beach renourishment has the potential to affect the biology of sea turtles by changing various aspects of their nesting environment such as beach slope, soil compaction, shear resistance, particle size and shape, color, temperature, density, moisture content, and mineral content. Renourished beaches that are thought to be too densely compacted, and therefore perceived as a hindrance to successful sea turtle nesting, can be softened by a process known as tilling. The decision to till a beach after it has been renourished is based upon measurements of sand compaction. However, the standard instrument used for obtaining these measurements—the cone penetrometer—has been shown to be dependent on the mass of the person using the instrument in densely compacted substrates. This study compares five different instruments used to measure soil compaction and shear resistance to determine the strengths and weaknesses of each and to ascertain which instrument, if any, is the most efficient and reliable. The instruments used in this investigation include the cone penetrometer, Lang penetrometer, Eijkelkamp penetrometer, soil compaction tester, and shear-testing device. Twenty reading were taken with each instrument in three different grain sizes of sand (coarse, medium, and fine) using a Latin-square design, standardized, and analyzed using a two-way ANOVA. We also compared the precision and the accuracy of each instrument, and we compared the instruments in terms of their cost, the relative time and effort required to use each instrument, and the amount of maintenance required to keep each instrument functional.

Status of marine turtle conservation on the southern beaches of Bioko Island, Equatorial Guinea

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Four species of sea turtles were studied on 19 km of beaches in southern Bioko Island, Equatorial Guinea, for a three and a half month period from November 2000 through April 2001. The species observed included the green turtle (*Chelonia mydas*), the leatherback turtle (*Dermochelys coriacea*), the olive ridley turtle (*Lepidochelys olivacea*), and the hawksbill turtle (*Eretmochelys imbricata*). Leatherback nests were the most abundant observed during this study; a total of 4600 were recorded. The green turtle was second with 1388 nests observed. The olive ridley (58 nests) and the hawksbill (2 nests) were least abundant. This data were compared to data collected by Tomas, Castroviejo and Raga during the same period in previous seasons. Based on this data there has been an increase in the number of recorded nests of the leatherback. The olive ridley and green turtle number of nests have remained constant, but the hawksbill nesting abundance has decreased.

Effects of natural and human threats on the loggerhead sea turtle population, *Caretta caretta*, on Masirah Island, Arabian Sea, Oman

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A single large nesting ground of loggerhead sea turtles, *Caretta caretta* (Linnaeus 1758), is on Masirah Island that holds the largest population of the World (Ro 1979, U. S. Fish and Wildlife Service and National Marine Fisheries Service 1993). This Island, has 52 Km long and is placed Southeastern Coast of the Arabian Peninsula at approximately 20º 30′ N and 58º 45′ E, in the Northern Indian Ocean.

During the 2001 nesting season (May-July), 52 loggerheads were sampled on the Northeast of Masirah Island, where 30 of them had injuries of direct boat collisions, shark attacks, violent contact with rocks and other underwater substrate accidentally encountered, and also known to result from fishing activities: 17 turtles had the shell damaged, 10 had the flipper(s) cut off, 2 had broken shells and 1 was caught with a fish hook in the skin. Sampling was conducted while the turtle was nesting or covering the nest site.

Turtles are threatened both on land, while nesting or as eggs and hatchlings, and at sea. Threats to loggerheads imposed by natural predators and human disturbance on turtle nesting beaches were identified. Depredation by natural predators was classified into two categories: potential predators of nests and potential predators of hatchlings. The occasional flooding of eggs by high tides and beach erosion, triggered by seasonal changes in wind and wave direction is also a critical natural threat to loggerhead sea turtle population. Human and fishery-related activities on the area were also registered.

Final Considerations. In order to stem the destruction of the sea turtle's nesting areas, has implemented restrictive legal measures in one beach with 3 km and a ranger station was also built in 1991 to support ranger activities. Clearly, there is the need to protect turtles from harm during all phases of life, and the absence of reliable data on marine turtle biology, their habit, nesting and feeding habitats and predation rates will continue to hinder conservation efforts. Directly related to these goals is the need to control predators and accidental capture. Harvest brings in both national and regional political issues, as it needs to be controlled in Oman, in international waters, and in the seas of nations through which the turtles migrate. Underlying all these activities is the need for focused scientific research.

Acknowledgements. We are grateful to the Directorate General of Nature Conservation/Ministry of Regional Municipalities and Environment of the Oman We also thank the Packard Foundation and the Sea Turtle Symposium for support.

LITERATURE CITED

Ross, J.P. 1979. Sea turtles in the Sultanate of Oman. Manuscript Report of IUCN/WWF Project 1320. 33 p.

U.S. Fish and Wildlife Service and National Marine Fisheries Service. 1993. The Loggerhead/Green Turtle Recovery Plan for U.S.: population of Loggerhead (*Caretta caretta*). Atlanta, Georgia and Washington: Southeast Region of the U.S. Fish and Wildlife Service and National Marine Fisheries Service. 64 p.

Clutch frequency of the Michoacan black sea turtle

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Black turtle nesting data registered between 1994 and 1998 at Colola beach (Michoacan, México) were used to calculate observed (OCF) and estimated clutch frequency (ECF). Mean OCF was 2.5 (range= 1 - 6, N=250) and mean ECF was 3.2 (range= 1 - 8, N=250). Both OCF and ECF were not significantly different between years. There was no correlation between carapace length and clutch size with ECF. Michoacan black turtle population size estimates have been calculated using observed nesting frequency values. Difference between OCF and ECF values herein reported indicates that black turtle population numbers are lower than reported and should be adjusted using ECF values.

Human and natural threats to the green turtles, *Chelonia mydas*, at Ra's al Hadd turtle reserve, Arabian Sea, Sultanate of Oman

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The green turtle is ubiquitous in the Sultanate and is the most commonly encountered marine reptile (Salm 1991). An estimated 50,000 to 60,000 green turtle egg clutches are laid each year in the Sultanate – the effort of about 20 000 turtles, or more. This gives Oman probably the greatest number of nesting green turtles, classified as Endangered specie worldwide, of any single Indian Ocean nation (Groombridge 1982). The vast majority of nesters are concentrated along a relatively short stretch of coastline between Ra's Al Ru'ays and Ra's Al Hadd. This area is of very high conservation value (Salm and Salm 2001).

Between July and August 2001, 15 dead turtles were found on the beach from Ra's Al Hadd to Ra's Al Ru'ays. When possible, the cause of death was determined. Most of the turtles were found after fishermen holidays in the beginning of the fisheries season. Possible causes of death were accidental drowning in trawl nets, boats collision due to the observed sections of the carapace broken and shark attacks. Most of the female turtles had marks on the carapace due to mating with males.

Of the human pressures, fishery-related threats are particularly severe. Most of Green Turtles in Ra's al Hadd suffer mortality as a result of incidental capture in fishing gear. Additional incidental loss or mortality is caused by, set nets and fish that prevent females from reaching nesting beaches, trapping of hatchlings in gill nets spread over beaches for maintenance and fishermen houses, direct collision of juveniles and adults with fishing boats and vehicles used by fishermen on nesting beaches destroy eggs and also damage vegetation, leading to increased beach erosion.

Other human activities, such as recreation and general coastal development, increasingly threaten turtle populations. Use of bright lights, patrolling of beaches and use of torches and camera flashes by turtle-watchers and group tours and littering of beaches are the most encountered recreation related threats in Ra's Al Hadd. The village of Ra's al Hadd is expanding seaward towards an important nesting beach, and its electrification is a critical problem for nesting turtles and their hatchlings in particular. Other human related threats such as ingestion of litter at sea, pet dogs that dig for eggs and sand mining by Omani workers are also critical to this marine turtle specie. Natural threats mostly affect eggs, hatchlings and juveniles. Adult turtles with missing flippers and sections of shell were recorded and also the damage attributed to shark attacks. On nesting beaches eggs and hatchlings are preyed upon by foxes, crabs, gulls and other bird species, ravens, and other predators. The occasional flooding of eggs by high tides, beach erosion, parasites and diseases are also critical natural threats to the green turtles in this area.

Green Turtles in Ra's Al Hadd Turtle Reserve are threatened by an assortment human activity as well as by natural processes and events. Although this turtles have been the subject of general surveys and a tagging project, which began in 1977, there has been little investigation of their management needs. While there are some general provisions for the protection of turtles at the national level, most specific conservation action has resulted from management issues at specific sites. The turtle beaches in the Ra's Al Hadd area have received most attention (Salm 1989). Clearly, turtles need to be protected from harm during all phases of their lives, and their critical nesting and feeding habitats need to be safeguard against destruction. Directly related to these goals is need to control predators, accidental capture, and deliberate harvest of turtles. Harvest brings in both national and regional political issues, as it needs to be controlled in Oman, in international waters, and in the seas of nations through which the turtles migrate. Underlying all of these activities is the need for focused research that will provide a sufficient scientific basis for management of the Ra's Al Hadd area turtle population (Salm 1989).

The Ra's Al Hadd – Ra's Al Junayz area is recognized as a valuable national heritage for its archaeological sites, and to be of extreme national, regional and global importance for its nesting turtles. The area requires conservation management to safeguard its valuable resources in the sea and on land, particularly the breeding stocks of turtles, and their nesting and feeding habitats, for the benefit of current and future generations of citizens.

Acknowledgements. We thank to the Directorate General of Nature Conservation, Ministry of Regional Municipalities, Environment and Water Resources of the Sultanate of Oman and its network of Park Rangers at Ra's Al Hadd, for the collaboration carried out at the fieldwork. We also thank the Packard Foundation and Sea Turtle Symposium for the travel support.

LITERATURE CITED

Groombridge, B. 1982. The IUCN Amphibia-Reptilia Red Data Book. Part I: Testudines, Crocodylia, Rhynchocephalia. IUCN. Gland, Switzerland.

Salm, R. 1989. Turtle beach management Ra's Al Hadd area: A proposed management plan for the turtle nesting beaches in the Ra's Al Hadd National Scenic Reserve and Ra's Al Junayz National Nature Reserve. Prepared for the Ministry of Commerce and Industry. IUCN. 57 p.

Salm, R. 1991. Turtles in Oman: Status, threats and management options. Muscat: Manuscript report of IUCN/WCU Project.

Salm, R. and S. Salm. 2001. Sea turtles in the Sultanate of Oman. 2nd Ed. Revised by Baldwin, R. and Al-Kiyumi, A. The Historical Association of Oman. Sultanate of Oman. 48 p.

Nest predation at a high density leatherback nesting beach

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The beach of Awala-Yalimapo in western French Guiana is a high density nesting beach for leatherback sea turtles. In the 2001 nesting season (March through August), we investigated the impact of different predators on leatherback eggs. The main predators of eggs that we identified were dogs, vultures, crabs and mole crickets. Regular surveys along the nesting beach revealed spatio-temporal variation in both predation events and also absolute numbers of predators. Based on our findings in the 2001 nesting season, we make recommendations for management of this nesting beach, and also for future studies related to nest predation.

Sea turtle monitoring activities in the Laguna de Tacarigua National Park, Miranda State, Venezuela: 2001 Nesting Season

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INTRODUCTION

In this area four endangered species of marine turtles deposit nests: leatherback turtles (*Dermochelys coriacea*), green turtles (*Chelonia mydas*), hawksbill turtles (*Eretmochelys imbricata*) and loggerhead turtles (*Caretta caretta*) (Rodriguez and Rojas-Suarez 1999). This study is following recommendations of the "Sea Turtle Recovery Action for Venezuela" (Guada and Sole 2000).

METHODS

Surveys for the monitoring of the nesting of the sea turtles were made in the Laguna de Tacarigua National Park, with the participation of eight Park rangers, between May to September 2001.

RESULTS AND DISCUSSION

The tracks of three sea turtle species were registered: *D. coriacea*, *E. imbricata* and *C. caretta* (Fig. 1). A total of 10 nests was found and the main part of them were from *D. coriacea* (Fig. 2). The number of tracks and nests during 2001 was higher than in previous years (Gómez et al. 2002).

Data on nesting success were registered, as well as the possible factors affecting the nesting of the sea turtles in the area. In addition, during the surveys two turtle carcasses were found, one of a juvenile loggerhead turtle and one of an adult leatherback turtle. The effort invested in the sea turtle monitoring activities during 2001 were 40 h/man (40 days).

CONCLUSIONS

(1) The results suggest it may be necessary to translocate nests to higher areas of the beach for the 2002 nesting season to increase the hatching success; and (2) the nesting of the sea turtles in the Laguna de Tacarigua National Park has increased during 2001.

Acknowledgements. The financial support to present this poster was provided by David and Lucile Packard Foundation and the National Fish and Wildlife Foundation.

LITERATURE CITED

Gómez, F., J.D. Alvarez, J. Navarro, Y. Vargas, J. Melchor, A. Lara, and R. Infante. 2002. Parque Nacional Laguna de Tacarigua. Informe interno de INPARQUES. 10 p.

Gómez, F., A. Arteaga, J.D. Alvarez, and H.J. Guada. 2002. Results of the 1998 and 1999 sea turtle monitoring activities in the Laguna de Tacarigua National Park, Venezuela. In: A. Mosier, A. Foley, and B. Brost, comps. Proceedings of the Twentieth Annual Symposium on Biology and Conservation. NOAA Tech. Memo. NMFS-SEFSC-477.

Guada, H. and G. Solé. 2000. WIDECAST Plan de Acción para la Recuperación de las Tortugas Marinas de Venezuela. In: A. Suarez, ed. Informe Técnico del PAC No. 39.. UNEP Caribbean Environment Programme. Kingston, Jamaica. xiv + 112 p.

Rodríguez, J.P. and F. Rojas-Suárez. 1999. Libro Rojo de la Fauna Venezolana. PROVITA, Fundación Polar. Segunda Edición. Caracas. 421 p.

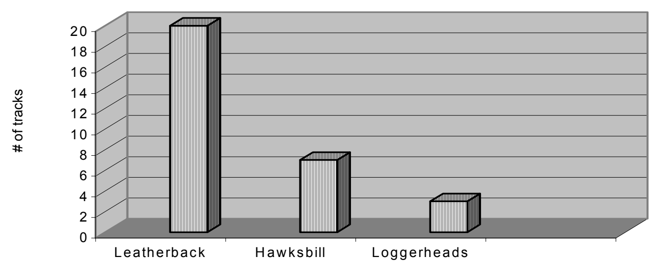

Fig. 1. Number of tracks for each marine turtle species in study area.

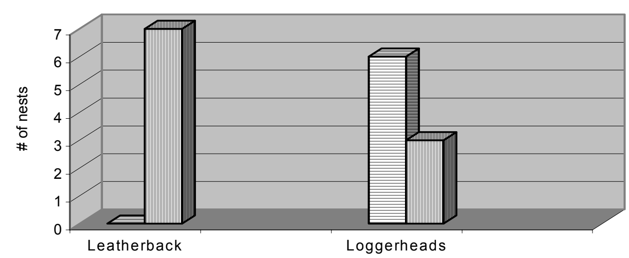

Fig. 2. Nesting trends of the sea turtles in the Laguna de Tacarigua National Park, 2000 (left) and 2001 (right).

Preliminary results of a leatherback PIT tagging program in Suriname, South America

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INTRODUCTION

Present leatherback (*Dermochelys coriacea*) nesting abundance in Suriname is among the highest world-wide, with an estimated 30,000 nests laid in 2001. Passive Integrated Transponder (PIT) tagging of leatherback turtles in Suriname started in 1999, following the PIT tag program in French Guiana (Chevalier and Girondot 2000, Girondot and Fretey 1996). The long term objectives of the PIT tag program in the Guianas are delimitation of the leatherback population and estimation of population size and trends. If carried out long enough, the tag program should yield information on (changes in) population size, the fraction of first time nesters, remigration rates and intervals, mortality at sea, and internesting frequency and intervals (McDonald and Dutton 1996, Spotila et al. 1998, Steyermark et al. 1996). Preliminary results of the 2001 nesting season are presented. We made an estimate of the total number of leatherback females that visited the Surinam beaches.

MATERIALS AND METHODS

In the Guianas, TROVAN ID100 tags are used. PIT tags are injected in the muscle of the right shoulder of nesting leatherback females. Scanning and tagging are done during all stages of the nesting process. A distinction is made between a new tag (just applied) and old tag (recapture). In 2001, Babunsanti was covered the entire peak leatherback nesting season, the other beaches were covered only shortly.

RESULTS

In 2001, we PIT tagged 2460 leatherbacks and recorded 2076 recaptures on 4 beaches (Fig. 1). We identified a total of 2926 individuals. Of these, 2460 were tagged by us and 466 were leatherbacks that already had a PIT tag. Of these 466, 442 turtles carried tags not originating from Suriname. It is likely that these turtles had been tagged in French Guiana during either the 2001 nesting season or before. Some may have been tagged in Guyana. The total number of observed remigrants from the 62 turtles tagged in 1999 was 25 individuals, three of which were reported from French Guiana (P. Rivalan, pers. comm.). Two turtles from 2000 were observed and we encountered one turtle with Monel tags from Trinidad. Of all observed leatherback individuals, 66% were seen once and 34% were seen twice or more. Mean internesting period was around 9-11 days. Internesting periods of 1-4 days were interpreted as false crawls. Out of 2926 individuals, 47 turtles (1.6%) were observed nesting on two or more beaches throughout the season. Due to the limited coverage of three of the study beaches (Babunsanti was the only beach covered the whole season) this number of 47 turtles is likely to be an under-estimate.

DISCUSSION

The strong increase of total tag records from 74 in 1999 to 4536 in 2001 is caused by a much increased and improved tag effort (more equipment, more field personnel, a strict every-night PIT tag protocol) and a strongly increased leatherback nesting population and presence of a new high density nesting beach. The PIT tag data demonstrate that at least 2926 leatherback females have nested in Suriname in 2001. Incomplete beach coverage and the obtained data (e.g., on observation frequency) indicate that at least 50% of the leatherbacks were missed. The size of the 2001 nesting cohort is estimated to be at least 5500 individual leatherback females. From 62 turtles tagged in 1999, 40% were observed again in 2001. Remigration may in fact be substantially higher given the high fraction of missed turtles. From our data, it is too early to be able to estimate mortality rates of females at sea. Turtles from the 1999-cohort that did not nest in 2001, may still return in 2002, 2003 or later, or be nesting elsewhere. Shifting of turtles between countries, and over nesting seasons, was found to occur on a regular basis (15% of the leatherbacks had been tagged elsewhere). This confirms assumptions made by Schulz (1975), Fretey and Girondot (1990), M. Girondot and P. Rivalan (pers. comm.) and Hilterman (2001) and Hilterman and Goverse (2002) that season to season returns from the Surinam rookery to French Guiana and vice versa may take place frequently. Continued use of PIT tags in a long-term tagging program that includes all regional leatherback beaches is needed to improve estimates of remigration and mortality.

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LITERATURE CITED

Chevalier, J. and M. Girondot. 2000. Recent Population Trend for *Dermochelys coriacea* in French Guiana. In: F.A. Abreu-Grobois, R. Briseño-Dueñas, R. Márquez-Millan, and L. Sarti-Martinez, comps. Proceedings of the Eighteenth International Sea Turtle Symposium. NOAA Tech. Memo. NMFS-SEFSC-436. p. 56-57.

Fretey, J. and M. Girondot. 1990. Numbering and Tagging of Leatherbacks for Four Years on French Guiana Beaches. In: T.H. Richardson, J.I. Richardson, and M. Donnelly, comps. Proceedings of the Tenth Annual Workshop on Sea Turtle Biology and Conservation. NOAA Tech. Memo. NMFS-SEFSC-278. p. 201-204.

Girondot, M. and J. Fretey. 1996. Leatherback Turtles, *Dermochelys coriacea*, Nesting in French Guiana, 1978-1995. Chelonian Conservation and Biology 2:204-208.

Girondot, M., J. Fretey, I. Prouteau, and J. Lescure. 1990. Hatching success for *Dermochelys coriacea* in a French Guiana hatchery. In: T.H. Richardson, J.I. Richardson, and M. Donnelly, comps. Proceedings of the Tenth Annual Workshop on Sea Turtle Biology and Conservation. NOAA Tech. Memo. NMFS-SEFSC-278. p. 229-232.

Hilterman, M.L. 2001. The Sea Turtles of Suriname. 2000. Guianas Forests and Environmental Conservation Project (CFECP). Technical Report World Wildlife Fund (WWF)/Biotopic Foundation, Amsterdam, 63 p.

Hilterman, M.L. and E. Goverse. 2002. Aspects of nesting and nest success of the leatherback turtle (*Dermochelys coriacea*) in Suriname, 2001. Guianas Forests and Environmental Conservation Project (CFECP). Technical Report, World Wildlife Fund (WWF)/Biotopic Foundation, Amsterdam. 33 p.

McDonald, D.L. and P.H. Dutton. 1996. Use of PIT tags and photoidentification to revise remigration estimates of leatherback turtles (*Dermochelys coriacea*) nesting in St. Croix, U.S. Virgin Islands, 1979-1995. Chelonian Conservation and Biology 2:148-152.

Schulz, J.P. 1975. Sea Turtles Nesting in Surinam. Zoologische Verhandelingen. No. 143. E.J. Brill, Leiden, The Netherlands. 143 p.

Spotila, J.R., A.C. Steyermark, and F.V. Paladino. 1998. Loss of Leatherback Turtles from the Las Baulas Population, Costa Rica, from 1993-1998: Causes and Corrective Actions.
Steyermark, A.C., K. Williams, and J.R. Spotila, F.V. Paladino, D.C. Rostal, S.J. Morreale, M.T. Koberg, and R. Arauz. 1996. Nesting leatherback turtles at Las Baulas National Park, Costa Rica. Chelonian Conservation Biol. 2:173-183.

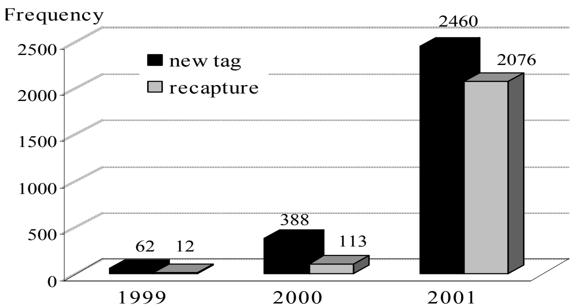

Fig. 1. Number of PIT tag records (new tags and recaptures) in Suriname 1999-2001.

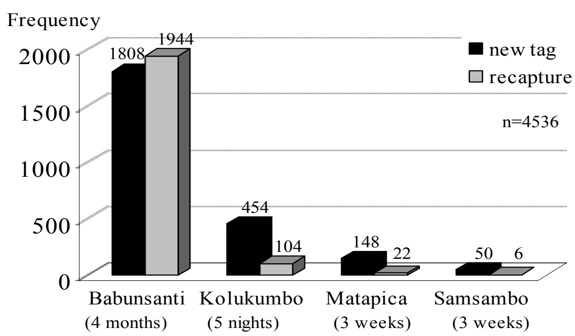

Fig. 2. Number of PIT tag records (new tags and recaptures) on the study beaches in 2001.

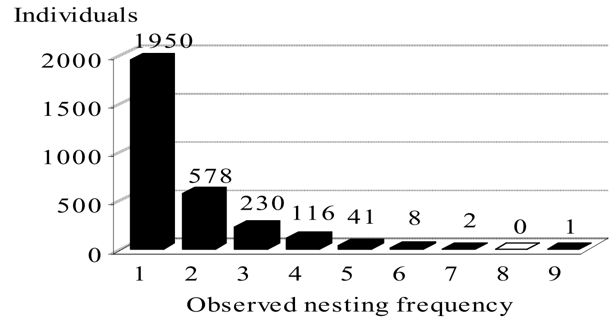

Fig. 3. Observation frequency of tagged leatherback individuals for all beaches grouped together.

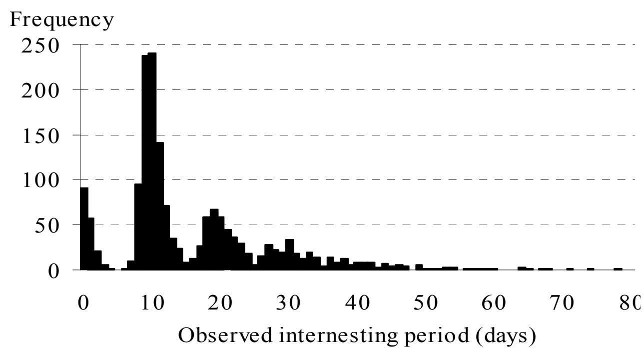

Fig. 4. Observed internesting periods for tagged leatherbacks on Babunsanti in 2001.

Leatherbacks stuck in the mud: a matter of life or death?

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INTRODUCTION

The Surinam coast is part of the extensive mud coast between the Amazon River (Brazil) and the Orinoco River (Venezuela). Due to the westward-oriented Guyana current and north easterly trade winds, the Surinamese coastline is highly dynamic and subject to successive phases of beach erosion and accretion (Augustinus 1978, Schulz 1975). The coastline is dominated by extensive mudflats. Sandy beaches can be found at only a few places. During the 2001 nesting season, extensive mudflats were found in front of Samsambo, one of the nesting beaches (10 km length) bordering the Galibi Nature Reserve. Suriname and French Guiana support one of the largest leatherback (*Dermochelys coriacea*) nesting colonies word-wide. In the 2001 nesting season, 30,000 leatherback nests were estimated in Suriname alone.

RESULTS AND DISCUSSION

During 30 days of observation, 122 leatherback turtles were observed stuck in the mud during day time. These turtles typically get stuck when they return late after nesting and the tide is retreating. They struggle for 30-60 minutes, get covered with mud and finally rest. At this stage, they may look dead. However, all of these turtles, except for one, released themselves at the next high tide and swam away. Apparently, the thick layer of mud protects the turtles against the hot sun and dehydration. As no relation was found between high numbers of turtles stuck in the mud and strandings, and we recaptured several of the turtles at a later nesting attempt, it can be believed that getting stuck in the mud is not lethal to leatherback turtles. No special rescue actions are needed, as these turtles generally survive.

Acknowledgements. WWF-Guianas provided financial support for this project, STINASU provided logistic and technical support.

LITERATURE CITED

Augustinus, P.G.E.F. 1978. The Changing Shorelines of Suriname (South America). Natuurweten-schappelijke Studiekring voor Suriname en de Nederlandse Antillen, Utrecht, The Netherlands, No. 95, 232 p.
Schulz, J.P. 1975. Sea Turtles Nesting in Surinam. Zoologische Verhandelingen. Leiden, E.J. Brill, The Netherlands: 143 p.

A preliminary survey of sea turtles in the Ivory Coast

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OBJECTIVES OF THE PROJECT

(1) Identification of the marine turtles species frequenting the Ivorian coast; (2) Identification of the nesting beaches, nesting seasons and feeding areas of adults and juveniles; (3) Biological data collection: Shell measurements, general condition, reproductive data of each species; (4) Identification and evaluation of the threats to sea turtles; and (5) Enhance public awareness of the endangered status of sea turtles in Ivory Coast.

ACTIVITIES

Study area. Southwestern Ivory Coast, from Fresco (5°06′ N 5°35′ W) to Bliéron (4°22′ N, 7°31′ W).

Duration of the study. February 2001- February 2002.

Training Session for the project assistants on sea turtle biology, species identification, data collection, conservation strategies and techniques in marine turtle first aid.

Data collection. (1) Direct observations on all beaches and fishing harbours in the area included in the project; (2) Counting and identification of all turtles observed, as well as tagging, measuring, photographing and collecting genetic samples; (3) Counting and identification of nests, and assessing the need for nest protection in hatcheries on beaches with significant numbers of nests; (4) Evaluation of other indicators of sea turtle presence, including fresh tracks, carapaces for sale, etc; and (5) Surveys of fishermen, poachers and tradesmen based on interviews.

Education and communication. We will introduce the project and begin to raise awareness on the importance of protection activities. These efforts are directed to (1) the authorities, to gather their advice and opinions; (2) the fishermen, villagers, and poachers. Meetings will be held in all villages and camps along the coast; and (3) the large public, with the publication of brochures and posters on the threatened status of marine turtles in the country.

RESULTS

Species and nesting season. Three marine turtle species have been recorded nesting in Ivory Coast: leatherback (*Dermochelys coriacea*), olive ridley (*Lepidochelys olivacea*), green turtle (*Chelonia mydas*). The dominant species in the area are the leatherback and olive ridley. Immature green turtles, hawksbills (*Eretmochelys imbricata*) and olive ridleys feed among nearshore reefs and rocks of all the study area. The nesting season extends from October to February, with a peak in November for olive ridley and green and in January for leatherback.

Beaches for marine turtle nesting. All beaches of the study area (Fresco to Bliéron) have been investigated. Sea turtles nest at many locations in the study area. The coastline is dominated by sandy beaches interspersed by rocky sections. However, extensive hunting and egg collection have reduced nesting activities. Many interviewees admitted that the turtle population has been considerably larger in the past. The most important nesting area is 90 km long from Taki (4°42′ N, 6°43′ W) to Blieron (4°22′N, 7°31′ W). Nesting in three beaches of this area has been subject to non-exhaustive monitoring in 2001-2002 nesting season (November – February). This beaches are: Mani beach :4° 32′ N; 7° 01′ W; Pitiké beach :4° 31′ N; 7° 10′ W; and Soublaké beach :4° 22′ N, 7° 27′ W. The total number of nests per species on each beach are as follows:

Beach	Total length	DC	LO	total	nests/km
Mani	5 km	27	32	59	12
Pitiké	14 km	121	72	195	14
Soublaké	8 km	41	50	91	11

Threats. The main important threat is extensive hunting and egg collection of all species. Egg poaching is widespread all along the coast, often approaching 100% of eggs laid. Three leatherback or four olive ridley eggs can be sold for $0.09. Slaughter of sea turtles is very frequent; during the period November 2001 – February 2002 at least 9 leatherbacks, 16 olive ridleys and 2 green have been slaughtered in Mani beach; 40 leatherbacks, 24 olive ridleys and 2 green have been slaughtered in Pitiké beach; 22 leatherbacks and 19 olive ridleys have been slaughtered in Soublaké beach. At least 71 leatherbacks, 59 olive ridleys and 4 green have been slaughtered this in this three beaches, suggesting that many hundreds are killed each year in Ivory Coast. The price for a leatherback is $25 and for an olive ridley is $7. Incidental catch in the fishing nets of immatures of green turtle and hawksbill and adults of leatherback and olive ridley is common. During 4 months of observation, 18 turtles were slaughtered in the Grand Béréby fishing market: 10 leatherbacks, 5 olive ridleys, 3 green. 16 nests were protected in situ during the study period.

Public awareness. Meetings were held with local villagers, the relevant local governors and authorities, as well as with the hotel-owners. Nine poachers have been hired to cooperate in the data collection. Three teachers of Biosciences and two local student have been trained in Biology, Ecology and marine turtle Conservation. A film and brochures about marine turtles of Ivory Coast are being prepared..

RECOMMENDATIONS

(1) Support the development of alternative economic activities; (2) Involved the local communities in the conservation of marine turtles; (3) Improve the knowledge about the biology and ecology of the turtles living in Ivory Coast: distribution, feeding areas and nesting beaches as well as migratory routes; (4) Reduce turtle mortality; (5) Protection of nests; (6) Promote information exchange and the cooperation among the countries with the same turtle populations; and (7) Priority from a conservation stand point is eliminating human induced threats.

Acknowledgements. The authors would like to express their gratitude to the David and Lucile Packard Foundation and the Sea Turtle Symposium for travel support and to the GEF Small Grants Program for financial support.

The effects of coastal development on nesting behavior and hatching success of hawksbill turtles (*Eretmochelys imbricata*)

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Deteriorating nesting beach habitat is a serious threat to the long term viability of sea turtle populations, particularly in countries where beach-based tourism is of economic importance. Many of the beaches used by nesting hawksbills in Barbados are impacted by coastal development, with buildings and enclosures reducing the availability of suitable space above the high water mark for placement of nests. Hawksbill females typically make their decision on where to nest at the point of emergence onto the beach from the sea.. On undeveloped beaches, this results in ascending crawls perpendicular to the sea, with a nest chamber being dug once the female reaches a suitable location above the high water mark. On developed beaches, there is more parallel movement of females above the high water mark prior to successful nesting than on undeveloped beaches. This apparently occurs as a result of sub-optimal conditions for nesting on these beaches. Average crawl length prior to nesting and average number of unsuccessful attempts at nest chamber construction prior to successful nesting, are higher on developed beaches than on undeveloped beaches. The effect of crawl length and numbers of unsuccessful nesting attempts on nest characteristics are investigated, and implications for reproductive success discussed.

Reproductive activity assessment of leatherback sea turtles, *Dermochelys coriacea* (Reptilia: Dermochelyidae) in Playa Parguito, Margarita Island

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Dermochelys coriacea is one of four nesting species of sea turtles in Venezuela. The northeast coast of Margarita Island is to date the second most important nesting ground in the country, Parguito Beach (11º 08 North 63º 51 West) is one of the more relevant nesting beaches in the Island. The estimation of the number of nesting females population and the clutch frequency, are useful tools to assess the reproductive activity of sea turtles in any given locality. The purpose of this study was to establish a preliminary assessment of leatherback nesting patterns in the northeast Coast of Margarita Island. Data were gathered during the nesting season from March through August 2001, using direct observation on nightly intensive beach patrols, 24 females were tagged during the sampling period, and other programs tagged 7 females more, corresponding with 64 nesting activities observed and 88 nests laid. The observed egg laying frequency varied from 2 to 6 clutches per season, and the average interval between nesting by the same female was 12 days. The sampling area only covered about a fifth of the nesting beaches in the northeast coast of Margarita Island, but the data obtained is one of the first formal intensive sampling in the zone. We hope that the recommendations raised from this research may be applied in the conservation strategies for the sea turtles of Margarita Island.

Spatial distribution of leatherback sea turtle nests in Playa Parguito, east coast of Margarita Island, Venezuela

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The purpose of this work was to analyze the spatial use of the nesting habitat by *Dermochelys coriacea* in Playa Parguito, Margarita Island, Venezuela. There are not previous published data about the habitat use by leatherback sea turtles nor about the use of GIS tools regarding marine turtles in Venezuela. Data were collected through daily intensive beach patrols on a mile long beach, from March through August 2001. 31 females were registered on the beach with a total of 74 nests recorded. The locations of the nests were recorded with a GPS and the position in relation with beach profile and general spatial distribution mapped and analyzed using GIS tools (MapInfo tm 5.1). The average distance between pairs of nests from the same female was 498 meters, although the more common values were between 200 and 300 meters. The average distance between randomly selected pairs of nests, from any female, was 451 meters showing no special preference for a certain part of the beach for each female. Analysis suggest an aggregation of the nesting to the more suitable portions of the beach, in as far as less risky factors like; light pollution, noise, beach seats and umbrellas are concerned. Although this human induced behavior, decreases the nesting in areas where the best eclosion rates occurs.

A comparison of recruitment success of the leatherback turtle on three major nesting beaches in Suriname, South America

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INTRODUCTION

Leatherback (*Dermochelys coriacea*) nest numbers in Suriname are amongst the highest world-wide, with an estimated 30,000 nests laid in 2001. In the 2001 nesting season, we studied reproductive output of leatherbacks on 3 important nesting beaches in an effort to determine some of the basic parameters of the population, such as hatch success, fate of eggs, and survival and failure of nests. The net output of hatchlings per beach is as important as nest numbers. Babunsanti and Samsambo are situated on the Marowijne River estuary, whereas Matapica is situated on the Atlantic coast.

METHODS AND MATERIALS

A random selection of 149 in situ marked leatherback nests on Babunsanti were excavated and analysed 3 days after first hatchling emergence, or 70 days after egg deposition in case of non- or unnoticed emergence. The same was done for 65 nests on Matapica and 35 nests on Samsambo. Hatch success=empty shells / total number of eggs (empty shells + pipped eggs + all non hatched eggs, yolkless eggs not included). Successful nests are defined as nests from which hatchlings have emerged. To compare sites, Kruskal-Wallis and Mann Whitney U tests were used.

RESULTS

On Babunsanti, only 51.3% of the marked nests were successful. Hatch success of these nests was 21.6%. On Matapica, 90.3% of the nests were successful, and hatch success of these nests was 58.3%. On Samsambo, 71.4% of the 35 excavated nests were successful, with an average hatch success of 30.2%. Nest failure on Matapica was in 3 cases due to beach erosion, in 3 other cases no clear cause was found. Nest failure on Babunsanti was due to frequent inundation for nests laid more than 4 meters below the spring tide line, but nest failure also occurred for nests laid above the spring tide line. A highly significant difference ($p<0.001$) exists between hatch success, the percentage undeveloped eggs, ruptured (defined as predated by mole cricket or ghost crab) and pipped eggs for the marked nests on the 3 beaches.

DISCUSSION

Hatch success for marked leatherback nests on Matapica almost doubled hatch success found on Babunsanti and Samsambo. The significantly higher hatch rates on Matapica can be explained by factors such as sand type, salinity of surrounding water, turnover rate of sand, lower abundance of mole crickets and lower nest density. Although on Babunsanti at least 4 times more leatherback nests were laid than on Matapica, we calculated that only 1.3 times more hatchlings were produced. Because of the high hatch success on Matapica due to good environmental quality of the beach, this beach is considered to be of essential importance for net hatchling production in Suriname.

Acknowledgements. WWF-Guianas provided financial support for the project. STINASU provided logistic and technical support. We also thank the volunteers and students that participated in the tag program.

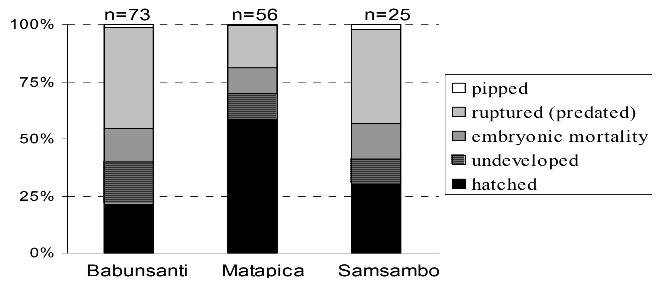

Fig. 1. Hatch success and egg development of marked nests (successful nests only).

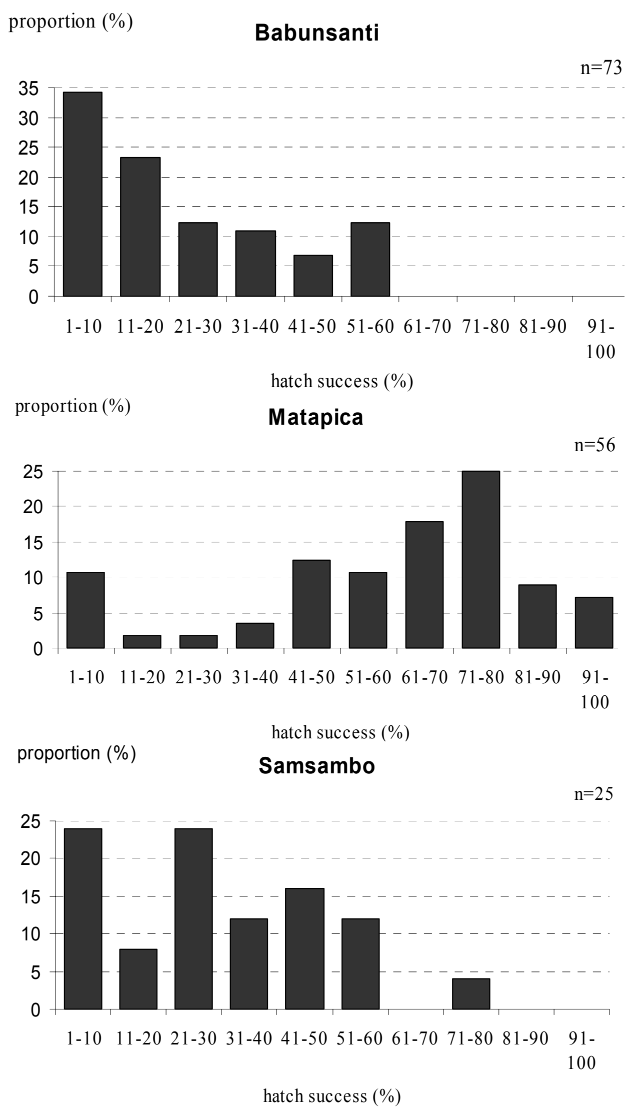

Fig. 2: Frequency distribution of hatch success (successful nests only) at the three beaches.

Monitoring of sea turtles in the Campo Maan area

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The Biodiversity Conservation Project Campo Maan is one of several biodiversity conservation and management projects in Cameroon. During the nesting season when female turtles come up to the beach to lay their eggs, night patrols are carried out. Every encountered turtle is tagged, species identified, body length and width measurements are taken and all nests are counted. In the Campo-Maan region four marine turtle species were encountered: green turtles, *Chelonia mydas*; hawksbills, *Eretmochelys imbricata*; olive ridleys, *Lepidochelys olivacea*; and leatherbacks, *Dermochelys coriacea*. From October to March only two species, *Lepidochelys olivacea* (87%) and *Dermochelys coriacea* (13%), were nesting on the beaches in the Campo-Maan region. The laying females occasionally became the victim of human hunting activities. Also nests were dug up by hunters to take the eggs. The other two species, *C. mydas* and *E. imbricata*, were encountered while captured in fishing nets. Most individuals captured were infants. Adults were rare. *C. mydas* and *E. imbricata* have been seen eating sea grass but they have never been encountered laying eggs on the beaches. Most green and hawksbill turtles marked and released in Kribi were recaptured in and around Kribi. However one hawksbill has been recaptured 70 km to the south, near Campo and one green turtle has been recaptured in Bata (Equatorial Guinea). A way of raising consciousness is marine-turtle-eco-tourism, tourists can sponsor and become the godfather of a turtle.

Increase in nesting activity by hawksbill turtles (*Eretmochelys imbricata*) in Barbados

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Nesting activity of hawksbill turtles (*Eretmochelys imbricata*) in Barbados has been monitored using standardised effort on high density nesting beaches during the peak of the hawksbill nesting season (June 01-September 30) since 1997. In addition, nest counts have been made on an index beach since 1992 and monitoring expanded to saturation tagging in 1997. The data indicate an upward trend in nesting activity by hawksbills. The extent to which the trend is attributable to national and international conservation measures protecting hawksbills in the Caribbean is discussed.

Status of marine turtles and conservation efforts along the Israeli coastline

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A look through the history reveals a relatively large population of nesting green and loggerhead turtles along the Israeli coastline (Sella 1982). An abundant green turtle hunting occurred during the thirties in this region. Hornell (1935) reported about 2000 mature turtles hunted along the coastline each year since 1920. These data indicate that the Israeli coastline was once an appropriate ecological niche for the feeding and nesting of large numbers of these turtles.

The present day nesting activity which result with less then 100 nests per season indicates a very small population of loggerhead turtles, not exceeding few dozens. Green turtles nesting population is estimated as lower then ten. Nowadays, as well as the danger to turtle numbers from pollution and natural predation the turtles in Israel are affected by additional threats; The declining width of the 190 kilometers long of Israeli coastline, resulting from urbanization, recreational activities on beaches, illegal sand mining, cut-off of sand source from the River Nile (Aswan Dam) and most significantly from the construction of harbors and marinas. The beaches within the central region of the Israeli Coast, which is most densely populated, have been most affected, with a vast reduction of suitable nesting beaches, resulting in relatively high occurrence of false nesting attempts. Fishing Activities along the Israeli coast: While turtles are not fished for in Israel they are still regularly caught as a bycatch. The exact number of turtle mortality and injury by fishing activities is yet unknown however surveys show that the numbers are relatively large in comparison to the estimated nesting population. Turtles wounded by incidental fishery are the most common amongst those treated by the Israeli Sea Turtle Rescue Center.

Established in 1999 by the Nature and Parks Authority, the Rescue center was created to address the above issues and follow a course, which helps significantly to maintain the existing mature population. Rehabilitation of injured turtles, data collection, and their release back to the wild, is the major mission of the rescue center. This activity raises public awareness of the need for conservation and is also an important part of the Rescue Center's role within Israel. The Sea Turtle Rescue Center is a substantial addition to the original management program set up in 1993, insuring the safe completion of the nesting phase, this is done by surveying the coasts, relocating nests to protected hatcheries, insuring safe incubation and release of hatchlings.

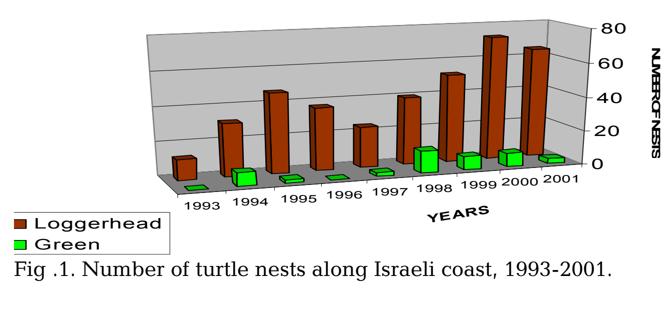

Fig .1. Number of turtle nests along Israeli coast, 1993-2001.

Nesting success on the emergences of *Caretta caretta* in the Island of Boavista, Cape Verde, Western Africa

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INTRODUCTION

The nesting population of loggerhead sea turtle, *Caretta caretta*, (Linnaeus 1758) in Boavista island (16º 40'N, 25º 55' W, Fig. 1) is being examined in order to its conservation as well as knowing the most significant aspects of its reproductive biology. Cape Verde Islands represent one of the most important population of *Caretta caretta* in the North Atlantic (López-Jurado and Andreu 1998, López-Jurado et al. 1999).

The main objective of the research is in the one hand, analyzing which places are mostly selected by turtles for emerge. On the other hand, being able to define which zones of the studied beaches are preferably chosen by turtles to nest, based on the relationship between the number of emergences and number of nests laid.

MATERIALS AND METHODS

From 7th of July to 22nd of October in 2001, it was monitored the *C. caretta* arrivals at Ervatão, Ponta Cosme and Calheta beaches (southeast of Boavista island, Rep. of Cape Verde), by nocturnal and diurnal dairy patrols. During these patrols, it was monitored: trace sort, width and length of the trace, number of nesting attempts, nesting, and zone of the beach where found the track. The presence of nest was marked as "Y", which was made in case of having seen the egg-laying, having found the eggs after digging or when obvious signals of nest (Schroeder and Murphy 1999).

In case of no signal, it was marked as "N". Another possibility was that after digging so as to find the eggs, they were not found, or that the signals were not clear enough to assure the presence of a nest, in that case it was marked as "U" (unknown). Ervatão and Ponta Cosme beaches were divided into six zones, according to their own characteristics defined arbitrarily (see Figs. 1a,b,c).

RESULTS AND DISCUSSION

The selection of the nest placement is influenced by several environmental factors (Mrosovsky et al. 1984, Ackerman 1980, Mortiner 1990). There are very little studies in which the possible influence of vegetation is taking into account (Cornelius 1976) and, those ones that consider this fact show that most of the nestings are in open sand (Hays and Speakman 1993).

Comparing the three beaches where we took data, Calheta is the beach with the main nesting success, almost half of the turtles that emerge (48.71%), whereas the success is low in Ervatão and Ponta Cosme beaches (28.06% and 21.07%, respectively). This could be due to the morphology of the beaches, being Calheta the most homogeneous which backshore is very wide out of the influence of high tides. Despite the other two beaches are "Short beaches", that is, those with a minimal traversal distance and, as a result, suitable for nesting (LeBuff 1990), are not very homogeneous, with flooded areas due to tides, and the vegetation line near high tide line what force turtles to nest in the vegetation zone.

The number of emergences depends on the morphology of the intertidal and subtidal (Mortimer 1982, Bjorndal and Wood 2000), while the success in nesting depends only on the backshore morphology ($p < 0.0001$). Consequently, we obtain that, in Ervatão, the main number of emergences occurs in zone three though few turtles lay eggs and, comparing to other zones, we see that the main nesting percentage correspond to zone 6. In contrast to Ervatão beach, in Ponta Cosme beach the distribution of the emergences is fair in each zone due to the apparently homogeneity of sudtidal and intertidal.

We find that the lowest success in nesting happens at ocassional flooded zones by tides (zone 1 and 5 in Ervatâo beach; and, zone 3, 4 and 5 in Ponta Cosme beach). In spite of this great success in zone 6, Ervatâo beach, turtles emergences to sand are few. The reason it occurred could be explained by the rocky intertidal area. But the conditions upwards are the most suitable of the others, with a sandy backshore out of the influence of tides. In Ponta Cosme beach, zone 1 and 2 show the highest percentage of nests though they have a vegetation line very close to the high tide line. However, the main number of emergences is at zone 6. This two factors make zone 6 have the major number of nests per length beach due to the combination between suitable conditions for going out the water and a good morphology for nesting (with a wide sandy backshore with some dunes not affected by tides).

We must emphasize that in Ervatâo beach, zone 4 is where few turtles nest though the number of emergences is the highest. This is due to the existence of a rocky wall which acts as a obstacle for natural transport of sand to beach what produces a dune in the upper part.

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LITERATURE CITED

Ackerman, R.A. 1980. Physiological and ecological aspects of gas exchange by sea turtle eggs. Am. Zool. 20:575-583.

Cornelius, C.E. 1976. Marine turtle nesting activity at Playa Naranjo, Costa Rica. Bresenia 8:1-27.

Hays, G. and J. Speakman. 1993. Nest placement by loggerhead turtles, *Caretta caretta*. Anim. Behav. 45:47-53.

LeBuff, C.R., Jr. 1990. The loggerhead turtle in the eastern Gulf of Mexico. 73-81.

López-Jurado, L.F. and A.C. Andreu. 1998. *Caretta caretta* (Linnaeus, 1758), In: A. Salvador, ed. Reptiles. Fauna Ibérica, Vol. 10. Museo Nacional de Ciencias Naturales, CSIC, Madrid. p. 44-56.

Mortimer, J.A. 1982. Factors influencing beach selection by nesting sea turtle. In: K.A. Bjorndal, ed. Biology and Conservation of Sea Turtles. Smithsonian Institution Press, Washington, D.C. p. 43-52.

Mortimer, J.A. 1990. The influence of beach sand characteristics on the nesting behaviour and clutch survival of green turtle (*Chelonia mydas*). Copeia 1990:802-817.

Mrosovsky, N. 1983. Ecology and nest-site selection of leatherback turtles *Dermochelys coriacea*. Biol. Conserv. 26:47-56.

Schroeder, B. and S. Murphy. 1999. Population surveys (ground and aerial) on nesting beaches. Research and Management Techniques for the Conservation of Sea Turtles. p. 45-55.

Wood, D. and K. Bjorndal. 2000. Relation of temperature, moisture, salinity and slope to nest site selection in loggerhead sea turtles. Copeia 2000:119-128.

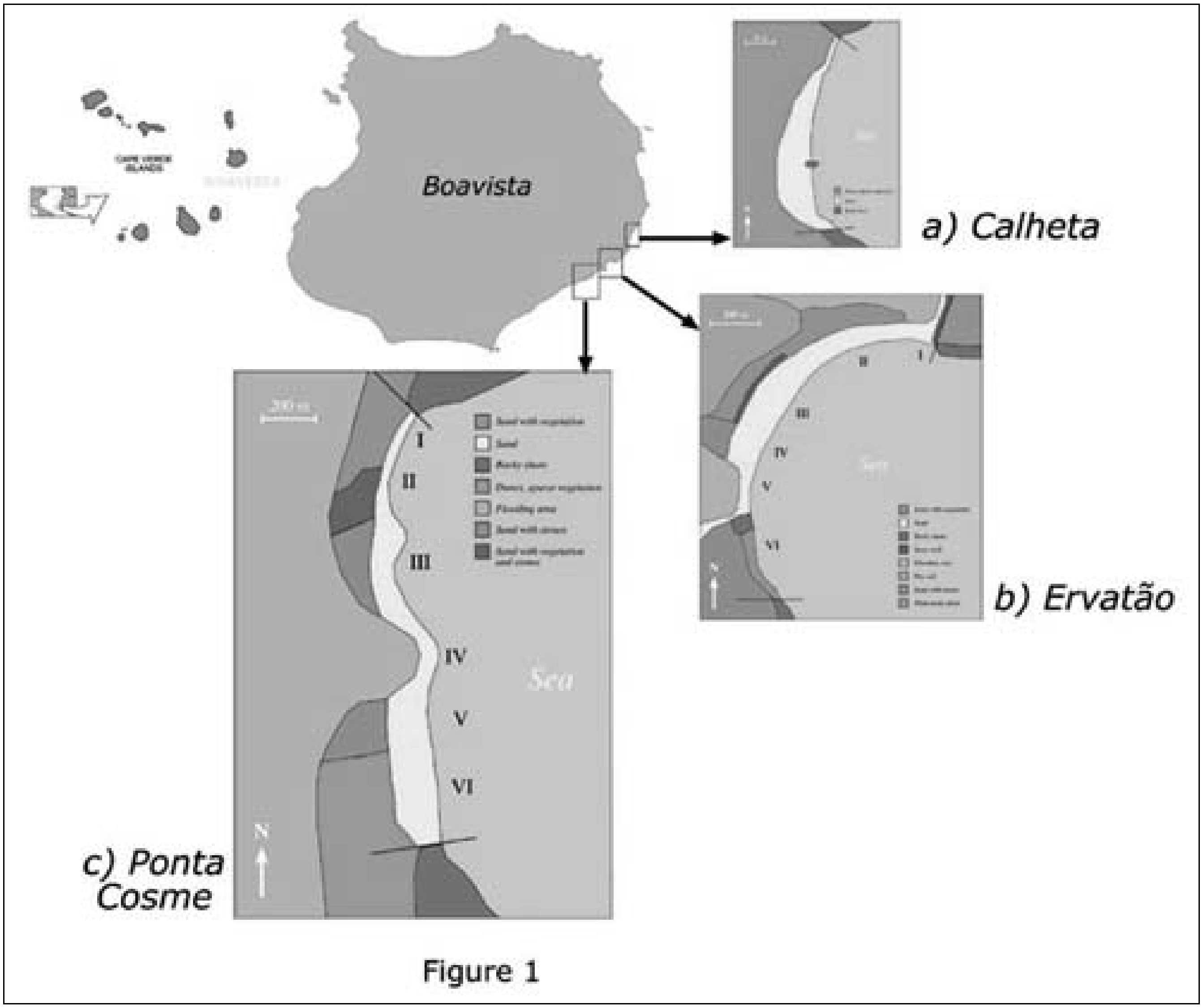

Fig. 1. Map showing the location of the Cape Verde archipelago and Boavista and the three beaches studied (a, Calheta, b, Ervatão, and c, Ponta Cosme).

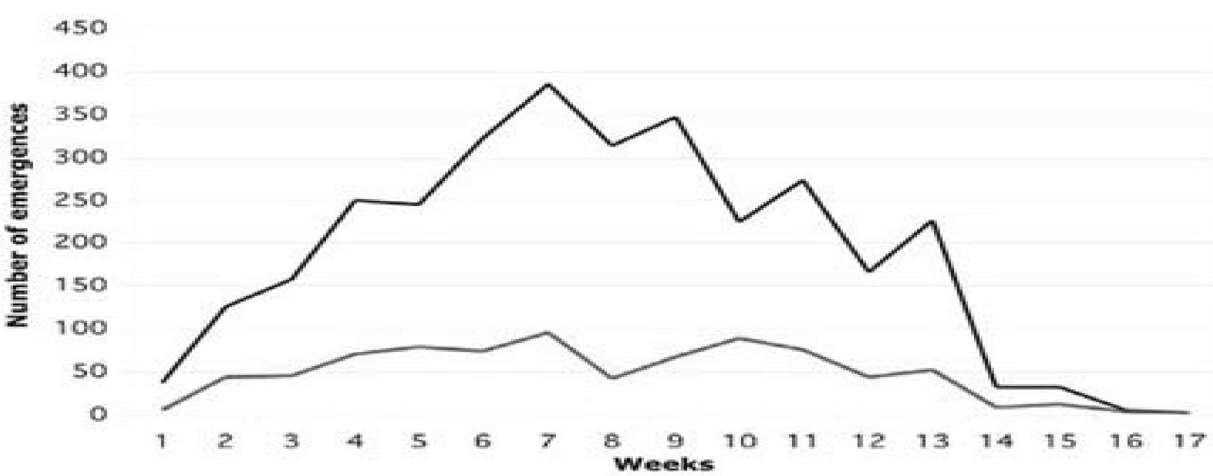

Fig. 2. Number of emergences (top line) and nests (bottom line) across 2001 nesting season in Boavista.

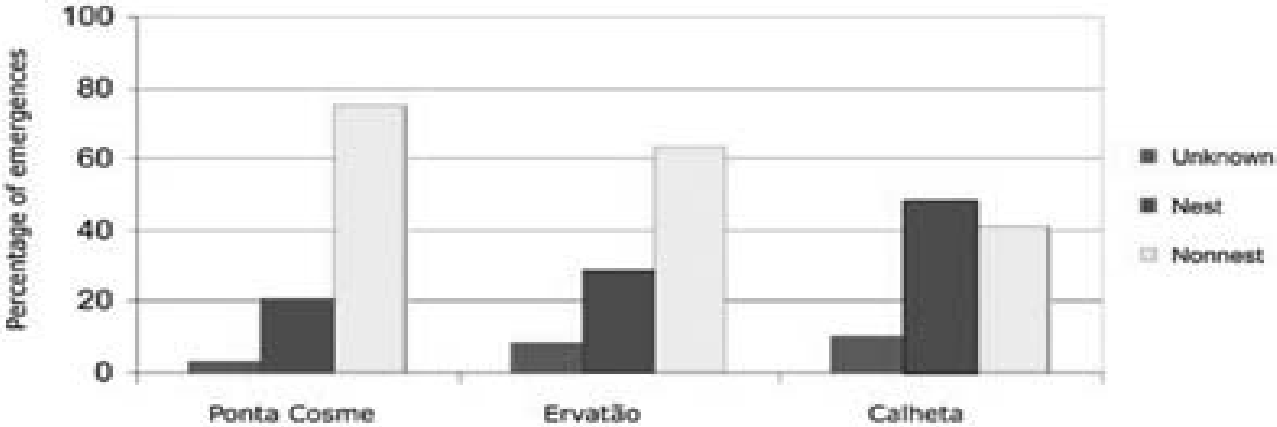

Fig. 3. Percentage of emergences with nest, with no nest, and unknown, in Boavista during 2001 season.

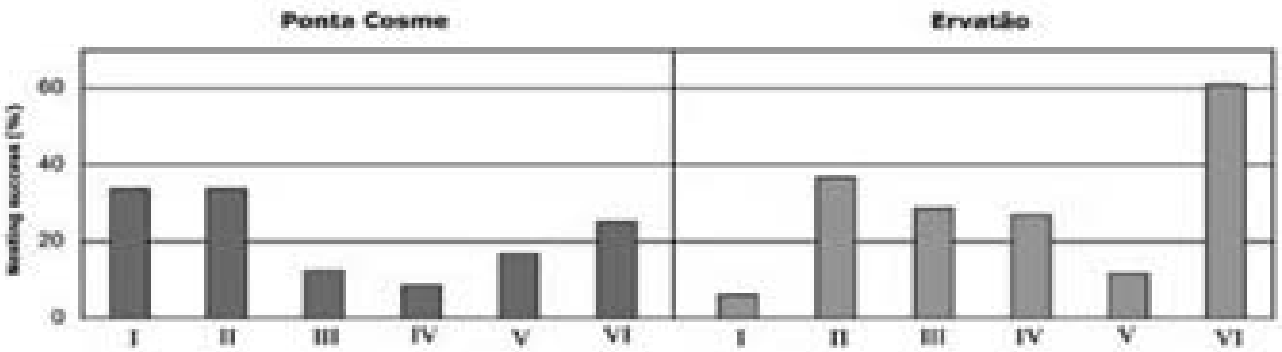

Fig. 4. Percentage of emergences with nests in Ponta Cosme (left) and Ervatão (right) during 2001 season (I to VI represent the zones).

A leatherback (*Dermochelys coriacea*) nest on the southwest coast of Florida

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Female leatherbacks in the western Atlantic nest from the southeastern United States to southern Brazil, with the largest nesting colony located in French Guiana. Other important colonies exist in Costa Rica, Panama, Suriname, and the Dominican Republic. The leatherback was once thought to be a rare visitor to the United States, but now is known to nest regularly in small numbers along Florida's east coast (Meylan et al. 1995). During the year 2001, 935 leatherback nests and 266 leatherback non-nesting emergences were recorded along Florida's coastline (FWC 2001). Leatherbacks generally lay an average of 5 to 7 nests per season. Based on this average, an estimated 16 to 31 individuals nest in Florida each year (Meylan et al. 1995). Occasional reports of leatherback nesting have also been reported along the coastline of the Florida panhandle, Texas, Georgia, and South Carolina (Pete and Winn 1998, Longieliere et al. 1998).

On May 31, 2001, a leatherback (*Dermochelys coriacea*) was observed nesting on Longboat Key, Sarasota County, Florida. This event marked the first documented nesting of a leatherback sea turtle on the southwest coast of Florida. The turtle was sighted at approximately 9:30 a.m. as it was digging its nest cavity, and observed throughout its nesting process. After the turtle deposited its eggs and began covering, it was measured and tagged by Mote Marine Laboratory (MML) personnel. Its carapace length was determined by measuring between the middle of the nuchal notch and the terminal tip of the caudal peduncle with a soft tape measure, without forcing the tape along the ridge (Wyneken 2001). The curved carapace length was determined to be approximately 146 cm, and the curved width was approximately 111 cm. The turtle was then tagged in the trailing edge of three flippers using metal Inconel tags obtained from the Archie Carr Center for Sea Turtle Research (left rear flipper - XXM274; right rear flipper - XXM275; left front flipper - SSZ401). The turtle was observed and photographed as it completed its nesting process. It returned to the Gulf of Mexico at 10:19 am and was not observed again during the remainder of the 2001 nesting season.

The nest was verified to determine the exact location of the egg clutch shortly after the turtle returned to the water. Once the exact location was known, the area was marked and encircled by four wooden stakes connected with yellow surveyors flagging tape and signage identifying the site as a protected sea turtle nest. It was monitored at sunrise each day by MML staff and volunteers looking for signs of damage by predators or tidal activity or evidence of hatch.

On July 24, after the nest had been inundated by severe high tides and tidal activity, the nest was relocated 43 feet landward of its original location. At the time of relocation, the nest cavity measured 13" wide by 21" deep. Due to erosion, only six inches of sand remained above the eggs at the time the measurement was taken. A total of 95 eggs were relocated, including 73 yolked eggs and 22 'yolkless', or non-viable, eggs. The yolkless eggs were relocated along with the yolked eggs in case of a possible function in serving as predator deterrents, facilitating gas exchange, or maintaining moisture within the nest (Dutton and McDonald 1995).

The nest continued to be monitored for 80 days after its initial deposition. After seeing no evidence of hatch during this time, the nest was hand excavated and a sample of eggs were opened for evaluation of development. None of the eggs within the nest had hatched, and those which were opened showed no evidence of development.

A total of nine leatherback nests were deposited along Florida's west coast in 2001. Only one of nine showed evidence of hatch. This nest was deposited on July 4 on St. Joe Beach, Gulf County. When this nest was originally deposited, the lower eggs in the nest were immersed in water, so the nest was relocated higher on the beach. The nest hatched despite numerous periods of inundation, and 27 hatchlings successfully emerged from the nest out of a total of 105 eggs (Eells, pers. comm.). Seven of the remaining eight nests located along the Florida Panhandle (including Franklin, Gulf, and Bay counties) were lost due to damage from Tropical Storm Barry, which made landfall on August 6, 2001 (Eells, Mitchell, Harris, Moore, pers. comm.).

LITERATURE CITED

Dutton, P. and D. McDonald. 1995. Hatch rates of leatherback (*Dermochelys coriacea*) clutches reburied with and without yolkless eggs. In: J.I. Richardson and T.H. Richardson, comps. Proceedings of the Twelfth Annual Workshop on Sea Turtle Biology and Conservation. NOAA Tech. Memo. NMFS-SEFSC-361. p. 177-178.

Florida Fish and Wildlife Conservation Commission (FWC). Florida Marine Research Institute. Statewide Nesting Beach Survey Database 2001.

LeBuff, C.R. 1990. The loggerhead turtle in the Eastern Gulf of Mexico. Caretta Research, Inc., Sanibel, Florida, 216 p.

Longeliere, T.J., G.O. Bailey and H.L. Edmiston. 1998. Unusual accounts of leatherback nesting in northwest Florida. In: S.P. Epperly and J. Braun. Comps. Proceedings of the Seventeenth Annual Sea Turtle Symposium. NOAA Tech. Memo. NMFS-SEFSC-415. p. 219-221.

Meylan, A., B. Schroeder and A. Mosier. 1995. Sea turtle nesting activity in the State of Florida 1979-1992. Fla. Mar. Res. Publ. No. 52. 51p.

Pete, S.J. and B. Winn. 1998. Leatherback turtle (*Dermochelys coriacea*) nesting in Georgia. In: S.P. Epperly and J. Braun, comps. Proceedings of the Seventeenth Annual Sea Turtle Symposium. NOAA Tech. Memo. NMFS-SEFSC-415. p. 243-244.

Wyneken, J. 2001. The Anatomy of Sea Turtles. NOAA Tech. Memo. NMFS-SEFSC-470. 172 p.

Last one's a rotten egg: differential emergence success of new and remigrant leatherback turtles (*Dermochelys coriacea*) at Playa Grande, Costa Rica: 1999-2000

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INTRODUCTION

The population of Leatherback sea turtles (*Dermochelys coriacea*) at Parque Las Baulas has experienced a severe decline in recent years (Spotila et al. 2000). Although egg poaching and adult bycatch seem to be major players in the population collapse (Spotila et al. 1996), low Emergence Success (ES) may be contributing to slow population recovery rates. ES directly relates to recruitment of hatchlings on the beach. If the factors leading to low ES in leatherbacks can be determined and corrected, population recovery rates could be increased significantly. One possible factor is that different groups of females within the Playa Grande population may be unevenly contributing to ES. Reina (pers. comm.) found significant morphological and reproductive differences between first-time nesters and remigrant females at Playa Grande, implying the existence of two sub-populations. Reynolds found that the three lowest ES scores at Playa Grande came from first time nesters. (Reynolds 2000). This study seeks to test for significant differences in ES between two sub-populations, remigrant turtles and first-time nesting turtles, at Playa Grande.

MATERIALS AND METHODS

We conducted this study at Playa Grande, Parque Marino Las Baulas, Costa Rica. The hatchery, constructed in 1998, was a 20 X 20 m area cleared of vegetation in the high beach area. We conducted night beach patrols to tag and identify ovipositing females with Passive Integrated Transponder (PIT) tags (Steyermark et al. 1996). Beach nests in danger of tidal inundation were relocated to the hatchery. We dug each hatchery nest 77 cm deep with a pole digger. We then shaped the nest cavity by hand to approximate the dimensions of a natural nest. Latex gloves were used to individually place eggs into their hatchery nest within 6 hours of oviposition. Each nest was labeled with a nest ID number and the PIT tag number of the parent female. Females that arrived at Playa Grande without a tag were assumed to be "new" nesters, while those females that had been tagged in previous years were labeled as "remigrants." We excavated each nest in the hatchery two days after the first hatchling emerged. We then calculated ES for each nest with the following equation (Reynolds 2000): $ES=H/(S + U)$, where ES is the emergence success, H is the number of emerged hatchlings, S is the number of egg shells, and U is the number of unhatched yolked eggs. We used Statview V.4 statistical analysis program to analyze the data. We used an unpaired t-test to look for differences in ES between new and remigrant turtles throughout the nesting season. We then performed a one-way ANOVA to look for differences in ES among the four quarters of the nesting season. We then used an unpaired t-test to determine differences in ES between new and remigrant turtle within time groups.

RESULTS

Overall, there was no significant difference ($p=0.11$) in ES between new and remigrant turtles throughout the year (Table 1). Because Reynolds found that ES could change significantly from month to month, we wanted to compare ES between the four sequential time periods of turtle nesting. A one-way

ANOVA showed that there was indeed a difference (p=0.009) in ES among the four time periods (Table 2). Time period 2 was significantly lower than time periods 1, 3, and 4 (Fig. 1). Because I wanted to see whether one sub-population contributed more to the decline in ES than the other, I tested ES between new and remigrants within time group two. At time group 2 there was no significant difference (p=0.1322) between new and remigrant turtles (Table 3).

DISCUSSION

The hatchery at Playa Grande provided a unique, controlled environment to study ES. Previous analysis has shown no significant difference in ES between the beach and the hatchery, therefore the data collected at the hatchery can be used to study the ES of beach nests. The degree of significance of sub-population status on ES remains unclear. Although I found no significant difference during the 2000-2001 nesting season, Reynolds's analysis showed that remigrants outpaced new turtles in ES during the 1998-1999 season. It is possible that escaped hatchlings could cause a false decrease in ES estimation. However, there were very few hatchling escapes from the hatchery. Another possible complication is that untagged or improperly tagged remigrants could be mislabels as "new' females. Fortunately, because Playa Grande has been intensely monitored for 9 years, the probability of missing an untagged female is quite low as this time greatly exceeds the mean internesting interval. As both Reynolds's study and my own had similar sample sizes, it can be assumed that sub-population status can affect ES one year and not the next. This suggests that the effect of sub-population status on ES may be dependent on environmental factors. The 1998-1999 nesting season, for example, was much wetter than the 2000-2001 season. Remigrant eggs may be better fit to survive in wetter substrates. Remigrant females could have superior skills in digging nest chambers in wetter sand, resulting in increased egg survival. Differential results between the nesting seasons may also be due to factors out at sea. Remigrant females, for example, may have larger nutrient storage potential than new nesters and thus be better fit to reproduce under stressful conditions. Remigrant females may also have a larger nutrient load in their eggs due to superior foraging habits. Additionally, remigrant females may have a higher proportion of fertile eggs than first time nesters. Because ES on the beach is directly related to recruitment, sub-population status can be used to further refine estimations of recruitment on the beach. An estimation of recruitment without inclusion of sub-population status could be; ES * ECF * N * 100 = New Recruits (1), where ES = emergence success, ECF = estimated clutch frequency, and N = number of nesting females. A more accurate estimate including sub-population status could be; [(ES(new) * ECF(new) * N(new) *100] + [ES(remig.) * ECF(remig.) * N(remig.) * 100] = New Recruits (2), where ES(new)= emergence success of new nesters, ES(remig.) = emergence success of remigrants, ECF = estimated clutch frequency, and N = number of nesting females. While it is shown that sub-population status can have an effect on ES, the overall significance remains unclear. A longitudinal study is needed to track individuals over time to determine if ES increases as females change sub-population group. Once quantified, differential ES among different sub-population groups may be used to further refine recruitment models of Leatherback turtles.

LITERATURE CITED

Reina, R.D., P.A. Mayor, J.R. Spotila, R. Piedra, and F.V. Paladino. 2002. Nesting ecology of the leatherback turtle, *Dermochelys coriacea*, at Parque Nacional Marino Las Baulas, Costa Rica: 1988-89 to 1999-2000. Copeia 2002:653-664.

Reynolds, D.P. 2000. Emergence success and nest environment of natural and hatchery nests of the leatherback turtle (*Dermochelys coriacea*) at Playa Grande, Costa Rica, 1998-1999. M.S. Thesis. Drexel University, Philadelphia. 50 p.

Spotila, J.R., A.E. Dunham, A.J. Leslie, A.C. Steyermark, P.T. Plotkin, and F.V. Paladino. 1996. Worldwide population decline of *Dermochelys coriacea*: are leatherbacks turtles going extinct? Chelonian Conserv. and Biology. 2:209-222.

Spotila, J.R., R.D. Reina, A.C. Steyermark, P.T. Plotkin, and F.V. Paladino. 2000. Pacific leatherback turtles face extinction. Nature. 405:529-530.

Statview. 2000. SAS Institute: Version 4. Cary, North Carolina.

Steyermark, A.C., K. Williams, J.R. Spotila, F.V. Paladino, D.C. Rostal, S.J. Morreale, M.T. Koberg, and R. Arauz. 1996. Nesting leatherback turtles at Las Baulas National Park, Costa Rica. Chelonian Conservation and Biology 2:173-183.

Table 1. Unpaired t-test of emergence success show no significant difference between new and remigrant sub-populations of leatherback turtles (*Dermochelys coriacea*) throughout the nesting season at Playa Grande, Costa Rica, 2000-2001.

	Mean Difference	DF	t-value	P
New, Remigrants	-6.948	162	-1.59	0.1137

Table 2. A one-way ANOVA indicated that there was a significant difference in ES between time groups in the 2000-2001 nesting season at Playa Grande, Costa Rica.

	DF	Sum of Squares	Mean Square	F	P	Lambda	Power
Time Group	3	11509.7	3836.56	5.776	0.0009	17.327	.957
Residual	159	105615	669.244				

Table 3. An unpaired t-test of ES within time group two showed no difference between new and remigrant turtles during the 2000-2001 nesting season at Playa Grande, Costa Rica.

	Mean Difference	DF	t-value	P-value
New, Remigrants	-11.229	38	-1.539	0.1322

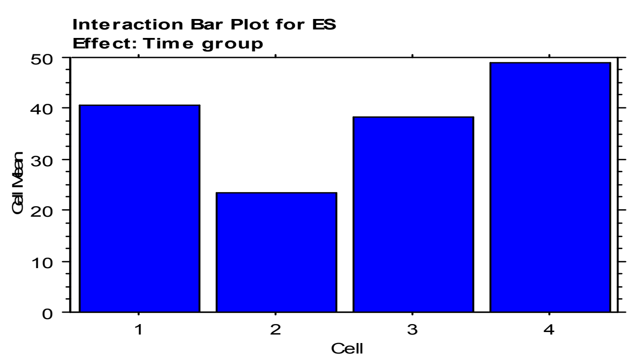

Fig. 1. Interaction bar plot of ES throughout the time series indicated that ES (cell mean) was smaller in the second quarter of the nesting season than all other quarters during the 2000-2001 nesting season at Playa Grande, Costa Rica.

Marine turtles nesting in the Cuban Archipelago, 2001

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Nesting of marine turtles arriving at the Cuban Archipelago beaches during the 2001 nesting season is described. The number of nest and tracks observed in species such as the green turtle (*Chelonia mydas*), hawksbill turtle (*Eretmochelys imbricata*), and loggerhead turtle (*Caretta caretta*) are quantified. We carried out surveys to determine the nesting magnitude and moment that the highest quantity of nets could be detected. The work was developed in several different areas: The Canarreos, Sabana-Camagüey, Jardines de la Reina archipelagos and Peninsula of Guanahacabibes. This study confirmed that the Cuban Archipelago is an important area for marine turtle nesting in the Caribbean. Nests of green turtles, loggerhead turtles and hawksbill turtles were reported in the three surveys in the Archipelagos. The most important area for the green turtle is the Canarreos Archipelago, specifically Cayo Largo del Sur, where 791 nests of this species were found. For the loggerhead turtle this Archipelago is also important, mainly the Guanal beach, at the south of Isla de la Juventud. The most important archipelago for the hawksbill turtle is Jardines de la Reina, mainly Cayería de las Doce Leguas, where this year 164 nests were reported. We recommend continued studies in these areas to determine the species behavior in no monitored areas.

Acknowledgements. We would like to thank the David and Lucile Packard Foundation, National Fish and Wildlife Foundation, Global Guardian Trust for supporting my attendance to this symposium. We are also grateful to the Japan Bekko Association for sponsoring this project.

Environmental conditions of the sand substrate during the 2000 leatherback nesting season in Tortuguero, Costa Rica

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This study was conducted with the intent to document the environmental conditions within the sand substrate during the Leatherback sea turtle nesting season in Tortuguero, Costa Rica. Measured parameters included sand moisture content, salinity, temperature and nest elevation above sea level. Researchers at the Caribbean Conservation Corporation Field Station in Tortuguero provided daily air temperature, rainfall and water table data. Physical data from the substrate were measured with an Aqua-Terr EC 200 meter from May through July, 2000 with additional spot checks in June, 2001. The average hatching success for marked leatherback sea turtle nests in 2000 was 55.6% (SD=11.6%), which is higher than normal, suggesting that environmental substrate conditions were quite favorable. The average sand moisture level (averaged over all data points) was approximately 68% (SD=13%), considerably higher than the 25% optimum reported in the literature for loggerhead sea turtles in Florida. Salinity levels were very low (below the sensitivity of the instrument) and remained low within 1 meter of the splash zone. There appears to be a strong movement of fresh water toward the sea, suggesting that salt water flooding may be cleared rapidly. Sand temperature averaged 26.6 C (SD=7), with little fluctuation. These results suggest that further study is needed to determine if optimum conditions vary from region to region within the nesting range of sea turtles and if optimum conditions differ among the various species.

Marine turtle nesting activity on South Jupiter Island, Florida

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INTRODUCTION

The southern portion of Jupiter Island is located on the three northernmost kilometers of Palm Beach County on the southeast coast of Florida. It encompasses three Florida Fish and Wildlife Conservation Commission (FWC) survey areas: Tequesta, Coral Cove, and Jupiter Inlet Colony. Monitoring for sea turtle activity has been variable and inconsistent since 1991, but provided indications that this area supported very high numbers of nests of three species of marine turtle, with nesting densities exceeding 1,250 nests per kilometer in the northernmost zones. In an effort to provide consistent monitoring of this beach, an intensive volunteer monitoring program was developed which included local residents and FWC staff. Nesting densities for loggerheads (*Caretta caretta*), leatherbacks (*Dermochelys coriacea*) and greens (*Chelonia mydas*) approach or exceed those of other exceptionally high nesting density beaches. These results support the need for special measures to protect this extraordinary nesting area.

METHODS

Study area. The study area on Jupiter Island is located between the Martin/Palm Beach County line and the Jupiter Inlet. The area was divided into 13 zones of varying length, which consist of condominiums, private homes, and a county park.

Beach surveys. From 1993-1996, surveys were conducted in zones 1-8 on a daily basis between April 15 and September 15. Data were collected once or twice a week in 1997-2000. The volunteer program began in 1998 in some areas, however, daily surveys were not conducted in all 13 zones until the 2001 nesting season. Data collected included the species and beach position for all nests and non-nesting emergences. All nests were left in situ and none were marked for evaluation.

RESULTS AND DISCUSSION

Historic data from zones 1-8 indicated very high density nesting comparable to other local "hot spots", including Hobe Sound National Wildlife Refuge, Jupiter Island, and Juno Beach (Fig. 1). These data justified funding for staff to train 40 volunteers to perform daily surveys of all zones. Results from the first full year of monitoring (2001) exceed previous estimates and confirm this is an exceptionally important beach for loggerheads and leatherbacks (Figs. 2,3,4). Loggerhead nesting density exceeds 1,250 nests/km in the northernmost zones, while leatherback nesting density exceeds 20 nests/km in the southern zones. Based on earlier surveys, green nesting is expected to approach 60 nests/km in 2002. These nesting densities are comparable to, and in some cases exceed, those of other important beaches in Florida, such as Archie Carr National Wildlife Refuge, Hutchinson Island, Jupiter Island, and Juno Beach (Fig. 3).

These results may be partially due to effects of natural armoring. A 1.2 kilometer limestone outcrop at Blowing Rocks Preserve limits access to the beach, resulting in redirected nesting to Jupiter Island zones 24-30 and 33 and to southern Jupiter Island. In some years, turtles may be avoiding less suitable nourished beaches north and south of the survey area resulting in increased nesting effort in a concentrated area.

Daily monitoring will be continued to document any changes over time. Nesting at these levels for all three species justifies the implementation of special protective measures such as strict control of beachfront lighting, limited nighttime access, and no mechanical beach cleaning, among others. Additionally, this unique area provides great opportunities for research.

Acknowledgements. We gratefully acknowledge the efforts of Palm Beach County's Volunteer Sea Turtle Monitoring Program members: Anne Alsup, Marilyn Barfield, Mary Belvin, Reubin Bishop, Ann Bissell, Dino Brownson, Jane Brownson, James Cecil, Elda Chisholm, Bernadette Cirillo, Meghan Conti, Nicole Cremens, Charlene Darville, Ellie DiSarno, Janet Glaspie, Ali Goode, Susan Grunke, Mark Holland, Richard Kline, Susan Koster, Tanja Koster, Aleix Koster, Laura Lambremont, Anna Marr, Dianne Mazziotta, George McDermott, Peg Minges, Beth Morford, Nancy Paradise, Zinta Petterson, Terri Roberts, Susan Schlapkohl, Carroll Shimer, Tracy Siani, Karrie Singel, Joan Sommerville, Ken Swain, Matt Tait, Tom Warwick, Bill Wunder, and Katherine Wunder. Without their dedication and hard work, this important beach would not be surveyed for sea turtle nesting activity.

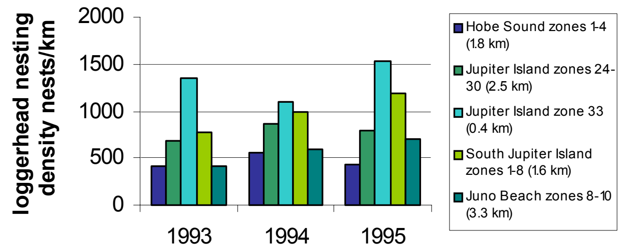

Fig. 1. Comparison to other nesting hot-spots, 1993-1995.

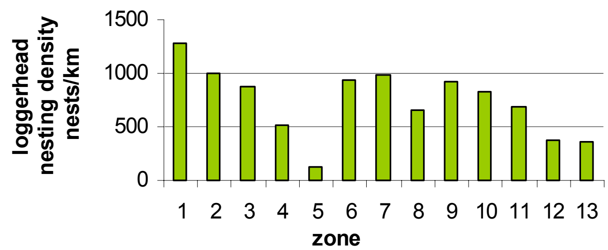

Fig. 2. South Jupiter Island loggerhead nesting density, 2001.

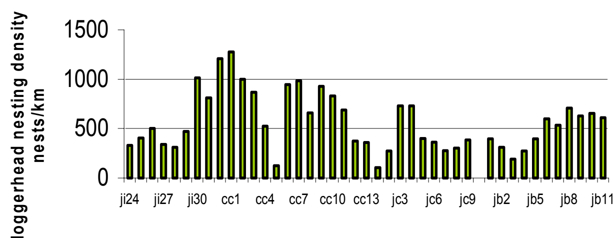

Fig. 3. Comparison of loggerhead nesting density on adjacent beaches by subzone, 2001.

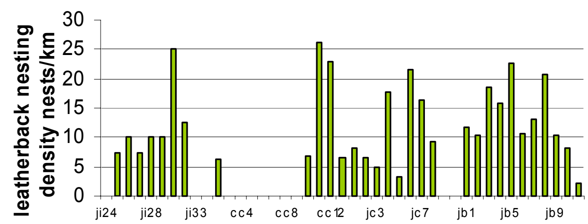

Fig. 4. Comparison of leatherback nesting density on adjacent beaches by subzone, 2001.

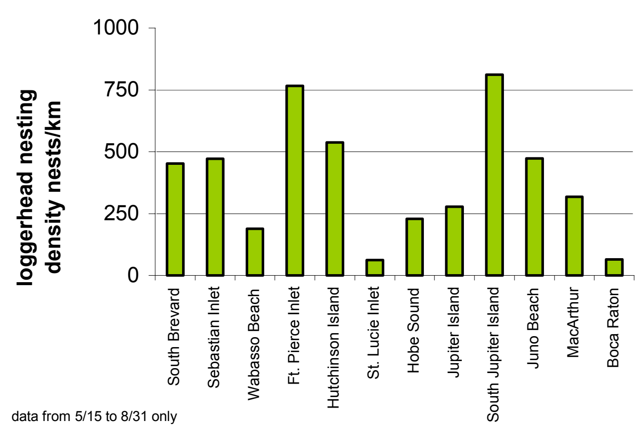

Fig. 5. Comparison of INBS beaches, 2001.

Long-term effects of beach renourishment on the nesting biology of sea turtles: a four-year study at Masonboro Island, North Carolina

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Significant alterations in sand density, moisture content, color, grain size, grain shape, temperature, mineral content, shear resistance, and beach slope may result with the input of sediment types from alternate sources of sediment storage during beach renourishment. The effects of beach renourishment on sediment characteristics were studied over a four-year renourishment cycle on Masonboro Island, NC. Since the construction of a jetty on its north end, Masonboro Island has been robbed of the natural longshore transport of sand and is severely eroding. Four-year renourishment cycles, begun in 1986, have deposited a total of 1,793,268 m3 of bypassed sand from Masonboro Inlet. This study focuses on the most recent renourishment cycle (1998-2002) and was designed to investigate the long-term effects of renourishment on grain size analysis, compaction, and sediment temperatures as is relates to sea turtles and their nesting environment. Sediments in the renourished section of Masonboro consist primarily of sand that varies tremendously in compaction and temperature across the length of the study period. This variation is attributable to beach tilling, resulting in poorly compacted sediments immediately after renourishment that become densely compacted over time. Sediments in the control section consist largely of shell hash that tends to maintain a constant level of compaction and temperature over time. This investigation indicates that renourished sections of Masonboro Island are more variable in sediment characteristics over time than are control sections, and that sea turtles must be able to deal with these fluctuating nesting environments to be successful.

Characterization of sea turtle nesting trends and depredation rates at the Merritt Island NWR, Kennedy Space Center, Florida

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US Fish and Wildlife Service, Merritt Island NWR, P.O. Box 6504, Titusville, Florida 32782, USA

The Merritt Island NWR (MINWR) manages and monitors 9.8 km of beach in east central Florida. Three species nest at MINWR including, Loggerhead (*Caretta caretta*), green (*Chelonia mydas*), and leatherback turtles (*Dermochelys coriacea*). From 1991-2001, the mean annual nests recorded for *C. caretta* was 1,338 (SD=320.6), and 54 (SD=72.0) for *C. mydas*. Six *D. coriacea* nests were recorded between 1991-2001. Predators at MINWR include: racoon (*Procyon lotor*), feral swine (*Sus scrofa*) and ghost crab (*Ocypode quadrata*). Since 1991, mean annual nest depredation by *P. lotor* was 36.4 (S=27.4), however, there were fewer nests depredated by P. lotor between 1994 -1996 (mean=29.7; SD=18.3). *S. scrofa* apparently displaced *P. lotor* as the primary predator during this period (mean=79; SD=11.5). Overall, a depredation rate of sea turtle nests over the past 11 years was 5.17%.

Federal lands along the east coast of Florida provide some of the most important sea turtle nesting beaches in the western hemisphere. Since 1991, there has been a significant increase in nesting *C. mydas* (r^2=0.28; p<0.01). Sea turtle nest depredation is well documented. Ehrhart (pers. comm.) indicated that nest depredation was as great as 90% during the late 1970s along the same MINWR beaches. Our data show that an aggressive and highly effective predator control program can decrease the depredation of sea turtle nests well below an annual rate of 10%.

Effects of an extensive shore nourishment project on marine turtle nest production and reproductive success at Patrick Air Force Base, Florida

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Patterns of marine turtle nesting success, nest production and reproductive success have been studied on the 7 km beach of Patrick Air Force Base on the central east coast of Florida, for fifteen years. In 2001, prior to the nesting season, 5 km of this beach underwent a shore nourishment project to extend the shoreline and reestablish dune structure by importing additional sand. The remaining 2 km of adjacent beach was maintained at its original profile. This provided the basis for comparison of nourishment effects on marine turtle nesting and reproductive success. Nesting success was studied by visual assessments of crawls to differentiate nesting and non-nesting emergences. In nourished areas non-nesting emergences were categorized as to the stage at which nesting was abandoned. A representative sample of these nests was monitored throughout incubation to assess reproductive success. As part of reproductive success, hatchling disorientations were also quantified. In the recent past Patrick Air Force Base has had a relatively small number of incidents involving the disorientation of emerged hatchlings. The 2001 season saw a substantial increase in the numbers of disorientations in the 5 km of newly nourished beach. This increase is attributed to the eastward extension and increased elevation of the beach profile. This new profile revealed light sources that had not been visible previously. The altered profile and the effects of beach nourishment on marine turtle nesting activity will be discussed.

Productivity and incubation parameters of the leatherback hatchery at Parque Nacional Marino Las Baulas, Costa Rica: 1999/2000 and 2000/2001 seasons

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Playa Grande, Parque Nacional Marino Las Baulas, Costa Rica is among the most important nesting beaches of the endangered Leatherback turtle. Since 1997 we have used a hatchery as a conservation tool to increase the number of hatchlings into the population. From October to December we relocate nests laid below the high tide line into the hatchery. Approximately five thousand hatchlings are recruited into the population every season from the hatchery. Clutches of relocated eggs would not survive due to tidal inundation if they were left at the natural locations. Here we explain our results for the 1999/2000 and 2000/2001 seasons and point out the effectiveness of the hatchery by comparing hatchery and beach Hatching and Emergence success. We excavated all hatchery nests two days after the hatchlings emerged from the nest. In-situ nests were marked on the beach when the eggs were laid. We recorded number of hatchlings that came up, number of hatchlings found dead and alive inside the nest, and the number of egg shells. We differentiated four development stages in the unhatched eggs: stage zero - when we could not visually identify any signs of fertilization; stage one - when we could observe a black spot from vein vessels and/or an uncolored embryo; stage two - when the embryo was not pigmented but had distinctive black eye balls; and stage three - when the embryo was pigmented. We calculated hatching success of each nest by dividing the total number of hatchlings by the total number of eggs. The emergence success was calculated by dividing the number of emerged hatchlings by the total number of eggs. Temperatures of incubation were monitored in hatchery and beach nests throughout the nesting season. In addition, we used thermal profiles at different depths (10, 25, 50 75 and 100 cm) inside and outside the hatchery and in a central part of the beach.

Hatching and emergence success were higher in the hatchery than in the beach in the two seasons studied. Excavation results showed that most of the eggs died in an early stage (0 or 1). Temperatures were not significantly different between hatchery and beach thermal profiles. We recorded hatchery and beach nest temperatures similar to those of the thermal profiles at 75 cm of depth at the beginning of the incubation period. The temperatures in the nest increased gradually throughout the incubation period reaching temperatures at the 00/01 season as high as 34 º C before hatching.

Finally, we have shown in the present work the effectiveness of the hatchery in Playa Grande and its importance as a conservation tool. Protection and monitoring of the nests moved to the hatchery do probably explain the highest success in the hatchery. We can conclude that hatchery and beach temperatures are similar and thus, the sex ratio in the hatchery will not differ of that of the beach. Differences in hatching success between seasons could be explained by seasonal changes at the beach, such as temperature, but other reasons could also lead to changes in hatching success. Variation in the oceanic and feeding conditions previous to migration and during migration could result in a variation of the fitness of the individuals that come to nest to Playa Grande and therefore, of the overall hatching success.

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The effects of 2001 summer storm events on nest incubation temperatures and implications for hatchling sex ratios during previous nesting seasons on Keewaydin Island, Florida

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INTRODUCTION

The loggerhead, *Caretta caretta*, nesting season in southwest Florida occurs from May to August with hatching continuing until October (LeBuff 1990). The nesting season overlaps with the hurricane season, which extends from June to November and peaks during September. Most nests are either hatched or fairly advanced in development by the time catastrophic storms impact the coast. During 2001, however, a major storm event occurred in July. Many nests were either severely inundated or washed away. Two more major storm events impacted southwest Florida before the end of turtle season. Hurricane Barry and Tropical storm Gabrielle impacted the coast in August and September, respectively.

Many studies have examined the roles of incubation temperature and incubation duration in predicting hatchling sex ratios of loggerheads, *C. caretta* (Yntema and Mrosovsky 1982, Mrosovsky 1988, Marcovaldi et al. 1997, Mrosovsky et al. 1999, Godley et al. 2001). In Florida, beaches on the east coast appear to be producing female biased clutches (Mrosovsky and Provancha 1992, Hanson et al. 1998), while the southwest coast beaches may be producing 1:1 sex ratios (Foley et al. 2000).

The initial goal of this project was to examine whether shade from Australian pines influenced nest incubation temperatures. However, due to the storm events, insight was gained on the effect of large rainfall amounts on incubation temperatures.

METHODS

The study was conducted on Keewaydin Island, which is located off the coast of Naples, Collier County, Florida. During the 2001 nesting season Hobo temperature data loggers (Onset Computer Corporation, Pocasset, MA) were deployed as controls in the sand at approximate mid egg chamber depth. Single channel and 4 probe Hobo temperature data loggers were opportunistically deployed in loggerhead nests throughout the nesting season. Upon hatching of the nests, the contents were excavated and evaluated to calculate hatching success. Data loggers were recovered and their data were downloaded using BoxCar Pro 4.0 software (Onset Computer Corporation, Pocasset, MA). Keewaydin Island sea turtle nesting data were obtained from the Conservancy of Southwest Florida for 1990 – 2001. Yearly average incubation duration and hatching success were calculated.

Monthly rainfall totals 1990 – 2001 were obtained from the Southwest Florida Water Management District for the Marco Island station. Rainfall totals were summed per sea turtle nesting season (May to October) each year. Monthly average air temperatures for 1990- 2001 were obtained from the Southeast Regional Climate Center for the Naples station. These data were also summed to represent the average air temperature during the sea turtle nesting season each year.

RESULTS AND DISCUSSION

The 2001 summer storms washed away large portions of beach and formed scarps several feet high in some areas on Keewaydin Island. Out of 184 nests, 110 were completely washed away. Out of 54 data loggers deployed, 28 were washed away, and 5 were washed away but later retrieved on the beach. Data from the loggers showed distinct temperature decreases that corresponded to the storm events. This indicates that large amounts of rainfall decrease incubation temperatures and therefore may affect sex ratios. The average and standard deviation temperatures for the middle third of incubation were also calculated. Based on a 29C pivotal temperature (Mrosovsky 1988), most of the nests appeared to be male biased.

Air temperature, rainfall, incubation duration and hatching success from 1990 – 2001 were tested for correlation. The Pearson correlation indicated that hatching success and rainfall were inversely correlated and that incubation duration and air temperature were inversely correlated. Based on a 62 day pivotal incubation duration (Godley et al. 2001), it appeared that 1994 and 2001 produced male biased clutches while other years may have produced ratios that were closer to 1:1.

Our results suggest that unlike predictions of Florida's east coast, Keewaydin Island is not producing female biased clutches. These results are similar to those of Foley et al. (2001), thus indicating that southwest Florida nesting beaches may be important in contributing males to a possible female skewed population.

Acknowledgements. The authors would like to thank everyone that contributed to this study: Conservancy of Southwest Florida 2001 sea turtle interns, Tricia Clune, Lisa Fairchild, Kristy McKee, and Christine Hodge for their hard work and dedication deploying data loggers; Alyssa Geis for calibrating and preparing the data loggers for deployment; Rookery Bay NERR staff for their assistance in the field searching for washed out and missing data loggers; and Jeff Schmid for his statistical assistance using SAS.

LITERATURE CITED

Foley, A.M., S.A. Peck, G.R. Harman, and L.W. Richardson. 2000. Loggerhead turtle (*Caretta caretta*) nesting habitat on low-relief mangrove islands in Southwest Florida and consequences to hatchling sex ratios. Herpetologica 56:433-445.

Godley, B.J., A.C. Broderick, and N. Mrosovsky. 2001. Estimating hatchling sex ratios of loggerhead turtles in Cyprus from incubation durations. Marine Ecology Progress Series 210:195-201.

Hanson, J., T. Wibbels, and R.E. Martin. 1998. Predicted female bias in sex ratios of hatchling loggerhead sea turtles from a Florida nesting beach. Canadian Journal of Zoology 76:1850-1861.

LeBuff, C.R. 1990. The loggerhead turtle in the Eastern Gulf of Mexico. Caretta Research, Inc., Sanibel. 216 p.

Marcovaldi, M.A., M.H. Godfrey, and N. Mrosovsky. 1997. Estimating sex ratios of loggerhead turtles in Brazil from pivotal incubation durations. Canadian Journal of Zoology 75:775-770.

Mrosovsky, N., C. Baptistotte, and M.H. Godfrey. 1999. Validation of incubation duration as an index of the sex ratio of hatchling sea turtles. Canadian Journal of Zoology 77:831-835.

Mrosovsky, N. 1988. Pivotal temperatures for loggerhead turtles (*Caretta caretta*) from northern and southern nesting beaches. Canadian Journal of Zoology 66:661-669.

Mrosovsky, N. and J. Provancha. 1992. Sex ratio of hatchling loggerhead sea turtles: Data and estimates from a 5-year study. Canadian Journal of Zoology 70:530-538.

Yntema, C.L. and N. Mrosovsky. 1982. Critical periods and pivotal temperatures for sexual differentiation in loggerhead sea turtles. Canadian Journal of Zoology 60:1012-1016.

Preliminary results of the effects of beach renourishment on nesting preferences in loggerhead sea turtles (*Caretta caretta*) on South Carolina's beaches

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INTRODUCTION

The loggerhead turtle (*Caretta caretta*) was listed as a threatened species by the United States Endangered Species Act of 1973, as amended. The loggerhead relies on many of South Carolina's beaches for nesting purposes. At the same time, sand renourishment occurs on many of these beaches. The purposes of beach renourishment are for storm damage protection, to restore habitat to promote the survival of plants and animals and to maintain aesthetically pleasing locations for human recreation. Unfortunately, beach renourishment can sometimes alter the sand compaction of the natural beach and therefore, affect nest site selection of sea turtles. It is typically required by the United States Fish and Wildlife Service to till the beach after a renourishment project takes place in order to reduce compaction levels. There has been debate in South Carolina on whether tilling is necessary and if compaction levels actually effect nest site selection in loggerheads. Therefore, this study was conducted to initiate the evaluation of the current situation in South Carolina. This study examined compaction levels of two South Carolina beaches, Hilton Head Island (a renourished, untilled beach) and Kiawah Island (a natural beach). The compaction levels were compared to loggerhead turtle nest site selection. Similar studies have been conducted on Florida's beaches, but none on South Carolina's beaches (Ernest and Martin 1999, Raymond 1984, Steinitz et al. 1998, Ryder 1998).

METHODS

Kiawah Island (Control beach) - a developed, private barrier island; never been renourished; homes are located away from the beach; beach is wide, flat and fairly stable; well-developed dune fields. Hilton Head Island (renourished beach) – the largest barrier island on the South Carolina coast; has large gated communities, homes, condominiums, and multi-story oceanfront hotels; the portion of the beach sampled was renourished and not tilled in both 1991 and 1997 (Hopkins-Murphy et al. 2001). A mile-long transect was set on both Kiawah Island and Hilton Head Island with sampling sites approximately every 500 feet. Nest location coordinates were recorded using a Geographic Positioning System (Rockwell PLUGR). Compaction measurements were taken using a portable static cone penetrometer (Durham Geo-Enterprises, Model S-214) at every sampling site on the top of the dune, berm, and intertidal zone at ~15 cm, ~30 cm and ~46 cm depth. The United States Fish and Wildlife Service Biological Opinion template of compaction methods for renourishment projects in the southeastern United States was followed. Data were analyzed using Microsoft Excel's Data Analysis function (Descriptive Statistics and Two-Sample t-tests).

RESULTS AND DISCUSSION

Kiawah Island (Control beach) – 6 nests on berm, 6 nests on dune. Hilton Head Island (renourished beach) – 7 nests on berm. Compaction – trend of compaction increasing as depth increased. Ernest and Martin (1999) found the same correlation. Dune compaction – Hilton Head Island more compact than Kiawah Island at ~15 cm, ~30 cm and ~46 cm depth at 0.01 significance level (Fig. 1). Ryder (1993) and Steinitz et al. (1998) both studied beaches in Florida. Ryder found that compaction values were significantly higher on a renourished beach than on the control beach. This was attributed to the manner in which the material was deposited and not the grain size and moisture content. Steinitz et al. found that hardness at the renourished sections was significantly greater than at the control section, except at the lower beach zone. The Steinitz study also showed that abandoned nesting attempts were positively correlated with the greater surface hardness of the renourished beach. Berm compaction – Hilton Head Island more compact than Kiawah Island at ~30 cm and ~46 cm depth at 0.07 and 0.04 significance level, respectively (Fig. 2). Intertidal Zone Compaction – There was no difference in hardness between Hilton Head Island and Kiawah Island sands. Compaction closest to nests – Hilton Head Island more compact than Kiawah Island at ~30 cm and ~46 cm depth at 0.005 significance level (Fig. 3). Hilton Head Island Nests – Turtles did not select nest site on hardness of sand. Typically, sand was more compact where turtles nested than on entire mile stretch, but results were not statistically significant (Fig. 4). Raymond (1984) and Ernest and Martin (1999) both studied beaches in Florida. Raymond observed turtles on the renourished beach wandering to the dunes to find a nest site after attempting to dig in the more compact sand of the berm area. Ernest and Martin found that compaction levels where the nests were laid versus abandoned digging sites were no different. Therefore, sediment compaction did not prevent the turtles from nesting on the renourished beaches. However, they observed that loggerhead turtles nested less frequently and abandoned digging attempts more often on the renourished beaches than on the control beaches. Kiawah Island Nests – Turtles did not select nest site on hardness of sand. Typically, the sand was more compact where the turtles nested than on entire mile stretch. Results were not significant, except for nests on the dune at ~15 cm depth at the 0.06 level (Figs. 5, 6).

CONCLUSIONS

Sand on the renourished beach was typically more compact than on the Control beach. In this small sample size, loggerhead sea turtles on Hilton Head Island (renourished beach) and Kiawah Island (Control beach) did not select nest sites based on compaction values. However, some studies in Florida have shown that greater compacted sands may decrease hatchling success (Ernest and Martin 1999; Steinitz et al. 1998). Conversely, Raymond (1984) found no significant difference in hatch percentages between the renourished and control beaches and Broadwell (1991) found that the renourishment project actually increased hatchling emergence success and hatchling fitness. This finding was attributed to the higher moisture content and increased pore spacing that resulted in better gas exchange between the turtles and the external environment (Broadwell 1991). It should be noted that each renourishment project and beach is unique in its physical parameters and characteristics and therefore, generalizations should not be made based on any one beach. In conclusion, additional data are needed before tilling requirements for renourishment projects can be relaxed.

Acknowledgements. I would like to thank A. Shirey, P. Sisson, D. Owens, A. Halfacre, M. Jones, R. Coller-Socha, J. Hadden, D. Marcy, L. Miller, S. Hopkins-Murphy and D. Griffin. I would also like to thank everyone at the United States Army Corps of Engineers, Charleston District, and University of Charleston, South Carolina for their support and encouragement. Thanks are also extended to South Carolina's sea turtle monitoring network volunteers, especially those at Kiawah Island and Hilton Head Island. Special thanks to my family and

friends for their moral support throughout this project. Without all of you, this study would not have been possible.

LITERATURE CITED

Broadwell, A.L. 1991. Effects of beach renourishment on the survival of loggerhead sea turtle nests. Masters thesis, Florida Atlantic University, Boca Raton, Florida, 32. p.

Ernest, R.G. and R.E. Martin. 1999. Martin County Beach Nourishment Project, Sea Turtle Monitoring and Studies 1997 Annual Report and Final Assessment. Ecological Associates, Inc., Jensen Beach, Florida. 86 p.

Hopkins-Murphy, S.R. Murphy, T.M. Hope, C.P. Coker, J.W. and M.E. Hoyle. 2001. Population trends and nesting distribution of the loggerhead turtle (*Caretta caretta*) in South Carolina 1980-1997. South Carolina Department of Natural Resources, Division of Wildlife and Freshwater Fisheries, Wildlife Diversity Section, 41 p.

Raymond, P.W. 1984. The effects of beach renourishment on marine turtle nesting in South Brevard County, Florida. Masters thesis, University of Central Florida, Orlando, Florida, 116 p.

Ryder, C.E. 1998. The effects of beach renourishment on sea turtle nesting and hatching success at Sebastian Inlet State Recreation Area East-Central, Florida. Masters thesis, Virginia Polytechnic Institute and State University, Blacksburg, Virginia. 109 p.

Steinitz, M.J., Salmon, M. and J. Wyneken. 1998. Beach renourishment and loggerhead turtle reproduction: a seven year study at Jupiter Island, Florida. Journal of Coastal Research 14:1000-1013.

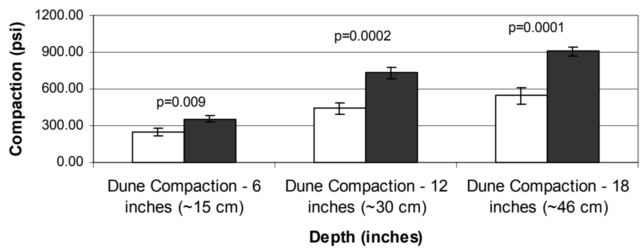

Fig. 1. Dune compaction – Kiawah Island (control, natural, n=12; white bars) vs. Hilton Head Island Stations (renourished, untilled, n=10; black bars).

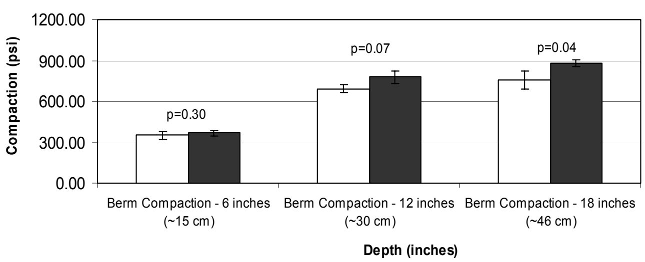

Fig. 2. Berm compaction — Kiawah Island (control, natural, n=12; white bars) vs. Hilton Head Island Stations (renourished, untilled, n=10; black bars).

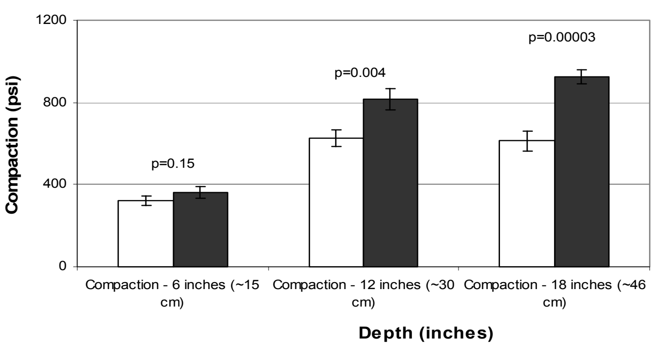

Fig. 3. Nest compaction — Kiawah Island (control, natural, n=12; white bars) vs. Hilton Head Island Stations (renourished, untilled, n=10; black bars).

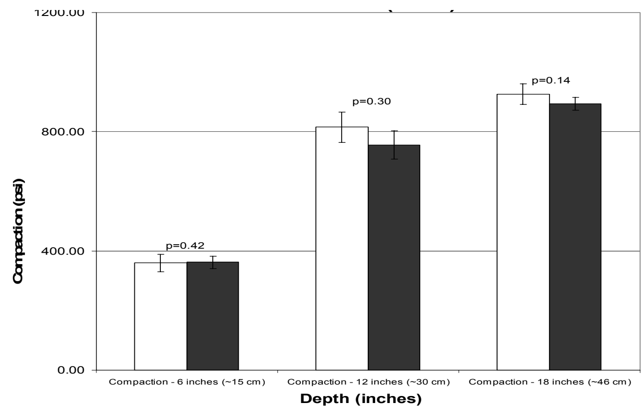

Fig. 4. Compaction – Hilton Head Island Nests (n=7; white bars) vs. stations (n=10; black bars).

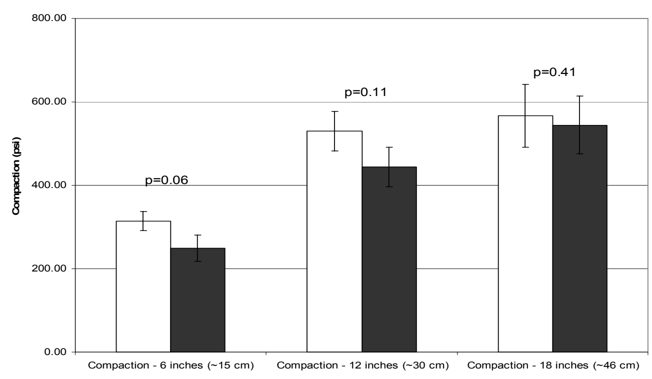

Fig. 5. Dune compaction – Kiawah Island Nests (n=6; white bars) vs. stations (n=12; black bars).

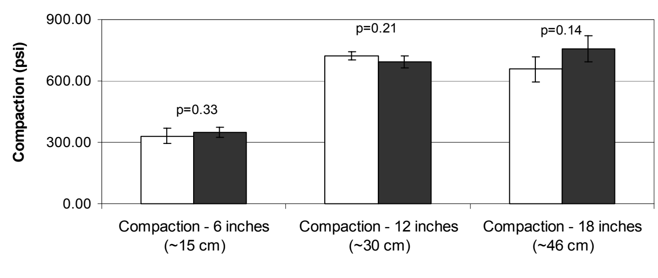

Fig. 6. Berm compaction – Kiawah Island nests (n=6; white bars) vs. stations (n=12; black bars).

Turtle conservation in Gabon and Republic of Congo

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CAPE ESTERIAS

Geography. From Point Corona in Equatorial Guinea to the Cape of Santa Clara in Gabon, Cape Esterias is an estuary coastline. In fact, there exist a variety of features, including rocky sectors, some sandy beaches and areas covered by mangroves. The area is also distinguished by two important bays: the estuary of Muni or the Rio Muni, and the Bay of Mondah.

Fauna. We distinguish four species of sea turtles which came for nesting and/or for feeding. Leatherback (*Dermochelys coriacea*) nesting, hawksbill (*Eretmochelys imbricata*) feeding, green (*Chelonia mydas*) nesting and feeding, and olive ridley (*Lepidochelys olivacea*) nesting and feeding.

Flora. Some of the rocky stretches are notable for the presence of vegetation which represent important feeding grounds for green turtles and for young hawksbill turtles. The importance of these areas for adult green turtles is confirmed by their high rate of capture by the artisanal fishermen.

Human activities. The local communities of Cape Esterias and the Bay of Mondah exploit sea turtles for meat. Turtles are captured in the nets placed by fisherman or are killed by gun or harpoon. We have evaluated this activity for its effect on the sea turtles which come to feed at the site. The tendency of the population is difficult to distinguish, but the long-term effects of unsustainable hunting will undoubtedly lead to a decrease in the rates of reproduction and growth in the population.

PONGARA

Geography. The site is separated from Libreville by an estuary of about 11 km wide. Pongara is about 5 km long, and includes all the beaches from Point Denis to Point Wingombe. The beaches are fine sand, up to 20 meters wide and surrounded by a coastal savannah. Close to Wingombe the beach is much more narrow due to marine erosion. The beach is encumbered in some places by logs which have escaped from the timber park of Owendo, which is located to the south of Libreville. Although these logs may help to reduce the beach erosion, they also constitute a serious obstacle for the turtles that came to nest.

Fauna. We distinguish four species of sea turtles which came for nesting: leatherbacks, hawksbills, green turtles, and olive ridleys.

Human activities. Pongara is a sensitive zone, exposed to the activities of fishermen, villagers and tourists who often do not understand the ecological importance of the area. As a result, the fauna of the site, and in particular the sea turtles, remain exposed to a large number of threats. Pongara attracts, on weekends and holidays, an important number of tourists from Libreville. On the 6 km from the Point Denis village, there exist more than 65 private bungalows and 4 hotels. There is also an intensive use of jet- skis and all-terrain vehicles along the beach night and day. In 1996, ASF investigations with the local communities (especially fishermen) revealed that sea turtle exploitation for their meat and eggs had decreased the capacity of the species to maintain the level of their population, mainly for the turtles with shells (green, olive ridley and hawksbill). Since 1997, the actions of sensitization of the populations and visitors are supplying the activities of identification and marking of sea turtles and the supervision of the beach.

MAYUMBA

Geography. The 80 km of beach from Mayumba in the south of Gabon to the border with the Republic of Congo shelter the most important breeding ground in the world for leatherback turtles. The beaches of Mayumba are interrupted by 6 lagoons, the largest being the Banio lagoon, which opens up to the sea to the north of Mayumba. Banio is enclosed by a peninsula of land adjacent to the sea which for nearly 70 kms. This lagoon is navigable in all seasons. The other smaller lagoons enter the sea by channels which open and close according to the rivers which are influenced by the tides.

Fauna. We distinguish four species of sea turtles which came for nesting: leatherbacks, hawksbills, green turtles, and olive ridleys.

Human activities. The mains threats which weigh on these sites are: 1) nest looting and the poaching of the females during the nesting period by the people from Mayumba and the villages located along the Banio lagoon; 2) the periodic discharges of oil from petroleum exploitation; 3) the marine pollution from various sources; and , 4) the industrial fishing boats working close to the shore. Given the importance of the beaches of southern Gabon for the reproduction of Leatherback and Green turtles, in 1998 ASF commenced a program of identification and intensive marking of sea turtles. In addition, we have engaged in an environmental education campaign with the local communities.

CONKOUATI

Geography. The Conkouati- Douli National Park is located in the south of the Republic of Congo, at approximately 160 km from Pointe Noire. This Park has an area of over 500,000 hectares, and includes a marine component as well as over 30 km of beaches important for turtles .

Fauna. We distinguish four species of sea turtles which came for nesting: leatherbacks, hawksbills, green turtles, and olive ridleys.

Human activities. Conkouati shelters a human population of about 3000 inhabitants who depend on hunting, fishing and agriculture. The villagers fish in the lagoons (the largest of which is the Conkouati lagoon, from which the Park gets its name) and sometimes in the sea, and they consume the meat and eggs of marine turtles of all the species (predominantly leatherback and olive ridley). The beaches of Conkouati are contiguous with Mayumba, and have been proposed from a transboundary protected area between Gabon and Congo. ASF has worked with the Wildlife Conservation Society in Conkouati-Douli to train field teams in turtle identification and marking, and to help with the environmental education program with local communities.

500 Hours in a Jeep: documenting the start of a new rookery and an explosive increase in leatherback nesting in Florida

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INTRODUCTION

To date there are just a few scattered reports of leatherback nesting data from Florida (nesting success, internesting intervals, population sizes), and fewer morphometric data for these turtles (Caldwell 1959, Yerger 1965, Meylan et al. 1995, Wyneken et al., in press). Northern Palm Beach County has the highest leatherback nesting density in the continental United States. In 2000 more than half the nests in Palm Beach County (83 of 160) and over 21% of the nests in the continental US were deposited between Jupiter Inlet and Lake Worth Inlet. We focused our study on Juno Beach because in the past this site alone received approximately 10% of all leatherback nests deposited in Florida each year (Witherington and Meylan 2001).

In response to the paucity of data on leatherbacks nesting and anecdotal trends in Florida, and the apparent increase in the population, a new mark-recapture project was initiated in 2001. The objectives of this program are to (a) establish the size of the Palm Beach County leatherback population, (b) collect data on individual turtles essential for future determination of vital rates (remigration intervals, internesting intervals, clutches/season and emergence success of nests), and (c) collaborate with others doing comparable studies on leatherbacks (individual identification, genetic sampling, and other tagging programs). We believe we may be witnessing the rapid development of a major rookery in Florida. We also hope that our studies will contribute to a better understanding of how rapidly these rookery sites are established by leatherbacks.

MATERIALS AND METHODS

The study area is in northern Palm Beach County, encompassing Jupiter and Juno Beaches. The beach (5.9 km in length) was surveyed each evening from 2100 h to 0600 h. Surveys, designed to be minimally invasive, were conducted by driving a Jeep on the coastal roadway that paralleled the beach, then scanning the area from frequent beach entry points. When a turtle was spotted using night vision equipment, we waited until egg deposition had begun. This was determined to be when the turtle stopped moving after having dug the egg chamber. The turtle was approached quietly, and on first inspection, examined for existing metal or plastic flipper tags or tag scars. Measurements included straight carapace length (notch to tip – SCL), curved carapace length (CCL), straight carapace width (SCW), curved carapace width (CCW), head width and length, and whenever possible circumference at the widest part of the body. Skin biopsies were taken from the rear flippers to provide genetic samples that were sent to the National Marine Fisheries Service (NMFS) for analysis and entry into their international sea turtle genetic database. Digital infrared photographs were taken of characteristic markings; particularly the pink spot on the head (used for photo id), and to document and catalogue any injuries (e.g. boat strikes, those consistent with fishery interactions, or courtship wounds).

Each morning, all nests were marked with stakes. Nest locations were recorded using real-time DGPS (sub-meter accuracy); data points were downloaded into a computer for analysis and mapping. After an emergence or 80 days after egg deposition, nests were excavated to determine success.

RESULTS

The nesting population. Thirty individual females, ranging in size from 148.0 cm to 163.0 cm (CCL) were identified. We tagged 22 turtles (20 with PIT tags and flipper tags, 2 with flipper tags alone). Other turtles were identified but not tagged because they were located as they were returning to the ocean (after nesting). Tagging data were sent to the Archie Carr Center for Sea Turtle Research (ACCSTR), for inclusion in the tagging database (available at: http://accstr.ufl.edu/cmttp.html).

Females. Most leatherbacks (40%) nested between 0200 - 0300 h, whereas only 10% were observed nesting later. Internesting intervals for the 5 turtles that we recaptured ranged from between 9 to 11 days. Several turtles had injuries on the flippers or head that appeared to be consistent with fishing or boating related interactions.

Nests. Juno Beach received a total of 127 leatherback nests - 38 of those were observed during our night surveys. 100 nests were excavated to determine nest success. The average clutch contained 79 yolked eggs (SD=17.2) and 22 unyolked eggs (SD=11.3). Hatching success values ranged from 60% to 87%, with an average hatch success of 66%. An average of 53 hatchlings emerged from each nest (range: 4 - 107); in total 5300 hatchlings entered the ocean from this beach for the 2001 season.

DISCUSSION

This study effectively doubled the existing morphometric information available on leatherback turtles in Florida. Our most surprising result was the large number of females we found nesting at our site. Initially we expected only 7 or 8 turtles, based on internesting intervals and clutch frequency/season values from other sites (Van Buskirk and Crowder 1994).

Northern Palm Beach County may serve as the most important southeastern US nesting site for leatherbacks for a number of reasons: its location close to the Gulf Stream, the darkness of the beaches, and its accessibility to deep water. Nearly 80% of all the turtles we observed (30/38), were previously unknown to us, and did not carry tags. It is likely that turtles nesting in southeast Florida show low site fidelity to specific beaches but probably show high site fidelity to the geographic region. This can be determined with future years of monitoring and through cooperation with other Florida research groups.

One-third of the turtles we observed (10/30) had open wounds, cuts and abrasions that may have been caused by entanglement with fishing gear or rope. Many of these injuries were on the head and front flippers. The most significant cause of mortality for these large pelagic turtles is fishing interactions (NMFS 2001). In the longline fishery, leatherbacks are most likely to be hooked in the head and shoulder region when diving or foraging for jellyfish (S. Epperly pers. comm.).

This relatively new population of nesting leatherbacks appears to be increasing explosively. Documenting and tracking the trends at this beach, and at others in Florida (e.g. Hutchinson Island, Melbourne, Boca Raton) could be critical to the recovery of Atlantic populations of leatherbacks. If, as our data indicate, the number of individuals nesting here is increasing, a significant portion of the Atlantic nesting population may come to depend upon continental nesting sites in the US. This is important because unlike island beaches, there is more nesting habitat available in South Florida, and this makes the overall risk of extirpation to the Florida population less than one would expect at isolated beaches. Other nesting aggregations in the Caribbean appear to be larger, but if present trends continue that balance may well eventually shift to Florida's beaches. It therefore becomes imperative that rookery beaches in southeastern Florida are properly managed, preserved, and protected to expedite the recovery of the Atlantic leatherback population.

Future plans. We plan to expand our survey area to include adjacent beaches to provide more robust data for the determination of vital rates (to be used in recovery plans). We also plan additional ecological and physiological studies that will lead to a better understanding of this turtle's life history characteristics. Because it is a new and growing rookery, our study site (Juno Beach) may be part of the most significant nesting habitat for this species in the Western Hemisphere. Defining the population genetically, establishing its trends in growth, and determining its contribution to the recovery of the species remain our top priorities.

The only other group to attempt this kind of labor-intensive study is the University of Central Florida, at Melbourne beach. Our expansive beaches and nesting habitat make saturation tagging more difficult than tagging on isolated or island beaches, but the important thing is that we have begun, finally, to properly document this population.

Acknowledgements. We would like to thank our night survey volunteers. Special thanks to Andy Simler and Barbara Geyer for housing. Funding was provided in part by the Pompano Fishing Rodeo, anonymous donors and personal resources. Thanks to Paul Davis and Bud Howard (PBC – ERM) for the use of aerial photographs. This study was conducted under Marine Turtle Permit #077. Mike Salmon and Jeanette Wyneken provided thoughtful discussion. The project continues in 2002; funding has been secured from National Save the Sea Turtle Foundation, the Florida Marine Turtle Grants Program and donations to our website (www.floridaleatherbacks.com), including turtle "adoptions."

LITERATURE CITED

Caldwell, D.K. 1959. On the status of the Atlantic leatherback turtle, *Dermochelys coriacea*, as a visitant to Florida nesting beaches, with natural history notes. Quart. J. Florida Academy of Sciences 21:285-291.

Meylan, A.B., B. Schroeder, and A. Mosier. 1995. Sea turtle nesting activity in the State of Florida 1979-1992. Florida Marine Research Publications June 1995, No. 52, 51 p.

National Marine Fisheries Service. 2001. Stock assessments of loggerhead and leatherback sea turtles of the Western North Atlantic. NOAA Tech. Memo. NMFS-SEFSC – 455 343 p.

Van Buskirk, J. and L.B. Crowder. 1994. Life-history variation in marine turtles. Copeia 1994:66.

Witherington, B. and A. Meylan. 2001. Sea turtle nesting in Florida. Presented at the annual sea turtle permit-holders of Florida meeting, Gainesville, FL, January 20, 2001

Wyneken, J. In press. The leatherback in US east coast waters. In: M. Coyne, comp. Proceedings of the 21st Annual Sea Turtle Symposium. NOAA Tech memo. SEFSC - Miami

Yerger. 1965. The leatherback on the Gulf Coast. Copeia 1965:365-366

Egg harvesting, predation, and green turtle conservation in Pulau Banyak, Indonesia

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INTRODUCTION

Six of the seven marine turtle species occur in Indonesian waters, with green (*Chelonia mydas*), hawksbill (*Eretmochelys imbricata*), leatherback (*Dermochelys coriacea*) and olive ridley (*Lepidochelys olivacea*) turtles forming nesting populations. Many locations in Sumatra are nesting sites (Salm and Halim 1984). West Sumatra and Bengkulu support populations of green and leatherback turtles (Polunin and Nuitja 1982) and Pulau Banyak is the most recent Sumatran location to be noted of its green turtle population (Stringell et al. 2000).

Pulau Banyak (97o 05'E, 02o 03'N) is a remote archipelago off the western coast of Aceh, a northern province of Sumatra. The archipelago is designated a Recreation Park/Multiple Use Management Area (Taman Wisata Alam). Protection status is largely attributed to the green turtles that nest on Amandangan Beach found on Pulau Bangkaru, the western-most island of Pulau Banyak. In 1997, the Yayasan Pulau Banyak (Pulau Banyak Foundation) (YPB) initiated an environmental conservation and community development scheme. A major role of the YPB was to monitor the green turtles on Pulau Bangkaru and protect nests from the human pressures of egg take and natural predation by the water monitor lizard (*Varanus salvator*). Our aim was to quantitatively estimate nesting and predation in order to develop a conservation management plan for the Pulau Banyak district.

Nesting intensity and distribution. Green turtle nesting occurs year-round with peak nesting coinciding with the eastern monsoon from November to May. Surveys in 1997 and 1999 revealed a maximum of 13 clutches laid per night. This level of nesting translates to several thousands of nests being laid by several hundreds (100 - 500) of females annually (Stringell et al. 2000). The Pulau Bangkaru *C. mydas* rookery has a comparable number of nests laid annually to important rookeries found at Sarawak Turtle Islands (Malaysia) (Leh and Yakup 1996) and Pangumbahan (Java, Indonesia) (Sloan et al. 1994).

Between 16 February and 6 March 1999, 145 turtle emergences were recorded (82 nests, 59 non-nesting emergences of which 36 were u-turns, 4 unknown). The distribution of emergences in each of ten 130m stretches of beach that were marked as zones A to J are shown in Fig. 1. The distribution of nests laid on the beach departed significantly from an homogenous distribution ($G_{adj}=24.94$, df=4, $P<0.05$, n=82) with few nests in zones B, C and G. Non-nesting emergences (pooled u-turns and body pits) were distributed evenly on the beach ($G_{adj}=6.060$, df=8, $P>0.05$, n=59). The nature of the nesting distributions could be caused by the turtle actively selecting nest sites or passively aggregating due to physical or topographical features.

Egg predation. The Asian water monitor lizard (*Varanus salvator*) is the main predator of turtle eggs on Amandangan beach. Since *V. salvator* tracks were evident at 87% (33) of turtle emergences (nesting and non-nesting), we set out to quantify the level of predation on clutches of eggs in situ. Every morning before the monitor lizards became active, a sub-sample of 38 emergences was observed for predatory activity. Apparent foraging events were ranked into: 1 = No direct predator activity / Undisturbed nest; 2 = Direct predator activity / Disturbed nest - no egg consumption; and 3 = Direct predator activity / Disturbed and fully predated nest. Only 13% of nests were predated fully (rank 3) by the monitor lizards. Significant exploratory foraging (ranks 2 and 3) occurred on 56.5% of nests and it is possible that rank 2 events would be elevated into rank 3 with time (Table 1). Predation events on nests follow the distribution of nesting emergences (X^2=3.453, df=4, P>0.05) thus, predation events are heterogeneously distributed (Gadj= 15.6009, df=4, P<0.05).

Nest protection. Locally available materials were used to make a variety of nest guards to test their effectiveness. Simple cylindrical mesh guards with a wired lid prevented all attempts of V. salvator to access hidden and visible food items inside the experimental protection. However, with 13% of nests being fully predated and 56% receiving some exploratory digging, we suggest that nest protection or hatchery methods are not necessary to sustain the nesting population through recruitment.

Egg harvesting. In Aceh and North Sumatra turtle eggs are widely consumed and eggs collected from Nias, Simeulue and Pulau Banyak are sold at the coastal markets of the mainland ports that provide access to Pulau Banyak. Pulau Bangkaru has a history of intensive egg harvesting. In 1984 a 10-year concession to collect turtle eggs was granted by the Regency of South Aceh. Intensive egg collection was carried out commercially for 7 to 8 years with a typical yield of 10 000 to 30 000 eggs per month from about 3 to 10 nests each night. Based on 100 eggs per clutch, we estimate an annual take of between 120 000 and 360 000 eggs or 75-100% of the clutches laid annually on Amandangan beach. This level of harvest is comparable to the overexploitation, during the late 1970s, of several Malaysian green turtle rookeries in Sarawak (King 1982) and Sabah (de Silva 1982). Prior to the harvesting concession it has been estimated from community interviews that up to 25% of clutches were taken each year.

After the concession expired, the presence YPB helped reduce egg collection to about two or three nests per month (<1%) (Authors' pers. Obs.). The presence of researchers or project infrastructure can deter would-be poachers (Boulon 1999). At the end of 1999 the YPB terminated due to insufficient funds and political instability. Currently (2002), levels of now illegal egg take are minimal (<10% of nests annually), sporadic, and unlikely to significantly affect the viability of the green turtle population. However, if poaching resumes to raise the total egg loss (including natural predation) to
over 30% then a strategy needs to be developed to reintroduce researcher presence on Amandangan beach.

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LITERATURE CITED

Boulon Jr., R.H. 1999. Reducing threats to eggs and hatchlings: In situ protection. In: K.L. Eckert, K.A. Bjorndal, F.A. Abreu-Grobois, and M. Donnelly. eds. Research and management techniques for the conservation of sea turtles. IUCN/SSC Marine Turtle Specialist Group Pub. No. 4.

de Silva, G.S. 1982. The status of sea turtle populations in East Malaysia and the South China Sea. In: K.A. Bjorndal, ed. Biology and Conservation of Sea Turtles. Smithsonian Institution Press, Washington D.C. p. 327-339.

King, F.W. 1982. Historical review of the decline of the green turtle and the hawksbill. In: K.A. Bjorndal, ed. Biology and Conservation of Sea Turtles. Smithsonian Institution Press, Washington D.C. p. 183-188.

Leh, M.U. and Y. Yakup. 1996. The green turtle conservation programme of the Sarawak Turtle Islands, In: The First SEAFDEC Workshop on Marine Turtle Research and Conservation. SEAFDEC, ed. Marine Fisheries Resources Development and Management Department, Southeast Asian Fisheries Development Centre, Kuala Terengganu, Malaysia. p. 107-116.

Polunin, N.V.C. and N.S. Nuitja. 1982. Sea turtle populations of Indonesia and Thailand. In: K.A. Bjorndal, ed. Biology and Conservation of Sea Turtles. Smithsonian Institution Press, Washington, D.C. p. 353-362.

Salm, R.V. and I.M. Halim. 1984. Marine Conservation Data Atlas. IUCN/WWF Project 3108. Conservation for Development Programme, Bogor.

Sloan, N.A., A. Wicaksono, T. Tomascik, and H. Uktolseya. 1994 Pangumbahan sea turtle rookery, Java, Indonesia: towards protection in a complex regulatory regime. Coastal Management 22:251-264.

Stringell, T.B., M. Bangkaru, A.P.J.M. Steeman, and L. Bateman. 2000. Pulau Banyak (Sumatra, Indonesia) and its nesting green turtles. Marine Turtle Newsletter 84:20-24.

Table 1. *Varanus salvator* predatory foraging events on green turtle nests on Amandangan beach, Pulau Banyak (Aceh, Indonesia). Data from February and March 1999 was standardised to 8 nights of observations per nest. Rank 1 = Undisturbed nest, Rank 2 = Nest disturbed but no egg consumption and Rank 3 = Nest disturbed and fully predated. *13.04% of nests (n=3) received no attention by *V. salvator*.

Number of nests			% Predatory foraging	
Rank 1*	Rank 2	Rank 3	Rank 2 and 3	Rank 3
10	10	3	56.52	13.04

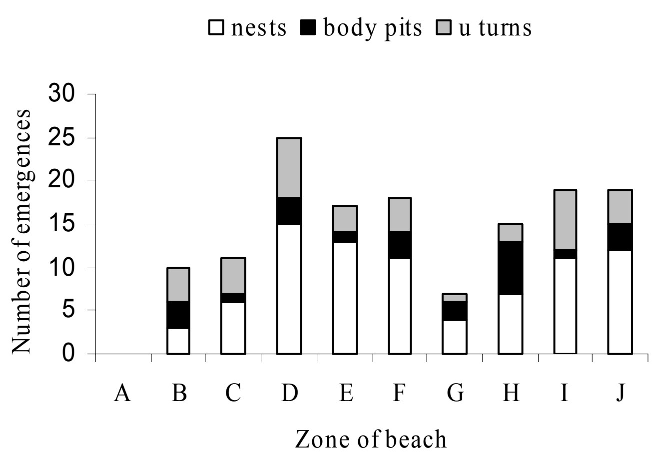

Fig. 1. The distribution and number of green turtle nests and non-nesting emergences ('u-turns' or primary body pit construction) recorded in February and March 1999 on Amandangan beach, Pulau Bangkaru (Aceh, Indonesia).

Breeding population status of sea turtles in Kachchh, Jamnagar and Junagadh coasts of Gujarat State, India

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Gujarat state is situated in the Northwestern frontier of India and has the longest coastline covering 1600 km and contributing 22% of the total coastline (7100 km) of India. However four endangered marine turtle species (*Dermochelys coriacea*, *Chelonia mydas*, *Lepidochelys olivacea* and *Eretmochelys imbricata*) are believed to occur in Gujarat coast, the information available on their breeding status and distribution is scant. Rapid industrial and maritime related developments along the coast posses severe threat to coastal ecology. Therefore under GOI – UNDP Sea Turtle Project an intensive status survey was conducted along the potential coastline of three districts (Kachchh, Jamnagar and Junagadh) of the state. During this study only nests of olive ridleys and green turtles were found. Out of 664 nests recorded, Green turtle nests contributed 69% (459 nests). Irrespective of species, the estimated overall nest density for the entire stretch was 1.82 nests/km. Among the districts, Jamnagar coast showed high nest density for both the (olive ridley 0.81 nests/km and green 3 nests/km) species compared to other districts. Egg predation by human and animal, spread of oil particles, sand mining and sewage pollution were the major threats identified in the study area. Overall egg predation rate along the coast was 57%. Nests were more prone to animal predation (36%) than human beings. Species specific predation rate showed that, olive ridley nests were under high predation (62%) compared to green turtle (55%) nests. Potential nesting beaches for each coastal district were identified and broad management strategies have been suggested.

Tayrona's National Park: a life opportunity for the sea turtles at the Columbian Atlantic Coast

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The evaluation made at the Tayrona's National Park of the 2001 nesting season as well as a beaches description, allowed us to establish *Eretmochelys imbricata* (hawksbill turtle) and *Caretta caretta* (loggerhead turtle) as the main species nesting in the area. There were a total of 22 hawksbill female turtles which laid 17 nests and 7 loggerhead turtles with 3 nests. The clutch size average it was 132. A total of 2 leatherback turtles (*Dermochelys coriacea*) with 2 nests and 1 green turtle (*Chelonia mydas*) showed a sporadic nesting behaviour of these species. This could be related to a migratory journey to Acandí beach in Colombia or towards other areas in Central America. According to these results, the Tayrona Park would be the main nesting place in the northern area of the Colombian Caribbean for species like loggerhead and hawksbill, despite other beaches considered important in this area. The beaches dynamic, its composition and the alternate use of beaches between species during the season were considered determinant factors in the selection of this area for reproductive processes of the species. However, in this preserved area threats like the stealing of eggs, tourist impacts, incidental catch in fisheries and the transformation of the habitats which affect the normal development of the reproductive process, still continue. This situation makes necessary to start protection campaigns, preservation and research of this area. The present study showed the importance that Tayrona's Park has for the preservation of the sea turtles in the Colombian Central Caribbean.

First nesting activity of the loggerhead sea turtle, *Caretta caretta*, in the Spanish Mediterranean coast

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INTRODUCTION

In the Mediterranean sea, the loggerhead sea turtle (*Caretta caretta*) nests preferably in the eastern and central basins, whereas in the western basin nesting activity is limited to sporadic emergences. The Spanish Mediterranean waters harbour large stocks of loggerheads, mainly juveniles, in foraging activity (Tomás et al. 2001). It is possible that this species has nested in the Spain's Mediterranean coast in the past. However, to date, the only nesting evidence reported in these coasts is the finding of a hatchling in a nature reserve at the Ebro River Delta (Llorente et al. 1993), although this possibility has been indicated in other previous studies. The sea turtle nesting season coincide with the tourist high season in the Mediterranean. The continuous development of tourism and the increasing demographic pressure throughout the Spanish Mediterranean littoral zone affects the conservation of these coasts. The environmental consequences caused by these human activities prevent the establishment of permanent sea turtle nesting beaches. Furthermore, if sporadic nesting activity exists, the daily cleaning of the beaches for tourists eliminate all the sea turtle tracks, making practically impossible the detection this activity. This presentation includes all the data concerning a loggerhead nesting event that occurred in July 2001 in Almería (southeast Spain), the first registered nesting of this species in the Iberian Peninsula.

RESULTS

On 27 July 2001 a sea turtle emerged to nest in a naturist tourism beach near the town of Vera (Almería, southeast Spain). This beach forms part of a 6 km sandy beach called "Palomares". In the part where this nesting event occurred the beach has approximately 50 m wide (in other parts reaches 150 m wide) and is limited by a promenade and urbanizations of bungalows. The beach is visited diary by a high number of persons, most proceeding from the urbanizations and being most of them foreigner tourists. The orientation of Palomares beach is east-southeast.

The geographical position of the nest was: 37º13′20.3′′N / 01º48′05.7′′W. The nest was placed at around 9 m to the high tide line. The owners of beach hammocks observed all the nest process, from 3:00 a.m. to 5:00 a.m., when the turtle returned to the sea after cover the nest. The description of the turtle given by the observers indicated that the turtle was likely a loggerhead, a fact that was later confirmed when the hatchlings emerged from the nest. The observers advised the local authorities and several actions were carried out to protect the nest. Several public institutions and volunteer associations, coordinated by the Centre for Rehabilitation of Threatened Marine Species (CREMA), participated in the tasks of protection and vigilance of the nest. Due to the relative short distance from the nest to the sea, and to the important east wind in the area, a protection was built around the nest. Despite this protection, the surface of the beach above the nest was invaded by the water twice in the first weeks of incubation. Temperature of sand in the surface near the nest was measured since August 13th to the day of last emergence of hatchlings. Beach surveys have been conducted in Vera during August and September for searching other loggerhead tracks, but without positive result.

Nest study. The first emergence occurred in September 24th, fifty-eight days after the nest event. In Table 1, we present the successive emergences and the number of hatchlings emerged from the nest. A total of 40 hatchlings that emerged from the nest over and 8-day period. Five of this hatchling (3 from the second emergence and 2 from the third) were weighed and measured. We used a caliper to measure the total length of the 6 hatchlings, and the straight carapace length (SCL) and maximum straight carapace width (SCW) of the former 3. Mean total length was 6.3±0.2 cm, and mean weight was 18.2±0.4 cm. All 3 hatchlings completely measured showed the same values of SCL (4.1 cm) and SCW (2.7 cm). On 1 October the nest was excavated. Two more live hatchling were found in the nest, extracted and released on the sand to let them to cover the path to the sea. These two hatchlings completed a total of 42 live hatchling loggerheads emerged from this nest. After the excavation we found that the female loggerhead laid 97 eggs. We found 42 shells (pertaining to the 42 emerged hatchlings), 38 undeveloped eggs (10 of them dead in the beginning of the incubation period, as revealed by their low calcification), 12 unhatched eggs with an embryo formed and 5 hatchling completely formed dead in eggs. These data give an emergence success of 41.2% and a hatching success of 43.3%. Most of dead eggs were placed in the part of the nest chamber oriented to the sea. It is possible that the two inundation events that occurred during the incubation period could be responsible for some of the dead eggs based on the two different calcification degrees found for some of the undeveloped eggs. Dead hatchlings have been preserved for molecular analyses to determine whether this nesting event is due to an erratic loggerhead from other population (Mediterranean or Atlantic) or to a first nester proceeding from this same area.

CONCLUSIONS

This event is the first observation of the complete nesting and incubation processes in the Iberian Peninsula, and may support the fact that loggerheads nested regularly in the past in the Spanish Mediterranean coasts. Further beach surveys are being planned to find more nesting activity of loggerheads in Vera and in adjacent areas in the next nesting season. This nesting event has demonstrated its utility for the developing of educational programmes for loggerhead conservation in Andalucía

Acknowledgements. We wish to thank the active participation of the Red de Voluntarios Mediambientales of Andalucía and Ecologistas en Acción (Almería), and particularly the town council of Vera, in all the tasks related to this event. We thank also the help of Xulio Valeiras (SEC), Luis Felipe López Jurado, Laura Sarti and all the sea turtle researchers that gave us useful comments and suggestions. Especial thanks to Guadalupe Fernández and Filippo Baronchelli, the observers, for their interest and collaboration. The Consejería de Medioambiente of the Junta de Andalucía supported the conservation and research tasks. We thank the David and Lucile Packard Foundation and the Sea Turtle Symposium for travel support.

LITERATURE CITED

Llorente, G.A., M.A. Carretero, X. Pascual, and A. Pérez. 1993. New record of a nesting loggerhead turtle *Caretta caretta* in Western Mediterranean. Bulletin of the British Herpetological Society 42:14-17.

Tomás, J., F.J. Aznar and J.A. Raga. 2001. Feeding ecology of the loggerhead turtle *Caretta caretta* (Linnaeus 1758) in western Mediterranean waters: implications for conservation. Journal of Zoology (London) 255.

Table 1. Relation of the emergences of hatchlings from the loggerhead nest laid Vera (southeast Spain) in July 2001.

	date	hour	No. hatchlings
1st emergence	24-Sep-01	6:50 a.m.	30
2nd emergence	26-Sep-01	6 a.m.	6
3rd emergence	28-Sep-01	4:00 a.m.	2
4th emergence	1-Oct-01	10:00 p.m.	2
excavation	6-Oct-01	12:30 p.m.	2

Hatchling success estimates for leatherback turtles (*Dermochelys coriacea*) on Ya:Lima:Po Beach, French Guiana, using two sampling methods

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INTRODUCTION

French Guiana is one of the most important leatherback turtle (*Dermochelys coriacea*) nesting areas in the world, with an estimated 40% of the world's leatherback nestings (Spotila et al. 1996). Of these, approximately 50% occur on the beach of Ya:lima:po, in the Amana Natural Reserve, between the Mana and Maroni river estuaries (M. Girondot, pers. comm.). Since the 1980s a monitoring program has tracked leatherback populations nesting on this beach, yielding considerable information concerning global and local population sizes and trends. Nevertheless, a lack of data relating to hatching success of in vivo nests on this beach has been a significant limitation to leatherback demographic studies.

The present study, conducted during the 2001 nesting season (March-July), was designed to obtain a preliminary assessment of in vivo hatching success for leatherback turtles on Ya:lima:po beach. A variety of methods have been used to estimate hatching success for other beaches and sea turtle species: 1) One simple strategy involves egg counts from nests detected after hatchling emergence, by a visible depression or tracks in the sand. However, concerns exist about overestimation of success using this method, since these counts automatically exclude zero- and low-success nests, which leave no marks or tracks and are therefore usually overlooked during surveys. 2) Another, more accurate technique, albeit feasible only on low-density nesting beaches, involves marking the exact location of a random sample of nests with a stake or wire mesh grid during oviposition, tracking the fate of each nest and excavating after a predetermined incubation period. On high density beaches such as Ya:lima:po, tracking the fate of individual nests is not a possibility. Rather, a variation on this technique was employed, using triangulation to record the location of each nest and a marker inside each nest chamber to confirm its identity. Hatching success estimates based on this technique were compared and contrasted with estimates obtained from a sample of nests detected after emergence of hatchlings.

METHODS

Nests marked during oviposition. A total of 50 nests were marked during oviposition during the month of May. The nests were randomly distributed throughout the 4 km length of the beach, which was foot-patrolled nightly during 4 hours (2 hours pre- and post- high tide). Selection of nests was based on random encounter of nesting turtles having completed excavation of the chamber and in the process of oviposition upon encounter during the patrol. The turtles were identified by their PIT (passive integrated transponder) tag. GPS coordinates were recorded for the nesting site and distance to the spring high tide line (SHTL) was measured for each nest. Distances were measured from each nest to the two nearest objects in the vegetation zone, most usually trees, which were identified using numbered tags. A numbered plastic label was deposited inside the nest chamber to confirm identity of each nest during later excavation. Nests were exhumed after approximately 62-66 days of incubation. Contents were divided into: 1- hatched eggs, including shells of live hatchlings, dead hatchlings and pipped eggs (hatchlings partially emerged from the egg), 2- unhatched eggs (including all stages of development) and 3- sterile yolkless eggs. When eggshells were fragmented, the fragments were grouped together to represent one egg. Hatch success was estimated by dividing the number of hatched eggs by the total number of yolked eggs laid.

Nests detected after hatchling emergence. Throughout the months of June and July, an additional 53 nests randomly distributed throughout the beach were identified after emergence of the hatchlings. The contents of these nests were analyzed in the same manner as those nests marked during oviposition. In order to reduce potential introduced errors stemming from inter-observer variability in basic counting techniques, all nests were excavated and analyzed by a single observer.

RESULTS

Nests marked during oviposition. Of the 50 nests marked during oviposition, two were discarded because they were found juxtaposed to one or more subsequently laid nests, making the contents of each nest indistinguishable and a reliable egg count impossible. Of the remaining 48 nests, seven failed to be recovered. The identity of the 41 successfully recovered nests was ascertained by the presence of the numbered plastic marker inside the nest chamber. Hatching success was estimated at 38.9% (SE=3.37) for recovered clutches. This estimate can be adjusted downward to 33.3% (SE=3.51) when the additional seven unrecovered nests are included and assumed to represent zero-success nests. Therefore hatch success is expected to lie in the range between 33.3% (SE=3.51) and 38.9% (SE=3.37). Total clutch size, as well as yolked and yolkless egg estimates are shown in Table 1. Distance to the spring high tide line (SHTL) was available for 47 of the 48 nests marked in the study. Hatching success for the 15 nests laid on or below the SHTL was estimated at 31.0% (SE=5.95), while hatching success for the 32 nests laid above the SHTL was estimated at 33.5% (SE=4.44).

Nests detected after emergence. Hatching success, clutch sizes and yolked and yolkless egg estimates obtained for nests detected after emergence are shown in Table 1.

DISCUSSION

Statistical analysis indicates a small but significant difference (z-test, P=0.03) in hatching success between the two sampling techniques. It was hypothesized that nests marked during oviposition would include considerably more low-success clutches than those detected after emergence, as can be interpreted visually from Fig. 3. However, the statistical difference is not concordant with this hypothesis. Indeed, hatching success for the 41 marked clutches that were recovered (38.9% ±3.37 S.E.) was remarkably similar to that of nests detected after emergence (38.0% ±2.75 S.E.). Only after inclusion of the seven nests presumed to be zero-success clutches does this difference (33.3% ±3.51 S.E. vs. 38.0% ±2.75 S.E.) become significant. The seven unrecovered nests could very likely be attributed to intraspecific nest destruction and/or dog predation, both important causes of nest destruction on this beach.

Intraspecific nest destruction. At the peak of the nesting season, nesting females often excavate previous nests. During the 1994 nesting season, Girondot et al. (2002) assessed the extent of intraspecific nest destruction on Ya:lima:po beach and estimated that approximately 21% of the females were destroying viable nests when digging. Indeed, for the study presented in this poster, two of the nests were initially discarded because they were found juxtaposed to other nests, and excavation at the indicated nest site yielded one or more freshly laid nests for two of the seven "failed" nests. Predation by dogs is also an important factor in determining nest success on Ya:lima:po beach, with the number of nests destroyed by dogs estimated at 2.9 nests/day during the incubation months of June and July 2001

(B. Viseux pers. comm.). 87% of all depredated nests were attributed to the approximately 26 adult stray dogs counted on the beach in 2001. Erosion did not seem to be a major cause of nest destruction during the 2001 nesting season. No significant difference was found between hatching success for nests laid above and below the SHTL (t-test, p>0.05). Contrary to many Caribbean beaches, where large percentages of leatherback clutches are laid in areas of the beach that are washed away by high tides, only a very few number of "doomed" turtle nests were observed on Ya:lima:po beach.

Estimates of hatching success for leatherback turtles on other beaches range from 19.8% for Playa Grande, Costa Rica (Bilinski et al. 2001) to 70.5% for Sandy Point, St. Croix (Basford et al. 1990), with great fluctuation even within same beach measurements. This variability results in part from differences in sampling protocols. Hatching success for nests on Ya:lima:po beach (based on either technique) seems relatively low within the ranges reported in the literature. No significant differences were found between the two sampling techniques using clutch size, mean number of yolkless eggs or mean number yolked eggs.

Acknowledgements. I would like to thank Matthew Godfrey, Stephanie Kamel, Johan Chevalier, Corinne Martin, Marc Girondot, Nicolas Roggy, and all participants of the Campagne Kawana 2001, Kulalasi and everyone at the Amana Natural Reserve. This project was made possible by funding from DIREN.

Table 1. Comparison of estimates of nest contents and hatching success (mean ± 1 S.E.) for nests analyzed using both sampling techniques.

	Nests marked after oviposition	Nests detected after emergence
N	41	53
Clutch Size	129.1 ±3.19 (range 71-170)	119.4 ±2.66 (range 54-152)
Yolked Eggs	99.3 ±2.89 (range 57-145)	96.4 ±2.70 (range 25-132)
% Yolked Eggs	77.70%	80.40%
Yolkless Eggs	29.8 ±2.75 (range 2-77)	23.0 ±1.50 (range 1-45)
% Yolkless Eggs	22.30%	19.60%
Hatching Success	33.3% ±3.51 (N=48)	38.0% ±2.75 (N=53)

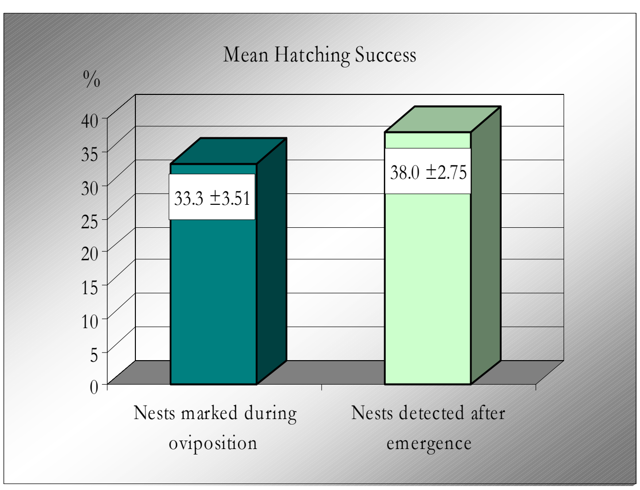

Fig. 1. Comparison of hatching success estimates (mean ± 1 S.E.) for nests marked during oviposition and nests detected after hatchling emergence.

LITERATURE CITED

Basford, S.J., R.L Brander, and R.H. Boulon. 1990. Tagging and nesting research on leatherback sea turtles (*Dermochelys coriacea*) on Sandy Point, St. Croix, US Virgin Islands. Annual report to the US Fish and Wildlife Service.

Bilinski, J.J., R.D. Reina, J.R. Spotila, and F.V. Paladino. 2001. The effects of nest environment on calcium mobilization by leatherback turtle embryos (*Dermochelys coriacea*) during development. Comp. Biochem. Phys. Part A 130:151-162.

Girondot, M., A.D. Tucker, P. Rivalan, M.H. Godfrey, and J. Chevalier. 2002. Density-dependent nest destruction and population fluctuation of Guianan leatherback turtles. Animal Conservation 5:75-84.

Spotila, J.R., A.E. Dunham, A.J. Leslie, A.C. Steyermark, P.T. Plotkin, and F.V. Paladino. 1996. Worldwide population decline of *Dermochelys coriacea*: are leatherback turtles going extinct? Chelon. Conserv. Biol. 2:209-222.

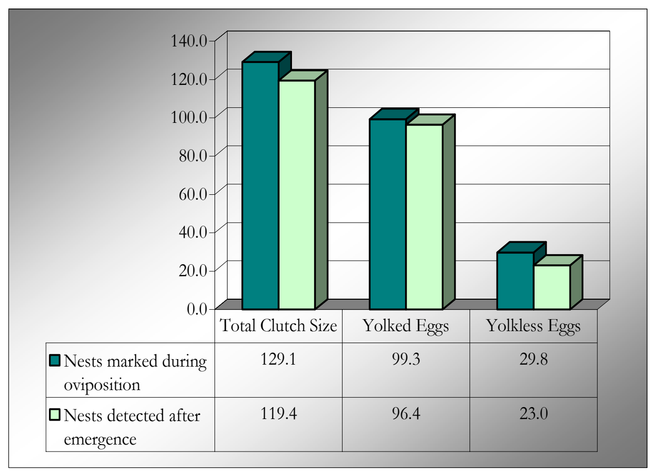

Fig. 2. Comparison of estimates (mean ± 1 S.E.) for total clutch size, yolked and yolkless egg numbers for nests marked during oviposition and nests detected after hatchling emergence.

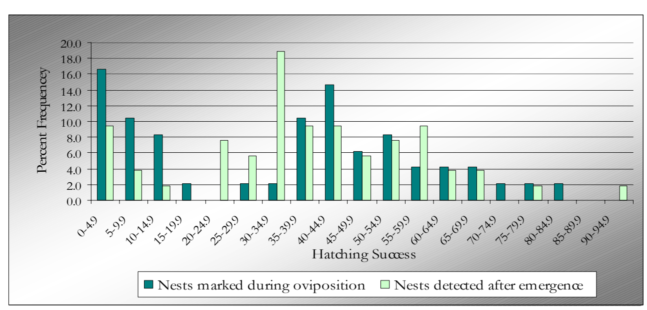

Fig. 3. Hatching success frequencies for nests marked during oviposition and nests detected after hatching emergence.

Monitoring the west coast of Aruba

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INTRODUCTION

Aruba (12°30'N, 70°W) is located 32 km north of Venezuela. The island measures 190 km^2, the max length is 31 km. Since 1986 Aruba is an autonomous entity within the Dutch Kingdom. Economically Aruba is very dependent on tourism. Aruba is part of the WIDECAST Network. The country coordinator is Mr. Tom Barmes. In 1993 a Seaturtle Recovery Action Plan (STRAP) for Aruba was made. The monitoring of nesting beaches and registration of turtle activity was one of the priorities of this STRAP. Over the last three years special attention is given to the white sandy beaches along the western shore where most of the hotels are situated. Recent results of the monitoring survey are presented. We now know that 4 species nest on the western part of Aruba, using different beach zones: I *Dermochelys coriacea*, II *Caretta caretta*, III *Chelonia mydas* and IV *Eretmochelys imbricata*. During 1994-1998 some data were registered about the nesting activity of *D. coriacea* on the west coast of Aruba. This data suggested an annually number of 4 - 18 nests of the leatherback on our western beaches.

METHODS

A monitoring effort was started in 1999 consisting of: (1) daily morning walk along the beach (2700 m), March 1- August 1; (2) marking and protecting nesting sites by eye-catching red and white bars; (3) nests are checked daily and starting day 63 guarded by volunteers at sunset (6-9pm); (4) night patrol (walking) is done starting 8 days after a nesting till renesting is noticed; (5) personnel and security guards of the beachfront hotels are informed about sea turtles and requested to call WIDECAST ARUBA if any activity is noticed .Basic information and the DO's and DO NOT's are made available to these employees and the public in general.

RESULTS

1999 and 2000. In 1999 there were definitely 0 (zero) nests of *Dermochelys* in the surveyed area. In 2000 the survey was continued and again the result was a certain 0 (zero) nests of *Dermochelys*. 2001. The method for monitoring nesting activity remained the same. There was activity this season and for determination of nesting versus non-nesting emergences we followed Schroeder and Murphy (Research and Management Techniques for the conservation of Seaturtles). Being personally present at most of the emergences, able to observe the egg laying and able to obtain egg counts after the hatching period, we specified the following definition of a confirmed nest: confirmed nest = female + oviposition observed and/or female crawl + nest-result observed (hatchlings or eggs). During observation of the nesting a cross bearing was made of the exact location of the nest chamber. The females could be identified and recognized by external natural scars. The CCL was measured. In May we placed thermometers in the vicinity of 4 nests. These thermometers were placed in PVC-tubes, 80 cm below the surface of the sand. They were read twice daily.

2001. 37 emergences, 34 confirmed nest (proof of oviposition), at least 7 different females. Average CCL of 6 measured females 154,3 cm (145.5-170). The largest female renested 10 times, lifting the average CCL to 159.0 cm, if based on the 32 nestings we were present, and could (re)measure the CCL. The majority of the nests (30) were protected in situ. Volunteers waited and guarded at the sites starting on day 63 of incubation (6-9 pm). The emergence of hatchlings occurred after AVG 65.9 days (min 60 - max 73). Remarkably, the hatching period in later nests is shorter: avg April 67.7 days (min 64 - max 73), avg may 65,7 days (min 61 - max 68), avg June 63,6 days (min 60 - max 69). With the small numbers it is difficult to state significance. Out of a total of 2520 yolked eggs, 1704 (67.6%) hatched and emerged from the nest spontaneously (based on hatchling count and shell-recount). Afterwards the nests had been excavated by hand and an additional 123 hatchlings could be released. (4.9%). Light is a major threat for hatchlings on Aruban beaches of the west coast. 633 hatchlings (34.6% of this season production) had problems in their way into the ocean. 553 hatchlings were able to reach the ocean with the help of additional flashlight-guidance. The fate of 80 is unknown. Four nests were relocated to protect them from high tide inundation. The hatch rate of these 4 nests: 53% spontaneous emergence, (after excavating the nests: 68%)

DISCUSSION

Focusing on the natural marks we used in 2001 for turtle identification it was possible to recognize the turtle "opener" on videotape of 1998 and pictures of 1995. She may be a regular nester every 3 years. The public awareness and presence of volunteers at the end of the incubation period attract large crowds (locals and tourists). Crowd handling is becoming a new problem and increasing by the use of mobile phones. During the season we developed preference to postpone the excavation for recount and hatchling saving till the first coming 17.00 pm. This enabled us to avoid artificial light and unnatural hatchling-stay-over in daytime one nest was washed out by rough waves after 46 days. A *Dermochelys* embryo measured 28 mm (carapace ca. 20 mm).

Caretta caretta. The nesting habitat of the loggerhead on Aruba's west coast (Fisherman's Huts, Malmok) is very fragile: the "hot spot of 2001" (about 300 m) is just a very small stretch of beach, bounded by a road with lamps (stationary artificial lights) and a lot of traffic (moving lights). The former type of lights is a danger especially for the hatchlings (disorientation), the latter frightens the nesting females. The beach is used for windsurfing, horse riding and "human dating" at night (cars are parked close to the sea, the lights repulse nesting female turtles and the weight and tires of the car can compact and damage the nests). During 2001 this area was monitored by daily walk in the early morning (May-August). WIDECAST volunteers Bosch and Wisse noticed several activities. The 7 crawls and nesting attempts on July 9 followed by 3 other attempts on July 10 resulted in just 1 nest and illustrate the difficulty of nesting in this area. Finally we can conclude that 4 nests produced hatchlings. On 2 occasions the proof was the finding of 22 and 29 dead hatchlings on the road. The incubation period for loggerhead was 54-57 days Two nests could be excavated and had a combined hatch rate of 47%.

Chelonia mydas . By the end of July a Police patrol noticed a turtle track and several deep body pits in the California Dunes. Daily patrol by WIDECAST revealed green turtle hatchlings emerging from the nest after 53 days. This was the first time on Aruba that complete data became available. At the end of August an other track + nest was found. The hatch rate of these nests was 93.2% Unfortunately not all hatchlings reached the ocean due to light distraction (Lighthouse)

Eretmochelys imbricata. Arashi beach has been known in the past for very incidentally nesting of *Dermochelys coriacea* and *Caretta caretta*. Detailed data from the past are not available. In November 1999 Aruba was effected by wild western seas as a consequence of hurricane Lenny. A surprising amount of seaturtle eggshells were noticed in the days after this force of nature. This was a good argument to improve the data collection of this beach. Anticipating loggerhead activity a monitoring effort was started May-August 2000. There was no activity recorded. Camping locals did not notice any activity either. The same strategy was applied as in 2000. There was no sign of activity and the heavy attention required by the leatherbacks and loggerheads at the other west coast beaches forced to reduce the patrol to twice a week. At the end of August a local visitor informed us about a track on Arashi beach. We marked the nesting activity with barricades. The patrols were intensified. (6 am and 6 pm) In September the first hatchlings were found. The surprises continued and finally on December 13 the season 2001 ended with the emergence of the 11th confirmed hawksbill nest. Hatch time avg 56 days (min 52 - max 58) , depth of nest avg 44.9 cm (min 39 - max 56) total eggs 1784, clutch size avg 162 eggs (min 124 - max 208), hatch rate 71%

The human assistance made a difference of 290 hatchlings (16%). This assistance was flashlight guidance at night, excavation of survivors and saving disoriented hatchlings from road and vegetation. The development and human use of the area caused the loss of 196 hatchlings (light disorientation and vehicle over nest). Three nests were laid on a "young" private beach, constructed after 1980

Acknowledgements. The information presented in the poster was collected with assistance of the WIDECAST country coordinator and other volunteers. The police department and the security-personnel of various resorts contributed by transferring signs of activity. The Department of Agriculture, Husbandry and Fisheries supported with the barricades. We thank the Seaturtle Organisation and WIDECAST for providing assistance to participate to the symposium.

Table 1. Data from Aruba.

Location	Avg temp 6 am	Avg temp 6 pm	Hatch time: days
Eagle	28.71	28.94	70
costa linda	28.95	29.03	73
divi-tamarijn	29.92	30.00	61
pirates nest	29.77	29.95	65 and 68

Restarting the green turtle (*Chelonia mydas*) tagging and conservation project in Aves Island Wildlife Refuge, Venezuela

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INTRODUCTION

Aves Island is the most important sea turtle nesting area in Venezuela, which is part of Aves Island Wildlife Refuge. In the Caribbean Sea it is the second most important place for nesting of green turtle (*Chelonia mydas*). In 1979 a local non-governmental organization (FUDENA) started tagging activities in Aves Island. This monitoring continued more or less regularly until 1997, at which time the bridge between the Simón Bolívar Scientific Naval Base and the island collapsed. The consequence of this accident determined that the activities related with this study ceased. At the end of 1999, the General Direction of Fauna belonging to the Environmental Ministry and Natural Resources, which is the official organization in charge of the administration and management of this protected area, started to elaborate the management plan of this wildlife refuge. In September 2001, a month that is part of main nesting period, the monitoring was restarted after approximately 4 years of interruption.

METHODS

During one month (from September 12th until October 13th 2001) the beach patrolling was performed in Aves Island from 8 p.m. until 3 a.m., except the days in which the weather conditions didn't allow access to the island. This beach is 550 meters in length and varies between 30 and 120 meters in width. When a turtle was observed nesting it was tagged in the left flipper (close to the first large proximal scale), using an applicator and the respective Monel tag. Moreover, the curved carapace length and width were measured with a flexible tape along with time, location (the island was divided in three zones) and the presence of distinguishing marks, wounds and barnacles. Because the military personnel could not facilitate the return to the naval base during the night it was necessary to stay overnight on the island after the activities were finished each day.

RESULTS

During the monitoring period a total of 62 sea turtles were tagged. Of these, three had been tagged in other years, but were re-tagged due to damage of the original tags. A total of 13 tagged turtles were detected coming back to nest at intervals of four to twenty days. The majority (54%) of them came back every ten to twelve days, which corresponds to the average inter-nesting interval already determined for this area. The total number of recaptures was 23 animals, mainly tagged between 1994 and 1996 (see Table 1). With respect the morphometric measures, mean curved carapace length and width (112.55 cm and 104.2 cm, respectively) determined in previous studies was very similar to that established in the 2001 monitoring (112.5 cm and 104.03., respectively). It was observed that the animals had a great preference to nest in the south zone of the island, since approximately 48% of them nested there. This result is completely opposite from previous analyses.

CONCLUSIONS

The results demonstrate that the nesting population from Aves Island remains very stable. In spite of this work performed for only one month, the results obtained are close to the tendencies previously observed between 1979 and 1997. During the 2002 nesting season, the project will comprise all the nesting peak (from July until September) and the Fauna Direction approved a specific budget for these activities. Our purpose is to establish a data base available for any researcher and organization interested, to avoid the troubles that we have had to get the information from previous studies.

Acknowledgements. At first, many thanks to David and Lucile Packard Foundation and National Fish and Wildlife Foundation for the financial support, which allowed me to attend to this event and to present this research. The field work had an excellent logistical support thanks to the personnel from Simon Bolívar Scientific Naval Base: José Boston, Also, I would like to thank to Samuel Narciso for his cooperation to get the tags used and to H. Guada for facilitating the applicators.

LITERATURE CITED

Gremone, C. and J.L. Gómez. 1983. Isla de Aves como área de desove de la tortuga verde (*Chelonia mydas*). Fudena, Caracas. 58 p.

Peñalosa, C. 2000. Demografía y viabilidad de la población de tortuga verde, *Chelonia mydas*, en Isla de Aves. Thesis. Universidad Simón Bolívar. 87 p.

Table 1. Sea turtles recaptured during the 2001 nesting season.

Tag	Tagging year	Recaptured date	Tag	Tagging year	Recap year
B2405	n.a.	09/24/01	N3443	1995	3/10/01
B6395	1987	09/28/01	N3452	1995	09/17/01
B6643	n.a	6/10/2001	N3623	1996	2/10/01
P1597	1986	09/17/01	N3674	1996	09/16/01
N1114	1993	09/25/01	N3737	1996	09/16/01
N1274	1994	6/10/2001	N4049	1996	09/13/01
N1275	1994	6/10/2001	N4143	1996	09/29/01
N1852	1994	09/20/01	N4184	1996	09/30/01
N3357	1995	09/28/01	N4226	1996	09/16/01
N3393	1995	09/23/01	N4252	1997	09/29/01
N3420	1995	1/10/2001	N4254	1997	09/13/01

n.a. = not available

Evaluation of specific biotic and abiotic factors affecting loggerhead (*Caretta caretta*) nests on Pritchard's Island, South Carolina, U.S.A.

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INTRODUCTION

Study 1: Ghost crab activity and hatch success. The Atlantic ghost crab (*Ocypode quadrata*) is known to prey opportunistically upon the eggs and hatchlings of loggerhead turtles, *Caretta caretta* (Dodd 1988). Observations on Kiawah Island, South Carolina suggested that the presence of burrows around loggerhead nests did not significantly affect hatch success (Thompson 1995). This study analyzed crab burrowing activity around loggerhead nests on Pritchard's Island.

Study 2: Sand temperatures and nest relocation practices. The temperature at which a nest incubates determines the sex ratio produced in a nest (Mrosovsky and Yntema 1980). According to Baptistotte et al. (1999), nests that are relocated to beach locations well above the highest tide line (i.e. hatcheries) may produce a different sex ratio than nests left in situ at locations lower along the beach profile. On Pritchard's Island 75 percent of nests on average were relocated to hatcheries or the dune line due to continual erosion of the nesting beach. Therefore, it is important to ensure that the hatcheries and the dune line have similar sand temperatures to sites where natural nesting occurs. The objective of this study was to record and compare sand temperature at nest relocation sites with the sand temperature at the dune line, spring and mean high tide lines across the nesting season.

METHODS

Study 1. The study was conducted from 31 May to 13 August 2001. Crab burrows at all nests were filled with sand daily. All nests were evaluated every other day and burrows were counted and measured within a 4x4 foot square area centered on the nest. Nests of similar location and management were compared. Cumulative activity in the form of total additive diameter and total number of burrows at individual nest sites were compared to hatch success using the MS Excel '00 correlation analysis tool.

Study 2. Calibrated electronic HOBO temperature dataloggers were used to monitor sand temperature at 30 and 60 cm. Sand temperature was measured every 1.5 hours in the hatcheries, the dune line, and at the spring and mean high tide lines from 08 May – 14 September 2001. Bi-monthly means of all measured sites were compared between each other using a one-way ANOVA ($P<0.05$).

RESULTS

Study 1. Table 1 shows cumulative activity at individual nests compared to hatch success. Table 2 shows correlation values for hatch success compared to both total burrow number and total burrow diameter for individual nests within groups. The independent measures of total burrow number and total burrow diameter correlated closely at each nest examined and yielded similar results when compared with hatch success.

Study 2. Table 3 shows the seasonal means for each measured beach location and which means that were significantly different (ANOVA, $P<0.05$) from other means in the data set at 30 and 60 cm.

DISCUSSIONS AND CONCLUSIONS

Study 1. No significant correlation was shown between ghost crab activity and hatch success in the nest categories examined, supporting the theory that ghost crab burrows constructed at nest sites do not significantly affect hatch success. These results support the findings from Kiawah Island, SC (Thompson 1995). Based on the results of this and similar studies, the validity of more aggressive crab control and elimination methods needs to be tested, especially given the ghost crab's important ecological role on sandy beaches (Wolcott 1978). This study promotes routine burrow filling as an effective method of controlling crab depredation without a significant decrease in hatch success.

Note on filling ghost crab burrows as a management technique: A 91% reduction in directly observed egg loss was observed during the 2001 season when burrow filling was used compared to the 2000 season when filling was not used. In situations where filling is practiced, trapping or destroying crabs may not be necessary. Given that ghost crab activity has been shown to result in some egg loss, further monitoring and study is recommended to accurately quantify the effect of ghost crab activity over nests, especially those that are not managed by filling.

Study 2. This study indicated that: (1) Sand temperature at the original nesting site is different than at the relocated site; (2) Significant differences (ANOVA, P< 0.05) were found between the bi-monthly means of the sand temperature: a) in the hatchery compared to the dune line, spring and mean high tide lines, and b) at the dune line compared to the spring and mean high tide lines. Therefore, the conclusion can be made that relocation of nests to the hatchery and dune may produce different sex ratios than nests laid at the spring high tide line or below; and (3) The mean sand temperature for the season at all measured beach locations (Table 3) is below the pivotal temperature for loggerhead nests (29°C, Mrosovsky 1987), Therefore, this study recommends that: (1) Nests laid at or above the spring high tide line need to be left in situ; (2) As some relocation is necessary on Pritchard's Island due to continual beach erosion, nests laid below the spring high tide line need to be relocated between the spring high tide line and the top of the dune line, where natural nesting already occurs; and (3) Hatchery use on Pritchard's Island needs to be discontinued as a nest relocation practice.

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LITERATURE CITED

Baptistotte, C., et al. 1999. Male-producing thermal ecology of a southern loggerhead turtle nesting beach in Brazil: implications for conservation. Animal Conservation 2:9–13.

Dodd, C.K., Jr. 1988. Synopsis of the biological data on the loggerhead sea turtle *Caretta caretta* (Linnaeus 1758). U.S. Fish and Wildlife Service, Biological Report. 88:14

Mrosovsky, N. 1987. Pivotal temperatures for loggerhead turtles (*Caretta caretta*) from northern and Southern nesting beaches. Canadian Journal of Zoology 66:661 – 669.

Mrosovsky, N. and C. Yntema. 1980. Temperature dependence of sexual differentiation in sea turtles: implications for conservation practices. Biological Conservation 18:271-280.

Thompson, M.S. 1995. The effect of ghost crab predation on the survival rate of loggerhead sea turtle eggs. In: J.A. Keinath, D.E. Barnard, J.A. Musick, and B.A. Bell, comps. Proceedings of the Fifteenth Annual Symposium on Biology and Conservation. NOAA Tech. Memo. NMFS-SEFSC-387. p. 323-324.

Wolcott, T.G. 1978. Ecological role of ghost crabs, *Ocypode quadrata* (Fabricius) on an ocean beach: scavengers or predators? Journal of Experimental Marine Biology and Ecology 31:67-82.

Table 1. Hatch success, total burrow number, and total burrow diameter information for the three nest categories observed in the study.

nest type	hatch success (%)		total number		total diameter (m)	
	range	average	range	average	range	average
low in situ nests (n=4)	0-96.5	31.4	8-25	16.5	0.28-0.82	0.55
high in situ nests (n=5)	55.8-98.1	80.5	1-16	5.8	0.04-0.53	0.18
high relocated nests (n=3)	62.5-79.0	73.0	0-3	1.7	0-0.09	0.05

Table 2. Coefficient of correlation values for total burrow number and total burrow diameter compared to hatch success. Nests were compared in three groups: low in situ; high in situ and high relocated.

Near +1 = positive correlation Near -1 = negative correlation Near 0 = no correlation	comparison	coefficient of correlation: low in situ	high in situ	high relocated
	hatch success vs. total number	0.304791	-0.24703	-0.26836
	hatch success vs. total diameter	0.391761	-0.12499	-0.23093

Table 3: Mean sand temperatures at 30 and 60 cm.

	Location of datalogger:	Mean sand temperature for the season (± SD)	Means significantly different (ANOVA, P<0.05) than means for:
at 30 cm depth	Hatchery 1 - 30 cm	27.73 (± 2.33)	All other locations
	Hatchery 2 - 30 cm	28.40 (± 2.13)	All other locations
	Dune, Transect 1 - 30 cm	27.74 (± 1.90)	All other locations
	Spring high tide line, Transect 1 - 30 cm	27.75 (± 1.80)	All other locations
	Mean high tide line, Transect 1 - 30 cm	*Data lost**	*Data lost**
	Dune, Transect 2 - 30 cm	27.99 (± 1.75)	All other locations
	Spring high tide line, Transect 2 - 30 cm	27.54 (± 2.23)	All other locations
	Mean high tide line, Transect 2 - 30 cm	*Data lost**	*Data lost**
	Dune, Transect 3 - 30 cm	*Data lost**	*Data lost**
	Spring high tide line, Transect 3 - 30 cm	27.59 (± 1.75)	All other locations
	Mean high tide line, Transect 3 - 30 cm	27.08 (± 1.75)	All other locations
at 60 cm depth	Hatchery 1 - 60 cm	27.01 (± 2.96)	All other locations
	Hatchery 2 - 60 cm	27.09 (± 1.94	All other locations
	Dune, Transect 1 - 60 cm	26.71 (± 1.90)	All other locations
	Spring high tide line, Transect 1 - 60 cm	26.84 (± 1.61)	All other locations
	Mean high tide line, Transect 1 - 60 cm	26.31 (± 1.87)	All other locations
	Dune, Transect 2 - 60 cm	27.18 (± 1.69)	All other locations
	Spring high tide line, Transect 2 - 60 cm	26.65 (± 1.71)	All other locations
	Mean high tide line, Transect 2 - 60 cm	26.56 (± 1.92)	All other locations
	Dune, Transect 3 - 60 cm	*Data lost**	*Data lost**
	Spring high tide line, Transect 3 - 60 cm	26.74 (± 1.63)	All other locations
	Mean high tide line, Transect 3 - 60 cm	26.56 (± 1.81)	All other locations

* Data were not collected at this location due to loss or damage to the datalogger.

Emotional effects of attitude in Wuayuú children of scholastic age before the violent death of marine turtles

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INTRODUCTION

The attitudes; they are beliefs that prepare the individual to prefer an answer (Hollander 1978). They are durable evaluations of diverse aspects of the social world that work as outlines or marks cognitive that possess and they organize the information it has more than enough specific concepts, situations or external events. They also act as mediator and oriented between the answers of people and their exhibition before the stimuli of the social atmosphere. Bandura; In their theory of social learning, the children in school age are in full stage of formation of attitudes through the principles of modeling and imitation; the example is one in the most primitive ways that the human beings have to learn, what means that the children imitate those people that are significant for them and if this behavior is reinforced it drives to that it is repetitive and be part of the individual's daily life. In relation to the Wayuú children, the violent death of marine turtles is perceived as part of its culture and of its daily life, these not alone they witness the aggressive event day by day but rather they also have the obligation of being made you participate of this. This situation has crossed generations and for this culture the marine turtles are but that a simple food; they are used to make homemade medicine for cardiovascular and bronchial illnesses, they are also used as sexual stimulants and the shells are used as domestic utensils, therefore for the children it is very difficult to escape the situation. From early age, the Wayuú children, specifically the males, are trained by adults to kill turtles following a rigorous and unalterable ritual that is conceived by the Wayuú culture like heroic, for the action of taking food to the home. Previous investigations corroborate that the school age children in their formulative years, are especially sensitive to the violence; it can generate such effects as aggressiveness, inhibition, difficulties in the learning, anxieties, escape of the external world, repression, feelings of blame, and infantile depression. Although these children are accustomed to kill the marine turtles and be part aware of its day by day, they don't escape from these effects that can generate psychological traumas and damages psychic many irreversible times.

OBJECTIVES

The general objective this project is to know those emotional effects and attitudinally that can be present and to affect the Wayuú children of school age in the face of the violent death of marine turtles. The specific objectives are to: (1) describe the cognitive attitudinal component of those effects that can be present and to affect the children wayuú in the face of the violent death of marine turtles; (2) describe the component behavioral and affective present in the attitudes of children wayuú in school age; and (3) establish of behaviors that can unchain the effects presented in the studied sample.

METHODS

The methodology of the investigation is based on the Goodenought-Machover psychological test. It is a technical projective based on the individual's subjective perception towards the atmosphere. This test analyzes the individuals drawings, looking for signs of subliminal issues, conflicts and features of personality, through emotional indicators that reveal the individual's attitudes, toward the tensions and demands of the life and also intense fears and anxieties that can affect it conscious or unconsciously in a given moment. This test was applied to 10 school children from Cojoro between 7 and 12 years of age,. This test followed the pattern of experimental design AB; that consists in applying the test in a base line (TO) that defines the general level of stability of the individual, after this application the children are stimulated recreating in a visual and auditory way the death of a marine turtle, trying to get the children to evoke the memory completely, later to the stimulant (B) they are applied the test again with the purpose of determining if it happens some change in the line of base of the execution of the fellows. This evaluation process was accompanied by an interview with each one of the fellows after the second application; taking into account ethnic, cultural and socioeconomic differences to achieve better results.

RESULTS AND DISCUSSION

The results of the tests reveal significant indexes of emotional uncertainty, repression, impotence; perhaps to the inability of facing their existent situation joined to the fantasy like compensation, followed by blame feelings, hostility toward the man, cruelty, escape and repressed aggression. It is necessary to highlight that the Wayuú children don't have an easy life; its day by day this filled with working, malnutrition, illiteracy, poverty, etc. Therefore, is possible that the emotional effects and attitudes may not be due only to the observation of marine turtle deaths. The effects that children experience today will continue being presented with more magnitude tomorrow, perhaps making them even more insecure, repressed, aggressive, anxious, and frustrated as adults. Above everything else, they also may continue as hunters of marine turtles. Finally, we conclude that the slaughter of marine turtles affects not just the turtles, but also the human beings. Children that have not chosen to take the life that you/they take that if in some moment they have thought of changing it, they have not had the option of making it or worse even the ignorance and the fear to the consequences have not allowed them to change.

LITERATURE CITED

Fernández Ballesteros, R. 1975. Introducción a la evaluación psicológica II. Editorial Pirámide.

Münsterberg Koppitz, E. 1976. El Dibujo de Figura Humana en los niños. Evaluación Psicológica. 8va Edición.

Papalia, D. and S. Wendkos Olds. 1993. Psicología del Desarrollo. Editorial Mc Graw Hill, 7ma Edición.

Sarason, I. and B. Sarason. 1997. Psicología Anormal. Editorial Prentice Hall. 7ma Edición.

Sattler, J. 1990. Evaluación Infantil. Editorial M/M. 3era Edición.

Sipos Gálves, L. 2001. El duelo de los niños. Interpsiquis.

XI[th] course on sea turtle biology and conservation in Venezuela

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COURSE BACKGROUND

The main goal of the course series is "To promote the survival of sea turtles in Venezuela by imparting scientific information, promoting national capacity-building regarding the conservation of sea turtles, and offering training for a new generation of competitive scientists and informed policy-makers" (Eckert and Guada 2001). The sea turtle courses began in 1992 and to date, over 200 persons have participated. The students are mainly from Venezuela, but also represent a number of countries in the Western Hemisphere (from Argentina to USA), Europe (France, The Netherlands), and Africa (Equatorial Guinea).

DEVELOPMENT OF THE COURSE

The XI[th] Course (Puy Puy, 4-10 June 2001) had 20 participants. The foreign guests were Biol. Didiher Chacón (Asociación ANAI, Costa Rica) and D.V.M. Carlos Mario Orrego (Gandoca Project, Asociación ANAI and from the M.S. Wildlife Program, Universidad Nacional, Costa Rica). In addition to Senior Instuctor Hedelvy Guada, Venezuela, Guest Instructors were Ecologist M.Sc. Joaquín Buitrago (EDIMAR-FLASA, Isla de Margarita, Venezuela), Fisheries Specialist Lic. José Alio (INIA, Ministerio de Ciencia y Tecnología), and donor representatives Pedro Molina (Fundacion Thomas Merle) and Henry Benavente (Corpomedina). The course was entirely taught in Spanish and English! This made possible the participation of professionals from non-Spanish speaking countries; namely, Aruba, USA and Equatorial Guinea.

The participants represented Universidad de Oriente – Nueva Esparta Nucleous (4), Universidad del Zulia (6), Marine Turtles of Santa Marta, Colombia (1), Aruba (3), Arcadia University, USA (2), Bioko Biodiversity Program, and Equatorial Guinea (2). The participants from Arcadia University were two professors (Biology, Economy). The participants from Aruba, USA and Africa were directly involved in sea turtle field projects. The course had theoretical, practical (field) and video sessions for a total of 56 hours of work. The theoretical sessions included: biology and ecology, monitoring techniques, conservation strategies, threats and solutions, sea turtle diseases and necropsies, current projects in Venezuela and Costa Rica, national and international laws, and current projects in Range States, economic value of the sea turtles, raising funds and networking. In the taxonomic sessions the participants worked preserved and pictures presented in a laptop computer. A necropsy session was conducted with dead hatchlings by D.V.M. Carlos Mario Orrego.

The Field sessions include diurnal and nocturnal beach surveys on Puy Puy beach. No nesting turtles were observed, but fresh tracks were seen in the beach and we found a leatherback nest which was moved to the protected hatchery. Besides the field work at Puy Puy, the group traveled by boat to Querepare, the most important nesting beach in the northern Peninsula de Paria, where we found over 40 nests; nearly all had been poached. Through video sessions we presented some advanced research techniques and foreign conservation programs (Brazilian "TAMAR Project", Costa Rican "Tortuguero Project", TEDs, hawksbill turtle use in Japan, fibropapillomas disease, feeding by hawksbill turtles, sea turtle necropsies, and others).

The course demands several reports (e.g., identification and measurement sessions, day surveys) and a Final Exam. All the participants approved the course. Participants received a valuable Course Package with numerous technical references (in Spanish and English), including a copy of the IUCN's "Research and Management Techniques for the Conservation of Sea Turtles" (Eckert et al. 2000) and WIDECAST's "Sea Turtle Recovery Action Plan for Venezuela" (Guada and Solé 2000).

FOLLOW-UP ACTIVITIES

As in years past, the XI Course provided great impetus for sea turtle conservation efforts! Several of the participants from Universidad del Zulia have been involved in sea turtle conservation. Two of them participated in a training workshop in Venezuela (March 2002). Hedelvy Guada was invited to join to the 2001-2002 Bioko Expedition (Africa) under the organization of Professors Gail Hearn and Wayne Morra during December 2001 and January 2002, but due to academic obligations could not accept. Lenín Oviedo (CICNE), course translator, was invited to join to the 2001-2002 Bioko Expedition (Africa) under the organization of Professors Gail Hearn and Wayne Morra during December 2001-January 2002. These types of international exchanges are very valuable to the conservation of migratory sea turtles.

The course was also extremely valuable in reinforcing institutional relationships between CICTMAR and the Universidad del Zulia, through Prof. Jim Hernández, a participant of the XI course and adviser of the biology students of the Universidad del Zulia.

In 2002 the Sea Turtle Courses celebrates its 10th year, and we have planned several special activities; for example, it was convened a special training session in March 11-12, 2002 (Workshop on standarization of working methods with sea turtles during reproductive period, co-auspiced by CICTMAR-WIDECAST, EDIMAR-FLSCN, Programa PROCOSTA-Provita and GTTM) with Biol. Laura Sarti (Mexico) as Invited Instructor.

The XIIth course will be held during the June 2002, keeping with recommendations we've received. Partial funding has been gained from the Rufford Small Grants (Whitley Award Foundation, U.K.).

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LITERATURE CITED

Eckert, K.L. and H.J. Guada. 2002. Xth Course on Sea Turtle Biology and Conservation in Venezuela. Final Project Report. 13 pp + annexes.

Eckert, K.L., K.A. Bjorndal, F.A. Abreu-Grobois and M. Donnelly, eds. 2000. Research and management techniques for the conservation of sea turtles. IUCN/SSC/Marine Turtle Specialist Group. Pub. No. 4. 235 p.

Guada, H.J. and G. Solé S. 2000. Plan de Acción para la Recuperación de las Tortugas Marinas de Venezuela. Informe Técnico del PAC No. 39. UNEP Caribbean Environment Programme. Kingston, Jamaica. xiv + 112 p.

Environmental education initiatives in Grenada

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E.A.R.T.H. (Environmental Academic Resource for Teachers and Higher Education) is a PC dependent, environmental science curriculum developed by Ocean Spirits for the Ministry of Education in Grenada. It provides a single source of information comprising of interactive topics, lesson plans, class projects and fields trips to facilitate the transfer of information from teacher to student. Over 30 video clips, animations and hundreds of photos make E.A.R.T.H. a visually enticing and exciting learning experience.

Ocean Spirits also sponsors a community development program. Through turtle watching trips, designed with support from our colleagues in WIDECAST, we illustrate to those who have traditionally relied upon turtles in some part, that alternative and more sustainable revenues can be derived from them. Members of local communities are employed on a nightly basis to provide tour guiding, cooking, and driving skills and are involved in all aspects of the eco-tourism initiative.

Community workshops are among Ocean Spirits longest standing programmes. The workshop programme has been refined and improved upon over the years to offer students valuable insight into marine issues pertaining to Grenada and the world. Ocean Spirits and the Red Cross have developed an environmental award - Grenadas first environmental achievement badge. Ocean Spirits also sponsors an Annual Festival designed to raise awareness of the ocean and the creatures that live within it.

Elements for the elaboration of an environmental education program with local inhabitants for an endangered species: the case of sea turtles based in the leatherback protection program in Acandí and Playona Beaches, Darién Caribbean, Columbia

Claudio Madaune

Fundación Darién

For the realization of a conservation program that we want to implement, it's necessary to consider the complexity of each reality. We must observe the way the diverse factors affect the problem or situation we want to change and how they interrelate. To do this, we need to maintain an integral and holistic vision in the design of the program. In the case of the elaboration of a sea turtle conservation program, some of the necessary components are: Protection, Research, Sustainable and Alternative sources of income for the local communities, and Education. The combination of these components permits a sure and concrete advance toward the desired objective. Specifically, an Environmental Education Program focusing on sea turtle conservation, should consider the following aspects and apply the respective procedures:

Observation. Often when confronting a specific conservation issue we attempt to apply our preconceived solutions to resolve conflicting interests. Before approaching any situation it is necessary to have an open mind and understand the particular factors before considering any possible solutions.

Diagnose. We must acknowledge the social, cultural, economic and environmental situation of the region and its inhabitants. The information must be taken directly from the local population and from secondary resources. It can be useful to apply a universal diagnostic methodology.

Localization, Geographic Coverage. It is essential to define the geographic coverage of the program and focal communities. As well as other areas that may be influenced by repercussions of the program.

Differences between Actors. We must be aware that the environmental education activities target a diverse assemblage of people, so it is necessary to use different mechanisms and tools to reach each one of the specific actors. Conservation strategies should address the needs of different generations, genders, socio-economic classes and occupational sectors. The way in which we approach an egg poacher is completely different from how we interact with an industrial fisherman; in each case different skills and information must be employed.

Methods and Tools of Sensibility. It is important to be creative and not conventional in order to engage people's interest and to facilitate processes where the protagonism is taken by the people themselves. The ultimate objective is to make people understand and realize that they are the only ones to solve their problems and to take initiative for the care of their surrounding in order to live a better life. Some techniques that we have found useful are: brochures, local newspapers, posters, games, puppets, street theater, informative panels, exhibits, videos, radio programs, school curriculum, word of mouth of the population, songs, dance, parades, other artistic-cultural expressions.

Period of Duration. It is important to promote an educative process for the short and long term. Our efforts must not be restricted to the nesting season, but throughout the entire year, organizing various activities periodically to maintain community involvement and consciousness.

Learning and Training. Not only is a certain level of biological knowledge required for sea turtle conservation, alternative technical skills should be provided for specific needs. Examples of implemented skills include: techniques of subsistence fishing that are low-impact to sea turtles, production of handicrafts, training in responsible tourism, strengthening community organization, raising of animals for food, fish farming, and training in the sustainable use of natural resources. All of which reinforce a sense of community within the locals, resulting in a higher standard of living while diminishing the impact on the local ecosystems.

Essential aspects of an Environmental Education Program. (1) appreciation of the natural surroundings and cultural traditions; (2) community involvement to identify local needs and generate potential solutions. Organizational structure is critical to build community and work towards a common goal; (3) creativity and imagination are essential in devising different medium for communicating with different sectors of the population (Effective communication and novel approaches are important to ensure the continuity of the program); (4) access to economic resources and human resources in order to achieve the expected goals; (5) to be aware and distinguish the existence of visible and invisible structures, specially those social and cultural facts which are not easy to identify without a more deeply knowledge about the local reality; (6) transform the problems into solutions, there should be a continuous feedback, transforming and adapting the program along the way; and (7) any successful environmental education program must generate changes within individuals, their communities and their natural surroundings. To awaken our sensibility, love and tolerance we must become respectful of all living beings. By improving living conditions and conserving natural resources we shall transform our society into a permanent culture.

Ecovolunteer program: an economic alternative supporting sea turtle conservation at Gandoca Beach, Costa Rica

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Gandoca Beach is the last extension of sandy coast along the Caribbean coastline of Costa Rica. From February to July this beach receives nesting females mainly of the leatherback sea turtle, in addition to smaller numbers of hawksbill and green turtles. The community of Gandoca was established in the 1940´s by ex banana plantation workers who stayed after working with lumber companies that high graded the area's rain forest. In 1985, an analysis supporting the creation of the Gandoca/Manzanillo National Wildlife Refuge showed that 100% of the sea turtle eggs were being poached, both for local consumption and sale outside the community. As part of an initiative to address the sea turtle conservation problem, Association ANAI began an eco-volunteer program that promotes the participation of national and international volunteers as project assistants. Food, lodging, transportation and other services are purchased from local families. The families that previously poached the nests and sacrificed the females today are offering services to the visitors, annually (2001) receiving more than US$ 60,000 in direct payments. The estimated black market price for 100% of the eggs laid is US$ 13,700, indicating that this conservation model is about 5 times more economically beneficial than poaching. The poaching rate has declined from 100% to 9%.

Education strategy for sustainable sea turtle conservation in Benin (West Africa)

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INTRODUCTION

With approximately 125 km of coastline, Benin, a relatively small country in West Africa is situated at the Gulf of Guinea. Four species of sea turtle frequent the coast. Most of them are captured by local communities. The main threats for the lives of sea turtle in West African region are various. Human consumption is the most important in Benin. Law enforcement and awareness raising amongst the local communities is executed by civil, political and administrative authorities. Also sea turtle conservation committees are put in place and alternative income-generating projects are being launched. The increasing consciousness amongst the authorities facilitates the implementation of the Convention on Biological Diversity and the Convention on Migratory Species signed by this country.

After the Abidjan Memorandum of Understanding concerning conservation measures for marine turtles of the Atlantic coast of Africa, in 1999, the Museum Nature Tropicale NGO elaborated and executed with thanks to several local and International institutions a large program of protection of the sea turtles particularly threatened on the coast of Benin. The main objective of this program is the conservation of the sea turtles, the ecosystems on which they depend in Benin by fitting into a regional frame and to create the conditions necessary for the promotion of the sustainable management of migratory species by the local communities. The mentioned program is diligently executed with care and dynamism through several specific objectives namely: (1) the intensification of national capacities for a better knowledge and conservation of sea turtles; (2) the establishment of awareness programs (Information, Education and Communication) at the national level; (3) the instigation of the participation of the general public and the empowerment of the local communities (Committees of Protection); (4) the stimulation of the initiatives of conservation of the sea turtles supported by developing for the activities of alternate incomes for the local populations; (5) the implementation of sustainable and durable management of the sea turtles through Eco-tourism; (6) the development of the scientific researches and the permanent follow-up of the species (monitoring); (7) the implementation of areas protected on the coast and in the sea; and (8) the promotion of a regional and international cooperation for sea turtles protection.

METHODS

To make successful the mission, the Museum Nature Tropicale NGO proceeded to the division of Benin coast in four zones (Pazh, Nature Tropicale 2000): Sèmè (24 km); Cotonou (22.8 km); Ouidah (28.2 km); and Grand-Popo (46 km). Each zone is placed under the responsibility of a team of two biologists. The methodology is based on the participative approach indispensable to moment of decentralization in Benin. The fishermen, local authorities, pupils who frequent beaches, owners of approved trawlers, and members of the National Union of the Fishermen are all concerned. Posters, images signboards illustrating the different species of turtles known in Atlantic Ocean and others information about the biology of sea turtles and the threats exercised on the sea turtles on coast of Benin. Awareness sessions and collections of data on the various sites were so organized.

RESULTS

Status of the species. The works engaged since 1999 allowed the identification of four species of sea turtles which frequent the Beninese coast (*Lepidochelys olivacea*, *Dermochelys coriacea*, *Chelonia mydas*, and *Eretmochelys imbricata*).

Awareness campaign. One of the important activities of the program is the permanent awareness campaign on local level. It is led by means of Eco-guards, superintendents, volunteers of the members of the Peace Corps of USA for the benefit of the local populations, the local elected members, the pupils and the teachers, the responsible for the cults and religious leaders, from customs officers, agents of national police forces, the communities of Beninese and Ghanaian fishermen and leaders of District. Posters and broadcast emissions were broadcast in local languages and in French, meetings and sessions of explanation and the public criers are the various supports used to achieve this awareness campaign of all the coat layers and the categories of the populations of Benin on sea turtles protection. It is necessary to note the invaluable contribution of Eco-guards on the success of this program through the night as day surveillance of the turtles and of their eggs on the beaches of Benin, the transfer of eggs for incubation, the release of the babies in sea, the construction of incubators, the Eco-tourism program.

Installation and training of Eco-guards. In interest coastal villages, twenty committees of sea turtles conservation were established with Eco-guards as well by male as feminine sexes native of the community. About twenty Eco-guards (members of Committees) followed training on the techniques of sea turtles biology and protection. These training so theoretical as practical carried on: (1) the knowledge of the texts of laws which protect the biological diversity in our country and other the world; (2) the techniques of identification of sea turtles species known on our coast; (3) the techniques of measurement and marking of sea turtles ; (4) the location of nests and collection of eggs; (5) the release of the babies and the maintenance of the incubators; and (6) the collection and the recording of the data on the field, etc. It is also approached with Eco-guards, the importance, functions and the wealth of the wetland zones, the necessity of protecting the wildlife for the present and future generations. A particular accent was put on the respect for the International Agreements of conservation of the nature to which Benin subscribed. It was necessary as well question of the necessity to make more functional and dynamic these local Committees and to assure their preparation for the activities of follow-up, collections of data and protection of the sea turtles.

Nature Tropicale NGO settled and stimulated in elementary schools and grammar schools of the coast, the environmental Clubs for the protection of sea turtles. Eco-volunteers of these schools participates actively in various actions in favor of the protection of the coast and the sea turtles.

Nesting of sea turtles in Benin. Two species of sea turtles nest in Benin (*L. olivacea* and *D. coriacea*). From July 2001 to February 2002 at Grand-Popo 53 olive ridley and 9 leatherback nests were deposited. A total of 7490 eggs were layed and 6105 hatchlings were release in sea.

Eco-guards on the various beaches of Benin and more particularly those of Grand-Popo organized every December 25, an exhibition for general public with the babies to make sensitive the populations and satisfy the curiosity of the tourists (PAZH et al. 2001a). During June 2001, the Museum organized for the benefit of Benin Eco-guards with the support of the PAZH, a trip of studies and exchanges on the conservation of the sea turtles in Ghana with the partnership of Ghana Wildlife Society, the Ghanaian NGO.

Threats on sea turtles in Benin. Sea turtles in Benin are in a spiral of massacres by the local communities thus in danger and measures deserve to be taken to protect them (Dossou-Bodjrenou et al. 2001). Among these threats, the main clauses which press on the survival of the turtles and other marine resources in Benin are: (1) the bycatch (fishing) in sea with destructive machines and the desolation of nets in sea (traditional, trawlers); (2) the collection of eggs and babies; (3) the capture of females on the beach by the waterside populations; (4) the degradation of the vegetation along the coast because the increasing demographic pressure; (5) the construction of houses and tourist infrastructures on beaches especially on the "Route des Pêches" after Fidjrossè; (6) the coastal erosion; (7) the plastic bags and the other household on beaches; (8) the collection of the maritime sand on beaches (Grand-Popo, Ouidah, Ekpè and Djèffa beach); and (9) the next construction of the industrial free zone to Sèmè etc. Others threats are the presence on the coast of dogs, cats, crabs ghosts (*Ocypode quadrata*) and reptiles, predators, known on other beaches in the sub-region like in Ghana. They are responsible of destroying nests and of arresting babies. A scientific study on this sector will allow to appreciate in its just value the incidence of these natural predators on the survival of sea turtles on Beninese coast.

Perspectives. It is to point out that all these good actions will really know success only thanks to the political will and the implication of African governments to display all the necessary means in the application of the International agreements in connection with repressive measures. Today, the national strategy and action plan for the conservation of the biological diversity in Benin takes into account the concerns in the protection by all the means of the migratory species among which the sea turtles.

A National Action plan and program for the conservation of sea turtles the other marines resources in Benin is in the course of editorial staff with some partners and takes into account the following points: (1) the reinforcement of information sessions with the populations of the coast, the schools with especially the installation of environmental clubs; (2) the progressive integration of the environmental preoccupations in the elementary school programs; (3) the reinforcing of the setting-up of monitoring and protection committees in respect of sea turtles in all coastal villages; (4) the creation of collection of follow-up of the sea turtles; (5) the supports of the revenue-generating activities beneficial for the program; (6) the training in the techniques of conservation and identification of turtles; (7) the scientific researches of accompanying; (8) the collection of data base and materials of information and educational; and (9) the establishment of partnership for exchanges of experiences on the conservation of turtles within the framework of a regional program of protection of the turtles on the coast of the Bay of Guinea. This program will allow to coordinate the actions of conservation and management of the migratory species.

The empowerment of the local populations through a system of joint management where these last ones and the service of the maritime peaches will have to play additional roles will allow a durable management of these resources. The regional cooperation for a complete protection of the present navy tortoises in the Atlantic Ocean and on the African coasts establishes a determining objective of any national plan because of the migratory status of the sorts in question. This program had considerable and quantifiable important impacts on Benin and its population in the sense that they know henceforth that the navy tortoises are to be protected. Towards all these actions, the tortoises have beautiful days in front of them and should thus consider themselves happy if they were conscious of it.

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LITERATURE CITED

ABE and PAZH. 2000. Elaboration de la Stratégie Nationale de Gestion des Ecosystèmes Humides du Bénin. Diagnostic de la Gestion des Zones Humides. Rapport de synthèse, 220 p.

Dossou-Bodjrenou, J. 2001. Espèces de tortues marines et habitats d'intérêt pour leur conservation: Inventaire et caractérisation des ecosystems humides des complexes Est et Ouest des Zones Humides du Sud-Bénin - Septembre 2001. Rapport PAZH, Cotonou, Bénin.

Dossou-Bodjrenou, J., W.E. Hoeckert and J. Fretey. 2001. Projet de protection des tortues marines à travers les frontières. Atelier international de formation sur les techniques de conservation des tortues marines et évaluation du programme de sauvegarde des tortues marines au Bénin. Rapport mimeogr., 26 p.

Fretey, J. 1998. Marine Turtles of the Atlantic Coast of Africa. Tortues Marines de la façade Atlantique de l'Afrique. UNEP/CMS Technical Publication n 1, 254 p.

Fretey, J., J. Dossou-Bodjrenou, A. Mama, W. Hoeckert, B. Oosting, D. Chaverri, and R. Arauz. 2000a. Identification et biologie des tortues marines – Atelier sur les tortues marines – Bénin Nov.-Déc. 2000.

Fretey, J., J. Dossou-Bodjrenou, A. Mama, W. Hoeckert, B. Oosting, D. Chaverri, and R. Arauz. 2000b. Eléments méthodologiques de suivi des sites de pontes – Atelier sur les tortues marines – Bénin Nov.-Déc. 2000.

IUCN/SSC. 2000. A global strategy for the conservation of Marine turtles – Marine Turtle Specialist Group, 25 p.

PAZH and Nature Tropicale. 1999. Programme de sauvegarde des tortues marines de la côte Atlantique du Bénin – janvier à juin 2000. Rapport d'activité n° 3, Cotonou, Bénin.

PAZH and Nature Tropicale. 2001. Programme de sauvegarde des tortues marines de la côte Atlantique du Bénin – Septembre 2000 à Février 2001.Rapport d'activité n° 4, Cotonou, Bénin.

Community-based sea turtle conservation in Trinidad by "Nature Seekers"

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WHAT ARE WE TALKING ABOUT?

In many parts of the world coastal communities share beaches and inshore waters with sea turtles. Furthermore, especially in the developing world, local people consume turtles or depend on turtles for their livelihood. Government agencies alone cannot conserve sea turtles due to a lack of human and financial resources. Therefore local communities provide an excellent co-management opportunity due to their year-round presence and experience with sea turtles and their habitats. There are a growing number of community initiatives worldwide and they are successfully filling a much-needed void. This is greatly due to the increasing awareness that conservation cannot be successful without the involvement of local people. The success of community-based conservation is based on (a) the active participation of local people, (b) direct economic benefits for community livelihoods, and (c) the empowerment of local people to manage sea turtle conservation initiatives. This paper describes a community-based programme to conserve sea turtles at Matura Beach, in Trinidad and Tobago.

WHERE ARE WE LOCATED?

Situated seven miles northwest of Venezuela, Trinidad and its sister island, Tobago, lie southernmost in the chain of Caribbean islands. Matura Beach is located on the east coast of Trinidad, surrounded by rivers and tropical forests. The beach was declared a protected area in 1990, dedicated to the conservation of sea turtles and lush coastal forests. The rural community of Matura, located three miles from the beach, has about 1500 people, whose primary livelihoods are subsistence hunting and agriculture.

WHY ARE WE CONCERNED?

Trinidad supports the largest nesting colony of endangered leatherback sea turtles (*Dermochelys coriacea*) in the Caribbean and possibly the 4th largest concentration in the world. Matura Beach is the most famous of the nesting beaches in Trinidad. There are as many as 2000 leatherback sea turtles nesting at Matura each year. Occasionally green (*Chelonia mydas*) and hawksbill (*Eretmochelys imbricata*) turtles nest as well, while juveniles of these species are seen more frequently feeding in the vicinity of the beach. Historically sea turtles were hunted throughout Trinidad and Tobago, primarily for subsistence use by local fishing people. In the 1970s and 1980s such hunting caused a rapid decline in sea turtles occurrences. Currently sea turtles are protected under national laws in Trinidad and Tobago, with an open and closed season for the hunting of these animals. To a great extent the seasonal ban is respected, however, the harvesting of turtles and their eggs is a constant threat. Furthermore, a high rate of incidental capture of turtles in fishing gear is prevalent around the island.

WHO ARE WE?

Community involvement in turtle conservation began in 1990 after concerned government officials and local residents from the Matura Village decided to work together. This collaboration prompted a tour guide-training course that led to the formation of a non-profit, nature-based group called "Nature

Seekers." Community volunteers started patrolling the beach on a nightly basis during the turtle season to stop the hunting and to collect data on the nesting turtles. As a result of these efforts, the slaughter of nesting females on Matura Beach has been reduced to zero percent. Investment from both the government and the community through training and volunteerism led to the success of the co-management initiative that exits today. After 12 years of growth, the 20 members strong organization is now capable of creating its own structure, activities, and small projects for conservation and community development.

Nature Seekers is respected in the community and in the country. Groups throughout the wider Caribbean and elsewhere know of the accomplished tour guides and dedicated environmental stewards that the organization represents. As a growing team, several steps have been undertaken to evaluate progress, activities, and management, with the goal of improving the organization and the services it provides. Nature Seekers now serves as a co-management and community tourism model for other communities in Trinidad and elsewhere. Since its inception, the organization has received numerous national and international awards for its conservation work, and several members have received awards for dedication and service.

WHAT DO WE DO?

While conserving sea turtles is the central focus, such conservation has required a wider environmental and social approach, from traditional sea turtle research to sustainable livelihoods for members of the community. Members bring a variety of skills and experiences to the organization, and where necessary develop local, national, and international partnerships, to accomplish this end.

The annual beach clean-up conducted before turtle nesting begins at Matura ensures that the beach is free from all debris which can prevent successful turtle nesting. This activity receives the participation of people of all ages and from both the local communities as well as neighboring cities. A sand turtle competition at this year's beach clean-up instilled a sense of fun, games, and education. The beach is also regularly monitored for erosion and pollution to safeguard and prevent the destruction of the nesting habitat.

During the turtle-nesting season (from March to August) the beaches of Matura are patrolled on a nightly basis to protect the nesting turtles from egg collectors and hunters. Each patrol has a member who has been formally trained as an Honorary Game Warden, a designation created by the government to assist in the enforcement of wildlife conservation laws. Also during patrols important scientific data are collected on individual turtles during the season (such as measurements and physical condition), on nest emergences and hatchlings, as well as on the weather. Through tagging a total of 881, 1204, and 1987 turtles have been identified during the 1999, 2000 and the 2001 turtle seasons respectively. Occasionally nests are relocated when threatened by erosion. All emerged nests are excavated so that any trapped hatchlings in the nest can be released. It is estimated that over 600 hatchlings are saved each year by this activity. Data collected by Nature Seekers represents the most accurate ever gathered for sea turtles in Trinidad.

In addition to monitoring and research activities, Nature Seekers acts as an approved tour guide agency to facilitate turtle-watching and interpretive services. Members have been trained and certified by the government's Forestry Division to carry out some of these activities. The major goals of the programme are to encourage the viewing of marine turtles, to create a bond between visitors and these animals, as well as to prevent harassment and disturbance as a result of such interactions. The total number of visitors is controlled by a pre-established carrying capacity of 200 visitors per night. Over 8000 visitors come to Matura annually to view turtles, of whom 13 percent are children and 10 percent are from outside Trinidad. Guides are very keen to answer questions and explain the nesting process to visitors.

Beyond beach activities, Nature Seekers has a proud legacy of community services, including environmental education in schools and to other community groups, community advocacy, and youth programmes. Nature Seekers is constantly involved in training courses for the development of its members and other local people. Some of these courses include topics such as tour guiding, personal development, business and natural resources management, host-home management, craft making, conflict management, communication skills, and turtle biology and conservation.

All activities carried out by the organization are geared towards a five-year community tourism and conservation plan for the development of the Matura community and its surroundings. This involves the expansion of hiking trails and nature tours, host-homes, crafts, a nature park, and revitalisation of the local culture. Nature Seekers hopes to make the community aware of the economic potential of conserving natural resources and the need to ensure sustainable livelihoods. The fact that some of the most committed members are former turtles hunters, or the children of such families, stands testimony to the approach taken by Nature Seekers.

WHO DO WE COLLABORATE WITH?

Matura Beach in managed under a collaborative co-management arrangement between Nature Seekers and the Wildlife Section--Forestry Division, the government agency responsible for conservation in Trinidad. As part of this arrangement the community organization gathers and tallies all the scientific data on turtle sightings during the season to share with government agencies. A national tagging database has been developed under joint management of Nature Seekers, the institute of Marine Affairs, and the Wildlife Section--Forestry Division. As part of national sea turtle conservation efforts, Nature Seekers has collaborated on training initiatives for other community-based sea turtle projects in Trinidad and Tobago.

Several collaborative research and training initiatives have been carried out through the years, and contributed to the advancement of Nature Seekers. Members have received technical training from international organizations experienced in a variety of topics relevant to conservation, tourism, and capacity building. Collaborating organizations include WIDECAST-Wider Caribbean Sea Turtle Conservation Network (which serves as scientific advisor to the tagging project), CANARI-Caribbean Natural Resources Institute, Hubbs-Sea World Research Institute, Glasgow University, The University of the West Indies-Barbados, the Community Participation Taskforce of the IUCN-Marine Turtle Specialist Group, and the Community Participation and Integrated Sea Turtle Conservation Initiative. Such collaborative projects range from high-tech tagging (satellite and radio tracking for swim speed and internesting movement of the leatherback turtles within Trinidad, the Caribbean and international waters), to community surveys, tourism, and organizational development. Nature Seekers members have attended and participated in the annual International Symposium on Sea Turtle Biology and Conservation, as well as several national and regional conferences on sea turtles, organizational management, and tourism as a way of sharing experiences and learning from other projects.

HOW DO WE SUPPORT OUR WORK?

Nature Seekers activities are financed in several ways. A collaborative co-management arrangement with the Wildlife Section--Forestry Division provides for beach patrols on a part-time basis and corporate sponsorship provides for special projects such as the acquisition of equipment, institutional strengthening, and the production of printed materials. Funds are also generated through tour guide services, an Adopt-a-Turtle Programme, and other on-site sales (t-shirts, crafts, etc.).

Project funding has been received from UNDP's GEF Small Grants Program, BP Trinidad and Tobago, the Canadian High

Commission (Fund for Local Initiatives), WIDECAST, BHP Billiton Petroleum (Americas) Inc and CANARI. Other support has come from a wide variety of public and private sources, including foundations and corporations. Every effort is made to ensure that the projects undertaken are sustainable over time and to completion.

Fund raising efforts from guide fees and on-site sales amount to over 50 percent of the total budget. These income sources provide stipends for taggers and tour guides as well as day-to-day expenses of the programme. A large portion of the budget however is offset by the voluntary services of Nature Seekers members (such as with additional assistance for patrolling, tour guiding, and manual labour). Nature Seekers believes that the leatherback conservation programme at Matura Beach has the potential to provide wider community employment and community development.

WHAT IS OUR MISSION AND GOALS INTO THE FUTURE?

The mission of Nature Seekers into the future is "to promote environmentally sustainable tourism, education, protection and preservation of the wild flora and fauna of the community for the appreciation and enjoyment of all present and future generations." The organization hopes to accomplish this mission by improving the community through sustainable community tourism, by providing for growth and development of its members, by protecting the biodiversity of wild flora and fauna of Matura and its environs, and by working with other organizations to improve and promote community conservation. Sea turtles will continue to be the flagship under which Nature Seekers will accomplish this end.

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Motivation to the teachers for the creation of educational material related to the conservation of sea turtles

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INTRODUCTION

There is general agreement among those who work in conservation programs that there is an increasing need for better environmental education activities that promote community participation, and enhance the probabilities of survival of sea turtles and associated habitats. The formative function of educators is essential to achieve community participation in conservation programs activities. Therefore, it is necessary to prepare faculty to exploit the didactic potential offered by cultural and natural environment, to impress and educate new generations in the sustainable use of natural resources for their own benefit. In our visiting to local schools, we have encountered motivated teachers eager to include environmental activities concerning biology and conservation of sea turtles in the educational curriculum. However, many have manifested that there is a lack of educational materials about the topic, adapted to school infrastructure, and the social reality of pupils and teachers. The limitations of economic and human resources are also common problem that hinder the implementation of conservation projects. It is very difficult to hire specialized personnel to elaborate innovative educational materials, adapted to the special needs of each school or region. With this problem in mind, we decided to conduct a series of pilot workshops and recreational activities with rural teachers in order to achieve the following: (1) Experiment with a simple, economic and amusing methodology to produce educational materials adapted to the reality of each region, using the regional and national objectives of elementary education in Venezuela; (2) Use the imagination, creativity and previous knowledge of the professorate to produce pertinent, simple materials with a local language; (3) Reduce production costs of educational materials and improve their quality; (4) Encourage educators to participate in environmental education activities for the conservation of sea turtles developed by CICTMAR; and (5) Increase the success of conservation projects.

METHODS

Two workshops were organized, directed to professors that work in the Elementary Education System of Venezuela. Educators were from 12 private and public schools located in the coastal region of Venezuela, specifically in the states Sucre and Falcón. These workshops had a duration of about 8 and 12 hours, divided into 5 sections that varied in time according to the logistics and availability of teachers.

Workshop design. The workshop was divided in five sections: (1) Integration: this section intended to emphasize the value of cooperation in the conservation efforts of sea turtles. By means of ice-breaking techniques participants had the opportunity to know each other, express their expectations about the workshop, and integrate as a working team. (2) Exploratory evaluation: this had the purpose of examining previous knowledge of participants about to sea turtles and served to adjust the subsequent sections based on the results. In order to avoid written-tests stress, we used and modified a very popular written-game in Venezuela. This section had a duration of 30 minutes, including the game itself and a posterior discussion of the answers, without using a grading scale. (3) Presentation of information relating to sea turtles and their threats: we supplied information about sea turtles biology, classification, actual threats, and conservation efforts of the species and their habitats carried out by governmental and non governmental organizations. Finally, the local sea turtle situation was summarized. We used slides, videos, and sea turtles shell models elaborated in paper. (4) Induction for the elaboration of materials: in this phase teachers received printed educational samples, identification keys and other materials on sea turtles. In addition, they were submitted to a section of challenge-type activities and regional games transformed to ecological games regarding sea turtles and their habitats. Our objective in this section was to demonstrate participants the utilities of adapted traditional games in environmental education as well as their simplicity in developing and carrying them out. The majority of these games were prepared with materials that are commonly found inside classrooms. And other objective was to reinforce the knowledge about sea turtles in the previous section. (5) Preparation of educational materials: Teachers were divided in 5 groups (one for each turtle species in Venezuela). Each group was assigned an objective in Natural Sciences or Environmental Education of the Curricula of Elementary Education of Venezuela. With this objective in mind and within the context of sea turtle biology and conservation, groups were expected to organize an activity, either by creating a game, transforming a traditional game or written material, keeping present the characteristics and materials existing in regional schools. At the end of this phase, each group presented their material. If a game was adapted or created, it had to be evaluated by other groups. The objective was to revise the material created by all groups and make recommendations to further improve them.

RESULTS

Teachers acquired knowledge on sea turtle biology and habitats, as participated in conservation programs of these species. A mechanism was provided for professional development of teachers of Elementary Education System in Venezuela were instructed on the elaboration and development of environmental educational activities and materials in the classroom. A entertaining and rapid methodology, which uses teacher's spontaneity, curiosity and creative potential was used for the creation of educational materials on sea turtles. A series of activities with clear objectives were produced: games, simulations, challenges, songs, drawings and research projects of investigation. The educational activities produced in these workshops have the following advantages: They are adapted to the needs and facilities of schools; they can be made inside or out of the classroom. In addition, materials used in the activities are simple and economic. Were based in the program of national and regional education of Venezuela The activities can be adapted to instruct about other environmental themes and different subjects of study. The use of the traditional games promotes the conservation of local culture and facilitates learning. They are cooperative activities that promote working for a common goal, thus eliminating competition and evaluation stress. Because activities are designed and adapted by local teachers, their use is guaranteed as it increases their self-esteem. Children were benefited in the learning process, with amusing educational activities, thought and especially designed having in mind their emotional and cognitive needs.

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LITERATURE CITED

Frazier, J. 2000. Conservación basada en la comunidad. In: K. Eckert, K. Bjorndal, F. Abreu and M. Donnelly, eds. Técnicas de investigación y manejo para la conservación de tortugas marinas. UICN/CSE. Publicación 4:6-20.

Pulido M., L. Batista, and A. Alvarez. Juegos ecológicos en el Aula. UN manual de actividades para la educación básica. Editorial Fundambiente. Caracas. Venezuela. 123 p.

Ministerio de Educación. 1998. Programa Nacional de Estudio de Educación Básica. Primera Etapa: 3er grado. Edit. Nuevas Ideas. Caracas, Venezuela.

Ministerio de Educación. 1998. Programa Nacional de Estudio de Educación Básica. Segunda Etapa: 4to grado. Edit. Nuevas Ideas. Caracas, Venezuela.

Ministerio de Educación. 1998. Programa Nacional de Estudio de Educación Básica. Segunda Etapa: 5to grado. Edit. Nuevas Ideas. Caracas, Venezuela.

Thinking outside the box: a strategy for educational programs

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The current philosophy within the conservation movement is to not only preserve species, but more importantly preserve habitat quality and quantity so that surviving specimens can thrive. This model can be incorporated into how we present our educational outreach to the broad-based public. Sharing information and data directly through booklets, brochures, and written materials can be the basis for any educational program, but also more importantly we must engage our fellow citizens in meaningful hands on activities. These actions benefit each participant with a closer association to the mysterious world of the sea turtle. We are no longer an agrarian society, tied to the earth for our welfare. Many individuals are disconnected from contact with the outside workings of a common habitat. They think of the ocean and the shore as a place of recreation only. These individuals need an opportunity to bond with not just the species but with all that is required to support them. To that end I wish to present the pro-active educational philosophy and programs provided by The Marinelife Center of Juno Beach.

Mediterranean, A Living Sea: a kit for environmental education and awareness for children

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INTRODUCTION

With extensive knowledge and experience of environmental issues in the Mediterranean region, MEDASSET has produced an educational kit in partnership with the Hellenic Children's Museum and Kaleidoscope Publications. The initiative, which has been funded with a grant from the Stavros S. Niarchos Foundation, focuses on the Mediterranean basin and is initially being produced in Greek and English. In contrast to some environmental education initiatives, and in a departure from the reward/sanction approach to raising awareness often seen in games, this package focuses exclusively on the region in order to engage users in a critical assessment of the role and value of its cultural and environmental heritage. Furthermore, the KIT will be distributed free of charge to schools around the Mediterranean to be used at their discretion.

BACKGROUND AND JUSTIFICATION

Over the past two millennia, the Mediterranean region has fostered the emergence of civilizations, religions and ideologies that have spread and influenced the world. Today however, this cultural and environmental heritage is bearing the brunt of unrestrained development. In addition to the Mediterranean's 145 million coastal inhabitants, each year sees an increase in the more than 187 million tourists that annually visit the region. This combined pressure, exacerbated by the lure of cheap package holidays, results in severe degradation of the coast, including localized yet dangerous instances of pollution, unregulated and often inadequate tourism infrastructure development and consequent loss of biodiversity. Because many of the Mediterranean's threatened species such as sea turtles and monk seals do not recognize borders, their survival depends on the concerted action of all the region's stakeholders. As legislation and agreements can only go a certain way towards achieving this, the real break-through lies in the awareness and empowerment of the Mediterranean people. In effect, the consequent involvement of the public is essential to stir policy-makers into implementing legislation and conservation measures.

MEDASSET firmly believes that in order to reach its aims for sea turtle conservation in the Mediterranean, action must be undertaken both at the research level and in the field of environmental education. Moreover, these initiatives must go beyond an immediate focus on sea turtles and delve into wider issues related to i.e., pollution, loss of biodiversity and protected areas, and must introduce notions of responsibility in children. In other words, it is essential to stress the crucial interconnectedness of all natural and man-made elements that constitute the Mediterranean region.

The ages from 6 to 12 correspond to a period where children gradually become familiar with concepts of space, time and numbers and are eventually able to provide logical explanations to the outcomes of a given task. On this account, the aforementioned age group was selected, split into two segments 6 – 9 and 9 - 12, as a realistic target for the kit. The activities included do not provide answers but create a framework that facilitates critical thinking, and are intended to catalyse tangible actions amongst the target group. Changing attitudes by instilling values and a sense of regional responsibility are processes more likely to be successful at this age group than at a later stage in development.

AIM AND OBJECTIVES

To build up eco-consciousness and present the richness of the region's natural environment, the threats it is facing as well as the highly multicultural character of the Mediterranean peoples, in educationally innovative ways. With regard to the target age group, the kit aims to: (1) Increase knowledge of the physical and cultural environment of the Mediterranean region; (2) Develop environmental awareness; (3) Enhance analytical and problem-solving skills; (4) Trigger interest and creativity; (5) Develop team skills; and (6) Promote capacity building for environmental education.

MEDITERRANEAN KIT CONTENTS

The material featured in the kit uses children's developmental theories, and relies on a 'hands-on' approach to learning to engender critical thinking, satisfy curiosity and encourage involvement. To this end, the range of activities that are offered cover the analysis of environment and culture-related news items, the development of observational skills in natural contexts and the analysis of short stories involving different stakeholders that children must enact. The kit will be produced as a loose-leafed package within a folder, and will contain the following items: (1) 4x4 size Map: the Mediterranean region featuring the main UNESCO World Heritage historical and cultural sites, as well as key protected areas along the coastline. (2) Eight fact sheets: Sea Fauna (3 sheets), Important Coastal Mediterranean Ecosystems, Threats facing the Mediterranean (2 sheets), Protected Areas, and Peoples of the Mediterranean. For example the 'Important coastal Mediterranean ecosystems' sheet lists a number of National Parks, with associated photos. Ranging from wetland areas to marine national parks, these sites are presented together with the threats to which they are exposed, and notable endemic and rare species. (3) Working sheets: 8 sheets, with material for both target age groups. A word hunt with words relative to ecosystems and role-playing activities where children impersonate community stakeholders in the context of an environmental issue, are featured. For example, a simulation scenario for 6-9 year olds: Children are asked to imagine themselves as a sea turtle returning to lay its eggs on the beach where it was born 20 years earlier. The beach has now become a sprawl of hotels, tavernas, deck chairs, umbrellas and tourists, while the sea is buzzing with jet-skis and speedboats. The children are then posed questions on what they would say as a turtle to all these people, and are asked to enact the story into a play. (4) Educator's material: 16 sheets include an educational guide, detailed information related to fact sheets, glossary, bibliography and an evaluation sheet.

DISTRIBUTION

In order to maximize its impact, the kit will be distributed free of charge to elementary schools, non-profit and youth organisations in countries around the Mediterranean coast. Currently, 2000 copies of the kit in Greek are being made available through the Greek Ministry of Education while the UNEP Mediterranean Action Plan (UNEP/MAP) network will handle the distribution of the 1000 English language versions. MEDASSET believes that the UNEP/MAP comprehensive and unique structure, through its' ties with all countries around the Mediterranean, is the most appropriate tool to guarantee the correct exposure for such an initiative. Meanwhile, the MAP office has offered to translate the kit into Arabic and will assist in its' distribution throughout the Arabic-speaking Mediterranean countries. The distribution process will also involve sending the kit to the relevant state ministries of the Mediterranean countries with the objective for them to translate it, and finance its' production. In a testament of faith in its potential, Kaleidoscope Publications has decided that the kit should also be released commercially in Greece.

PROMOTION

The availability of the KIT will be publicised through press releases, specialised environmental publications (Marine Turtle Newsletter, UNEP'S MedWave magazine etc), educational publications and electronic media (EuroTurtle and other educational websites, sea turtle mailing lists etc).

ASSESSMENT

In order to gain an insight into how effective the educational kit has been in schools around the Mediterranean basin, an evaluation sheet has been included in the package. Coordinators in charge of implementing the game activities will be required to rate which sections were the most successful, how the material was adapted to the particular group and how they intend to pursue their involvement in environmental education. Thus, in the event of further forays in such educational ventures, feedback from the kit will be incorporated into the next production.

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The effect of incubation temperature on morphology and swimming performance of the green sea turtle hatchling

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Along the Great Barrier Reef cays, the highest mortality for the green sea turtle population occurs as a result of hatchling predation within the first hours of entering the sea. This research addressed whether some hatchlings develop with a greater post-hatching swimming capacity, giving them a competitive advantage over conspecifics, as they evade reefal predators during their journey offshore. A total of 240 eggs (60 eggs from four clutches) of the green sea turtle were artificially incubated at each of the temperatures 26°C, 28°C and 30°C. Emergent hatchlings were measured for external morphology (n=190), experimentally swum in aquaria for 24 hours to determine swimming performance (n=109), and dissected for internal morphology (n=54). Measures of body size in the turtle varied negatively with incubation temperature, suggesting that temperature significantly affected embryonic growth. The internal morphology of the hatchlings was also significantly affected by incubation temperature, with hatchlings incubated at warmer temperatures hatching with a larger residual yolk, an important energy store for the neonatal hatchling. Swimming performance measures (stroke and breathing rates) were significantly influenced by the temperature of incubation. Hatchlings incubated at warmer temperatures had faster stroke rates and more frequent breathing rates, than hatchlings incubated at cooler regimes. Temperature-dependent sex determination in the green sea turtle acts to produce predominantly males at 26°C and females at 30°C. Incubation temperature significantly affected hatchling morphology and swimming performance. Therefore, results from this study suggest that there is potential for gender differences in swimming performance that may lead to sex-bias survival during offshore swimming.

Eversion and detachment of the oviduct in nesting loggerhead turtles (*Caretta caretta*)

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The beaches of south Brevard County have been surveyed by our group daily during the marine turtle nesting season (May 15th –August 31st) since 1989. In the summer of 2001, our group discovered two loggerhead (*Caretta caretta*) nests from which a segment of oviduct protruded. We are aware of two other cases of cloacal prolapse/oviduct expulsion. This is the first record of any such occurrence on our study site in over 13 years of nesting beach research. The first nest containing oviduct was discovered during our morning nesting survey on the 6th of June and the second on the 14th of June. The turtle was not actually seen in either case. No evidence of human activity was observed around either nest site. The oviduct was removed from each nest along with all broken eggs. The remaining eggs were left in-situ. Oviducts from both nests were collected and frozen for subsequent histological examination. One of the nests was inventoried and there were 121 eggs, of which none hatched.

Embryo and hatchling abnormalities in loggerhead sea turtles on St. Vincent Island, Florida

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INTRODUCTION

Abnormalities in embryo and hatchling sea turtles may serve as indicators of genetic, contaminant, or other ecosystem health problems, but few baseline data exist on their occurrence. Herein, we summarize abnormalities in loggerhead (*Caretta caretta*) sea turtle embryos and hatchlings recorded on St. Vincent Island, Florida, USA, for 1992-2001.

METHODS

Study area. St. Vincent Island is a 5005 hectare undeveloped barrier island at the western end of Apalachicola Bay in the Florida Panhandle. The U.S. Fish and Wildlife Service manages the island as a National Wildlife Refuge. Modest numbers of loggerhead (mean = 45 nests/year) and occasionally green (*Chelonia mydas*) and leatherback (*Dermochelys coriacea*) sea turtles nest on the 16 km of Gulf of Mexico beach.

Study design. We monitor sea turtle nesting daily from mid-May through the end of September and hatching success at least twice a week until all nests hatch or should have hatched (70 days after deposition). We excavate all available nests and determine hatching success based on criteria set by the Florida Fish and Wildlife Conservation Commission. We also record data on hatchling and embryo abnormalities.

For this study, we tabulated abnormalities in loggerhead sea turtles from nest evaluation notes in annual field data sheets for 1992-2001. We counted each abnormal hatchling and pipped embryo as one abnormality. If all unhatched eggs were examined, we also counted each abnormal embryo as one abnormality. In cases where we examined only a portion of the eggs, we extrapolated the percentage of detected abnormal embryos to the number of eggs remaining in the nest. Supernumerary or subnumerary scutes alone were not counted as abnormalities.

For analysis, we grouped abnormalities in the following categories: miniaturism; leucistic pigmentation; deformities of the carapace, flippers, eyes, or mouthparts; multiple deformities; twinning; and abnormality not specified. We calculated the frequency of abnormalities (all types combined) in two ways based on the extrapolated totals of abnormalities from Table 1: (1) as a percentage of the total number of eggs, embryos, and hatchlings available for examination, and (2) as a percentage of the total number of eggs (including those of emergent hatchlings) in evaluated nests per year.

RESULTS

Overall, we recorded only a low incidence of abnormality in loggerhead embryos and hatchlings between 1992 and 2001. We found 0.32% abnormalities in 14,361 unhatched eggs and hatchlings remaining in the nest. We summarize numbers and types of abnormalities in Table 1.

Abnormalities included unusually small size; absence of pigmentation; deformities of the carapace; folded or foreshortened flippers; missing, enlarged, or malformed eyes; misshapen mouthparts; and twinning. Occasionally several abnormalities afflicted the same individual. One leucistic embryo examined in 1998 had only one eye, which was oval-shaped and centered above its misshapen beak. In other instances, several embryos and hatchlings from the same nest manifested different combinations of the same deformities. For example, one nest in 2001 contained four deformed dead embryos: one with a malformed left eye; one with a malformed left eye and half-length front flippers; one with half-length front flippers; and one with a large, bloated plastron and unusually small head and flippers. Unusual scute patterns sometimes occurred along with other abnormalities. One case of twin embryos (fully separated but sharing the same yolk sac) was detected in 2001. Additionally, a pink coloration of eggs and embryos, indicating the presence of the bacterium Serratia marcesens (Wyneken et al. 1988), was noted to affect at least two nests in 2001 and has been observed in the past (Lewis, personal observation).

We summarize the frequency of abnormalities calculated from Table 1 in Fig. 1. Abnormalities were proportionally greatest in 1993 and 2001, with 0.70% and 0.75% of examined embryos and hatchlings (0.27% and 0.61% of total nest contents) exhibiting deformities in these years, respectively. One instance of twinning yielded a frequency of less than 0.01% of examined embryos and hatchlings. Averaged over a ten-year period, the incidence of abnormalities was 0.32% of the examined embryos and hatchlings (46 abnormal embryos of 14,361) or 0.16% of the total eggs in evaluated nests (46 abnormal embryos of 29,420).

DISCUSSION

Our calculated frequency of abnormality in loggerhead embryos and hatchlings falls well within the range reported for marine turtles generally. Blanck and Sawyer (1981) found fewer than 1% abnormalities in 2811 unhatched eggs. We found 0.32% abnormalities in 14,361 unhatched eggs and hatchlings (dead and live) in the nest.

Although we were not able to examine most emerged hatchlings, we are fairly confident that the greater portion of aberrant hatchlings remained within the nest (Miller 1985). Therefore, the proportion of abnormal hatchlings to total eggs in the nest (our second figure, which includes the eggs of emerged hatchlings) probably gives a truer picture of the proportion of abnormalities overall. McGehee (1979) reported 0.6% abnormalities in 5666 eggs, whereas Miller (1982) reported 0.17% abnormalities in 90,000 eggs. We found 0.16% abnormalities in a total of 29,420 eggs. Incidence of twinning at St. Vincent Island, 0.007% of examined eggs and hatchlings, and only 0.003% of total eggs, is far less than the 0.02% reported by Fowler (1979) for green sea turtles.

While levels of abnormality in sea turtle embryos and hatchlings at St. Vincent Island appear to be normal, little is known about the natural frequency or the natural and possible anthropogenic causes of such abnormalities. Bishop et al. (1991, 1994) found a significant correlation between embryonic deformities and PCB concentrations in eggs of snapping turtles (*Chelydra serpentina*) from Lake Ontario, Canada. The additive and synergistic impacts from contaminants for loggerhead sea turtles are largely undocumented, but it is hypothesized that chemical contamination may also cause abnormalities and reduced hatching success in sea turtles (Alam and Brim 2000). Alam and Brim (2000) documented detectable levels of contaminants such as PCBs and heavy metals in loggerhead sea turtle eggs collected from St. Vincent Island. It would be reasonable to assume that long term monitoring of sea turtle hatchling and embryo abnormalities may identify changes that indicate contaminant-related impacts. However, long-term baseline data on the occurrence of abnormalities in sea turtles do not exist. A more concerted system for reporting abnormalities during routine nest evaluations would encourage more consistent and standardized data collection and would likely increase the numbers of reported abnormalities. The results of standardized nest evaluations are compiled statewide in Florida and elsewhere; the inclusion of reporting on deformities as part of the nest evaluation process would generate a large amount of data that could be used in the future to assess temporal and geographic trends.

LITERATURE CITED

Alam, S.K. and M.S. Brim. 2000. Organochlorine, PCB, PAH, and metal concentrations in eggs of loggerhead sea turtles (*Caretta caretta*) from Northwest Florida, USA. J. Environ. Sci. and Health B35: 705-724.

Bishop, C.A., R.J. Brooks, J.H. Carey, P. Ming, R.J. Norstrom, and D.R.S. Lean. 1991. The case for a cause-effect linkage between chemical contamination and development in eggs of the common snapping turtle (*Chelydra s. serpentina*) from Ontario, Canada. J. Toxicol. Envir. Health 33:521-547.

Bishop, C.A., G.P. Brown, R.J. Brooks, D.R.S. Lean, and J.H. Carey. 1994. Organochlorine contaminant concentrations in eggs and their relationship to body size and clutch characteristics of the female common snapping turtle (*Chelydra serpentina serpentina*) in Lake Ontario, Canada. Arch. Environ. Contam. Toxicol. 27:82-87.

Blanck, C.E. and R.H. Sawyer. 1981. Hatchery practices in relation to early embryology of the loggerhead sea turtle, *Caretta caretta*. J. Exp. Mar. Biol. Ecol. 49:163-177.

Fowler, L. 1979. Hatching success and nest predation in the green sea turtle, *Chelonia mydas*, Tortuguero, Costa Rica. Ecology 60:946-955.

McGehee, M.A. 1979. Factors affecting the hatching success of loggerhead sea turtle eggs (*Caretta caretta*). M.Sc. Thesis, Univ. Central Florida, Orlando.

Miller, J.D. 1982. Development of Marine Turtles. Ph.D. Dissertation, Univ. New England, Armidale, NSW, Australia.

Miller, J.D. 1985. Embryology of marine turtles. In: C. Gans, F. Billett, and P.F.A. Maderson, eds. Biology of the Reptilia, Vol. 14. New York: John Wiley and Sons. p. 269-328,

Wyneken, J., T.J. Burke, M. Salmon, and D.K. Pedersen. 1988. Egg failure in natural and relocated sea turtle nests. J. Herpetology 22:88-96.

Table 1. Numbers of hatchling and embryo abnormalities by type and year.

Year	Miniaturism	Leucistic Pigmentation	Deformed Carapace, Flippers, Eyes, or Mouthparts	Multiple Deformities	Twinning	Not Specified	Total
1992	--	--	--	--	--	--	--
1993	--	--	--	--	--	10	10
1994	--	--	--	--	--	--	--
1995	--	--	--	--	--	--	--
1996	--	1	--	--	--	--	1
1997	1	--	2	--	--	--	3
1998	--	2	--	1	--	--	3
1999	--	1	--	--	--	--	1
2000	--	--	--	--	--	--	--
2001	--	--	14 (25*)	2	1	--	17 (28*)

*Number of embryos assumed deformed based on extrapolation from known sample.

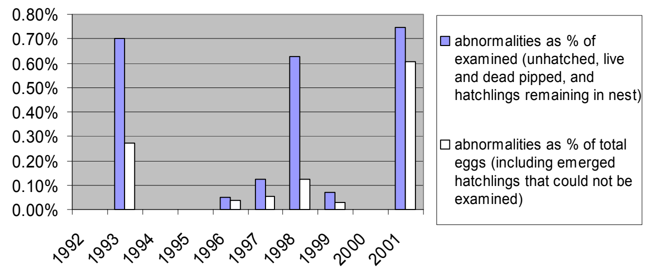

Fig. 1. Percentage of embryo and hatchling abnormalities by year.

Quantification of estrone in plasma of female *Chelonia mydas*, *Caretta caretta*, *Eretmochelys imbricata*, and *Natator depressus* populations in Eastern Australia

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Our laboratory has recently identified by HPLC that estrone appears to be the primary natural estrogen circulating in plasma of adult female *Chelonia mydas*. To further investigate the role of estrone in the reproductive cycle of female marine turtles, we measured estrone in a series of female *Chelonia mydas*, *Caretta caretta*, *Eretmochelys imbricata* and *Natator depressus* in different reproductive stages. We validated an ELISA developed for measuring human estrone (dbc Corporation, Ontario, Canada) to measure quantities of estrone in the turtle. The ELISA was found to be reproducible and reliable for measuring estrone in marine turtles. The ELISA kit contains a 96-well anti-estrone coated plate and all necessary reagents. To begin, pipet 100 microliters of each calibrator, control and serum sample into labeled wells in duplicate. Pipet 100 microliters of conjugate into each well and incubate the plate on a plate shaker for 2hr at room temperature. Wash 5 times with 300 microliters of diluted wash buffer. Pipet 150 microliters of TMB substrate into each well and incubate on a plate shaker for 25 minutes. Pipet 50 microliters stopping solution into each well and read the plate on a micro well plate reader at 450nm. Estrone concentrations in vitellogenic females ranged from 29.63pg/ml to 2.000 ng/ml when assaying 100 microliters of plasma. No species differences were seen. Non-vitellogenic had significantly lower estrone levels (undetectable) as expected. The knowledge of the natural estrogen present in adult female turtles is important in terms of understanding the reproductive cycle of normal free-living turtles.

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Reproductive parameters of nesting *Caretta caretta* on Georgia's Barrier Islands

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The reproductive physiology of the loggerhead turtle (*Caretta caretta*) was studied at Wassaw and Blackbeard Island National Wildlife Refuges, Georgia during the 2000-2001 nesting seasons. Plasma levels of three hormones-testosterone (T), progesterone (P), and corticosterone (B) were measured by using specific radioimmunoassays in samples taken from nesting females. The results of this study were used to assess nesting fecundity of *C. caretta* utilizing Georgia's barrier islands as nesting sites. Female T levels were observed to decline, whereas P remained constant until ovaries became depleted. B levels where shown to remain relatively constant throughout the nesting season. Ultrasonography was also used to assess the females reproductive status and ovarian condition. Mean follicular diameter was observed to be 2.66±0.02 cm and did not vary significantly throughout the season. Post-ultrasonographic samples did not show a significant increase in plasma T levels compared to preultrasonographic samples. Plasma B levels did show a significant increase during this time, however this did not indicate a normal stress response. This supports the conclusion that non-invasive techniques for monitoring the reproductive status, such as ultrasonography, cause minimum stress to nesting females. Reproductive condition was strongly correlated with T levels, indicating nesting periodicity for *C. caretta*. Based on our physiological data, we estimate *C. caretta* are capable of nesting 6 times per season in Georgia, with an average of 5.2 nests per female. The focus of this project was to evaluate if Georgia's current management practices and estimates in nesting fecundity are satisfactory for estimating nesting population size.

Barnacles, drag, and the energetics of sea turtle migration

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Each spring, 5,000 to 10,000 sea turtles migrate into the Chesapeake Bay. The majority are juvenile loggerheads with 45-75 cm curved carapace lengths (CCL). Each spring, 100-300 of the recent migrants strand within Virginias waters. Many of these strandings have heavy loads of epibionts covering their carapaces and heads. Biofouling is known to increase drag and it is possible that there may be a connection between heavy fouling load, poor condition of the turtles and high spring mortalities. We modelled the impact of fouling on the energetics of turtle migration. One barnacle on a 50 cm CCL loggerhead can increase drag 1.3 times and energetic requirements 1.14 times. Heavy fouling (barnacles covering most or all of the carapace) increases drag up to 10 times and energetic requirements 3.16 times. Satellite tracking data indicate that Virginias loggerheads may over-winter as far south as the Carolinas, Georgia and the Florida Keys. On a 1,000 km migration, one barnacle may add an additional six days of travel and require an extra 0.21 kg of fat reserve. The most energetically efficient strategy for a heavily fouled turtle requires an additional 3.19 kg of fat reserve and would theoretically require an extra 92 days of travel.

Skeletochronology versus plastron annuli inspection: a comparison of the two techniques for aging terrapins

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Age has previously been estimated for Diamondback terrapins (*Malaclemys terrapin*) only by counting annuli rings on plastrons. In this study, we salvaged dead, intact terrapins of both sexes, ranging from hatchlings to adults, from North Carolina. For each animal, we determined sex, measured straight carapace length (SCL), and removed humeri for skeletochronology. Growth marks were counted in cross sections of each humeri (MLS) independently from counts of annuli on the corresponding plastron (KMH). Seven morphometric measurements of bones were taken. Each of these measurements was regressed against SCL using least squares linear regression. There was a strong correlation for each regression, indicating constant proportional allometry between humeri and somatic growth. This allows back-calculation of size-at-age from growth layer diameters in cross sections of terrapin humeri. The innermost growth layer observed in each bone was a very consistently sized line of arrested growth (LAG) In North Carolina, hatchling terrapins emerge in late summer and early fall, with almost no activity period before brumation during the winter. Based on the seasonal ecology of this reptile, we interpreted the first LAG and the earliest annuli ring to represent the end of the second winter. Using the regressions, this layer would represent an animal of approximately 4.5-5.0 cm SCL. Our independent age estimates were close, never more than one year apart. The close agreement between these two techniques for estimating age of terrapins supports the validity of each method.

Evaluation of sex ratios in egg corral and in situ nests during the 2001 Kemp's ridley nesting season

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INTRODUCTION

The Kemp's ridley, *Lepidochelys kempii*, is currently the most endangered species of sea turtle in the world. Like all species of sea turtles, the Kemp's ridley possesses temperature-dependent sex determination (TSD), wherein the incubation temperature of the eggs determines the sex of the developing embryo (Mrosovsky 1994, Wibbels et al. 1994). Under this form of sex determination, there exists the potential of producing a variety of sex ratios. Biased sex ratios could alter the effectiveness of nesting beach conservation programs; therefore, it is important to monitor hatchling sex ratios.

Unlike other sea turtle species, the Kemp's ridley commonly nests during the day in large groups called "arribadas". The primary nesting beach of the Kemp's ridley is located on the coast of Tamaulipas, near Rancho Nuevo, Mexico. Nesting season usually begins in April and extends through July (Márquez-M 1994, Ernst et al. 1994). The majority of nesting occurs over a wide stretch of beach extending approximately 20 km north and south of Rancho Nuevo, Mexico, and has been divided into three main camps (Rancho Nuevo, Tepehuajes, and Playa Dos). For over 30 years the Mexican government has been protecting the nesting beach and for over 20 years, a joint conservation program between the United States and Mexico, has been monitoring all nesting and relocating almost all the nests to protected egg corrals.

Nest temperature data from recent years has indicated that a significant number of nests have produced female biases (Geis et al., in press), furthermore, the number of nesting females has significantly increased over the past 5 years (R. Márquez-M. pers. comm.). Based on this information, the number of nesting females may continue to grow. Consequently, it is conceivable that the number of nests may exceed the limited space of the egg corrals in future nesting seasons. As a result, some nests may need to be left to incubate on the beach (in situ). Therefore, it is of interest to monitor the natural incubation temperatures of in situ nests on this nesting beach. In addition to monitoring the incubation temperature of egg corral nests, the current project monitored incubation temperatures within approximately 20 in situ nests. These temperatures were then compared to the temperatures monitored in nests relocated to the egg corrals. Such information is a prerequisite to evaluating the impact of leaving nests in situ during future nesting seasons.

METHODS

Incubation temperatures were monitored using Hobo temperature data loggers (Onset Computer Corp.). These are small, battery-powered units that contain a microprocessor, data storage unit, and a thermistor probe, and at temperatures common to sea turtle nests have a resolution of approximately 0.3º-0.4ºC or better. They are programmed to record by temporarily connecting them to a computer loaded with BoxCar Pro 3.51, and are reconnected to the computer to download data.

Data loggers were used to monitor nest temperatures in approximately 50 nests within the egg corrals located at Rancho Nuevo, Tepehuajes, and Playa Dos. Data loggers were placed in the approximate center of the egg mass to monitor temperatures. Further, 21 in situ nests were monitored on the beach. These nests were marked upon initial finding, and within 6 hours the egg masses were located, approximately 50 eggs were removed, the data logger was placed in the nest, and the eggs were replaced. Data loggers were retrieved from all nests after the hatchlings had fully emerged.

For all nests which contained data loggers, the average, maximum, and minimum temperature during the middle-third of incubation was calculated. The temperature parameters for the Kemp's ridley suggest a pivotal temperature of 30.2ºC, and that temperatures above 31ºC produce 100% females, while temperatures below 28ºC produce 100% males (Aguilar 1987, Shaver et al. 1988). The average temperature during the middle-third of incubation was used as a predictor of the clutch's overall sex ratio. Thus, nests with average temperatures between 30.2º and 28.0ºC would be predicted to produce a male-biased sex ratio, while nests with average temperature between 30.2º and 31.0ºC were predicted to produce a female-biased sex ratio. Average temperatures above 31.0ºC would be predicted to produce all females, and all males were predicted if the average temperature was below 28.0ºC.

RESULTS AND DISCUSSION

Nest incubation temperatures were monitored in both egg corral and in situ nests during the 2001 Kemp's ridley nesting season. A total of 49 nests (lay dates 4/17-6/25) were monitored within the egg corrals and 21 nests (lay dates 5/8-7/19) were monitored in situ. Of those nests monitored in the egg corrals, 32 were predicted to produce 100% females, 5 to produce a female bias, while 12 were predicted to produce a male bias. Of those nests monitored in situ, 12 were predicted to produce 100% females, 8 to produce a female bias, and 1 nest was predicted to produce a male bias. A majority of the male biased nests (11 of 13) were laid early in the nesting season (during April), when incubation temperatures have a tendency to be low. However, one egg corral nest and one in situ nest laid in mid-June produced male biases, presumably due to the influence of weather (e.g., rain) during their thermosensitive periods. No nests, within the egg corrals or in situ, were predicted to produce 100% males.

As with previous years (Geis et al., in press), the results indicate an overall female bias of nests translocated to the protected egg corrals. Preliminary analysis of incubation temperatures in nests remaining on the beach (in situ), show a similar trend where the majority of nests produced a female bias or 100% female. The 2001 season did, however, show a two-week period of decreased temperatures and rain, which is believed to have influenced the production of male-biased nests during the middle of the season.

The in situ nests were cooler than nests in the egg corral. A subset including 11 in situ nests were compared incubation temperatures of egg corral nests laid on the same date. Results indicate that the incubation temperatures of the in situ nests were significantly cooler ($n=8$, z-test and t-test, $p < 0.05$) than those of the egg corral, except in 3 in situ nests (z-test, $p > 0.05$). Although the in situ nests were cooler, they were still warm enough to produce female-biased sex ratios.

The translocation of nests to egg corrals, which has the potential of biasing hatchling sex ratios, is a major aspect of the conservation effort at Rancho Nuevo, Mexico. The Kemp's ridley has been making a steady recovery over approximately the past 15 years. Thus, it is reasonable to believe that the number of nesting females may continue to grow. As such, it is plausible that the number of nests may exceed the limited space of the egg corrals in future nesting seasons. Consequently, some nests may need to be left to incubate on the beach (in situ). The results of this preliminary study suggest that the temperatures of in situ will follow the temperature trends observed in the egg corrals and will produce an overall female sex ratio in a typical year. Additionally, the results are consistent with previous years of this study (Geis et al., in press) indicating a significant female bias being produced in the egg corrals. It is plausible that this female bias has accelerated the recovery of this species.

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LITERATURE CITED

Aguilar, H.R. 1987. Influencia de la temperatura de incubacion sobre la determination del sexo y la duracion del periodo de incubacion en la tortuga lora (*Lepidochelys kempii*, Garman 1880). Tesis de Licenciatura. Instituto Politecnico Nacional Mexico, D.F.

Ernst, C.H., J.E. Lovich, and R.W. Barbour. 1994. Turtles of the United States and Canada. Smithsonian Institution.

Geis, A., T. Wibbels, R. Márquez-M, M. Garduno-D, P. Burchfield, and J. Pena. In press. Predicted sex ratios of hatchling Kemp's ridleys produced in egg corrals during the 1998, 1999, and 2000 nesting seasons. Feb. 2001. NOAA Technical Publication NMFS-SEFSC.

Márquez-M., R. 1994. Sinopsis De Datos Biologicos Sobre La Tortuga Lora, *Lepidochelys kempi* (Garmin 1880). FAO Sinopsis sobre la Pesca, No. 152.

Mrosovsky, N. 1994. Sex ratios of sea turtles. J. Exp. Zool. 270: 16-27.

Shaver, D.J., D.W. Owens, A.H. Chaney, C.W. Caillouet, P. Burchfield, and R. Márquez-M. 1988. Styrofoam box and beach temperatures in relation to incubation and sex ratios of Kemp's ridley sea turtles. In: Proceedings of the Eighth Annual Workshop on Sea Turtle Biology and Conservation. NOAA Tech. Memo. NMFS-SEFC-214, p. 103-108.

Wibbels, T., J.J. Bull, and D. Crews. 1994. Temperature-dependent sex determination: a mechanistic approach. J. Exp. Zool. 270:71-78.

Seasonal sand temperature profiles of four major leatherback nesting beaches in the Guyana Shield

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INTRODUCTION

The Guyana Shield region stretches from eastern Venezuela to northeastern Brazil. Some of the most important nesting beaches for leatherbacks world-wide are found in eastern Suriname and western French Guiana. Peak nesting in the area occurs between April and July. In 2001, we measured sand temperatures concurrently on four major leatherback nesting beaches: Awa:la-Ya:lima:po, Babunsanti, Samsambo and Matapica. Beach topography differs between these beaches. The objective was to study spatio-temporal variation in sand temperature profiles and thus hatchling sex ratio of the leatherback population as a whole.

METHODS AND MATERIALS

Temperature dataloggers were placed at 75 cm depth at two different beach zones (High and Low perpendicular to the spring tide line) on the beaches at the beginning of the leatherback nesting season, and recovered at the end of the season. Data were recorded every two hours for the whole period. Data were grouped by 10 day intervals for which the average temperature was calculated. We used ANOVA, followed by Tukey multiple comparison test, to make statistical comparisons among sites.

RESULTS

Sand temperatures profiles fluctuated through the season with a gradual increase towards the end of the season. Sand temperatures differed significantly among the sites, specifically for Babunsanti and Matapica, also between the high and low zones. Beach sand on Samsambo was warmest, followed by Awa:la-Ya:lima:po and Babunsanti. Matapica sand was coolest for both beach zones. Both high and low beach zones were used by high numbers of leatherbacks for nesting.

DISCUSSION

The pivotal temperature for leatherbacks in the Guianas is 29.5ºC (Rimblot-Baly et al. 1987) and the thermosensitive period for the determination of sex occurs in the middle third of the incubation (Desvages et al. 1993). Using this information with the sand temperature data, we estimate that: I. Only males were produced by nests laid on the low zones of Babunsanti and Matapica throughout the season, and also by nests laid before the beginning of June on the lower zone of Awa:la-Ya:lima:po, and before early July at the higher zone of Matapica. II. Females hatchlings were produced by nests laid after 15 May in the high zones of Awa:la-Ya:lima:po, Babunsanti and both zones of Samsambo. Thus, different beaches have a different sex ratio production. Further comparative studies are needed to determine if these differences and variations are typical for these beaches.

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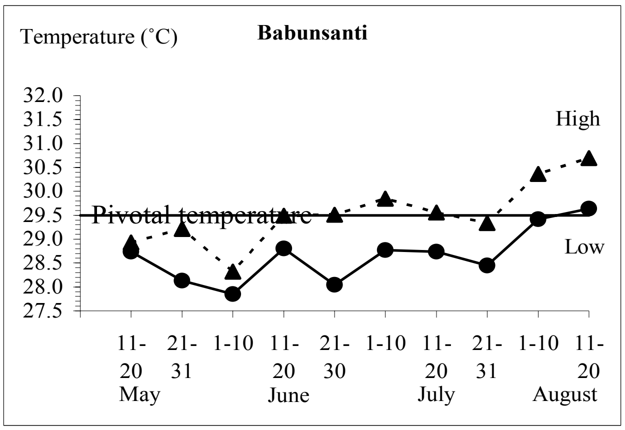
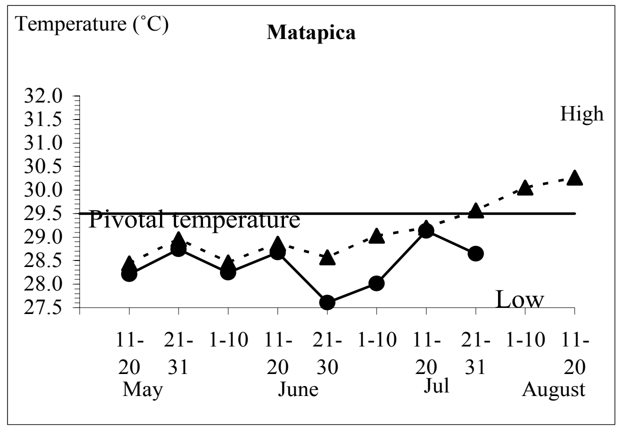
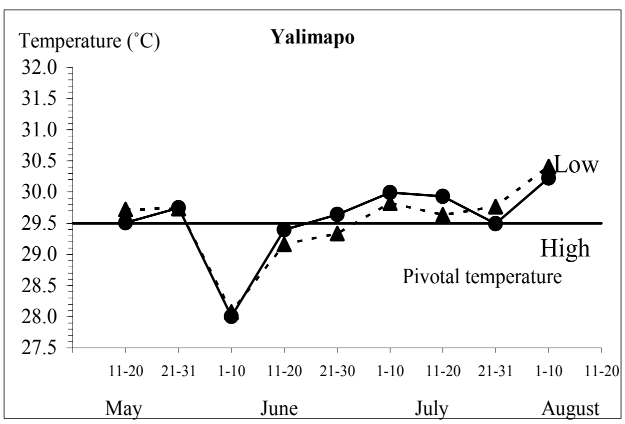
LITERATURE CITED

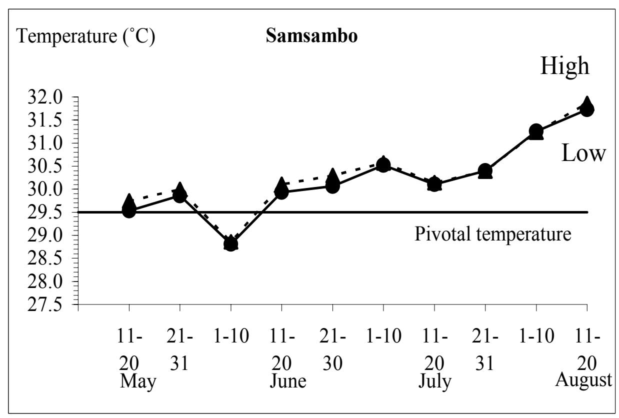
Rimblot-Baly, F., J. Lescure, J. Fretey, and C. Pieau. 1987. Sensibitite a la Temperature de la Differencation Sexuelle Chez la Turtue Luth, *Dermochelys coriacea* (Vandelli, 1761): Application des Donnees de l'Incubation Artificielle a la Etude de la Sex-ratio dans la Nature. Ann. Sci. Nat. Zool. (Paris) 8:277-290.

Desvages, G., M. Girondot, and C. Pieau. 1993. Sensitive Stages for the Effects of Temperature on Gonadal Aromatase Activity in Embryos of the Marine Turtle *Dermochelys coriacea*. General and Comparative Endocrinology 92:54-61.









A comparison of the ontogeny of oxygen consumption in leatherback, *Dermochelys coriacea*, and olive ridley, *Lepidochelys olivacea*, sea turtle hatchlings – different strokes for different life styles

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INTRODUCTION

Evidence suggests that the hatchlings of most species of sea turtle leave the beach and swim to major oceanic currents and passively migrate for up to a decade while feeding on organisms within large seaweed drifts (Bolten 1995, Brongersma 1968, Carr 1986, 1987). The leatherback hatchling, however is an exception in that they swim to upwelling zones where they assume a completely pelagic active lifestyle (Eckert 2000, Jones et al. 2002). The purpose of this study was to compare the energetic strategies of olive ridley and leatherback hatchlings bridging the gap of beach to post-hatchling ocean habitat. Changes in age-specific oxygen consumption during the first few weeks of life were measured in rest, swimming, and maximal exercise in leatherbacks and olive ridleys during hatchling and post-hatchling development. We also determined available energy to leatherback hatchlings after emergence for frenzy and post-frenzy movements.

METHODS

Animals. Forty leatherback hatchlings *Dermochelys coriacea* and 12 olive ridley hatchlings *Lepidochelys olivacea* were obtained during January and February from the hatchery at Playa Grande, Parque Nacional Las Baulas, Costa Rica. Hatchlings were maintained in the lab as described in Jones et al. (2000).

Oxygen consumption. Animals were placed inside a closed flow respirometer for experimental trials. Air was pumped from the respirometer through Drierite® (water absorbant) and soda lime (CO_2 absorbant) to an oxygen analyzer (Qubit Systems S102 Oxygen Sensor). The volume of air inside respirometer was recorded; ambient air oxygen percentage minus post -trial oxygen percentage gave total volume of oxygen consumed.

Animals were run through experimental trials at one-week intervals from emergence until 5 weeks of age for leatherbacks and at emergence, 1 week, and the 4th week for olive ridleys. Experimental trials consisted of a half-hour acclimation in chamber followed by a half-hour trial of one of three different conditions/behaviors: resting, swimming, and maximal exercise. Observations of breath and stroke rate were recorded during swimming and maximal exercise. All statistical analyses were carried out with JMP Statistical Package. We ran a non-repeated measures analysis of variance on a 2x3x5 factorial design. The Tukey HSD test, with alpha value set at 0.05, was used to determine where the statistically significant differences occurred within the significant effects having more than two levels. N=6 – 8 animals in all cases.

Whole Hatchling and Yolk Energetics. Hatchlings that died from natural causes at emergence, 1 week, and 4-6 weeks were immediately frozen for latter energetic analysis. Hatchlings were later thawed and the residual yolk sacs removed. Hatchlings and yolk were dried at 60° C for 3 days. All energetic analyses were run on a Parr Instrument Company Bomb Calorimeter. All calculations and corrections were performed as described by Paine (1971).

RESULTS AND DISCUSSION

Leatherback hatchlings unlike any other reptile are committed high endurance animals in that they have a narrow aerobic scope (28% over resting at emergence to 61% over resting at 5 weeks) and swimming oxygen consumption is indistinguishable from resting oxygen consumption after their frenzy period (week 0; Fig. 1). It would appear that their normal metabolism is geared towards activity and they would have no great benefit from resting in *Sargassum* drifts or at the surface. By contrast the olive ridley had a large aerobic scope (80% over resting at emergence to 258% over resting at 4 weeks) and swimming oxygen consumption remained intermediate between resting and maximal exercise oxygen consumption until week 4 where swimming and maximal exercise oxygen consumption were indistinguishable. Thus the ridley is conservative and expends very low energy in routine activities. The ridley turtle can thus maximize the benefits from combinations of activity and drifting with a highly variable VO_2.

Leatherbacks do not begin feeding until 5 – 8 days after emergence (Jones et al. 2000) and they therefore must have a large enough energy store to fuel their high endurance machine until reaching suitable foraging habitat. Leatherback turtles produce the largest eggs and thus the largest hatchlings of any other sea turtle (Buskirk and Crowder 1994). More interestingly leatherback hatchlings emerge from the nest with approximately 88 KJ of energy in their yolk sac double the energy value of loggerhead residual yolk (34 KJ of energy; Kraemer and Bennett 1981) and olive ridleys (45 KJ of energy; Silas et al. 1984).

Leatherback hatchlings maintained the same dry mass while gaining 10 g in wet mass during their first week of age however they consumed nearly 92.5% of their yolk reserves by 4 - 6 weeks (Table 1). Thus leatherbacks are replacing their lost weight in yolk with tissue during their first week while the remaining 70 – 80% in weight gain is strictly water weight. Hatchlings emerging with 2.5 - 3 g dry yolk mass would have approximately 75 - 90 KJ of energy for growth and migration. Using Wyneken's (1996) velocity of 0.93 Km h-1 (frenzy leatherbacks) and 0.43 Km h-1 (post-frenzy hatchlings; Jones et al., in press), Wyneken and Salmon's (1992) leatherback diel activity model, and our rates of metabolism (Fig. 1) a 40 g leatherback could travel 76 Km during its first week after emergence consuming only 47.18 KJ of energy.

CONCLUSION

Our results show that the divergent energetic strategies reflect differences in the early life history stages of leatherback and olive ridley hatchlings. Ridleys use a combination of swimming and drifting to reach oceanic gyres whereupon they passively feed and migrate in large seaweed drifts. Contrastingly leatherbacks utilize continued high endurance aerobic swimming to reach convergent zones, divergent zones, upwellings, and downwellings not feeding during this extended journey. Leatherbacks carry the fuel in a large "fuel tank" yolk sac. This unique strategy could be considered "energetic neoteny".

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LITERATURE CITED

Bolten, A.B. 1995. Biology of the early pelagic stage the 'lost year'. Biology and Conservation of Sea Turtles. (Revised Edition). Smithsonian Institution Press. Washington, D.C. and London. p. 579-581.

Brongersma, L.D. 1968. Notes upon some turtles from the Canary Islands and from Madiera. Koninkl. Nederl. Akademie van Wetenschappen Proc. Series C71, p. 128-136.

Buskirk, J.V. and L.B. Crowder. 1994. Life-history variation in marine turtles. Copeia 1994:66-81.

Carr, A. 1986. Rips, fads and little loggerheads. Bioscience, 36:92-110.

Carr, A. 1987. New perspectives on the pelagic stage of sea turtle development. Conservation Biology 1:103-121.

Eckert, S.A. 2000. Global distribution of juvenile leatherback sea turtles. Hubbs Sea World Research Institute Technical Report 99-294.

Jones, T.T., M. Salmon, and S. Weege. 2002. The ontogeny of diving in leatherback hatchlings, *Dermochelys coriacea*. In: A. Mosier, A. Foley, and B. Brost, comps. Proceedings of the Twentieth Annual Symposium on Biology and Conservation. NOAA Tech. Memo. NMFS-SEFSC-477.

Jones, T.T., M. Salmon, J. Wyneken, and C. Johnson. 2000. Rearing leatherback hatchlings: protocols, growth and survival, Marine Turtle Newsletter 90:3-6.

Kraemer, J.E. and S.H. Bennett. 1981. Utilization of posthatching yolk in loggerhead sea turtles, *Caretta caretta*. Copeia 1981:406-411.

Paine, R.T. 1971. The measurement and applications of the calorie to ecological problems. Ann. Rev. Ecol. Syst. 2:145-164.

Silas, E.G., Vijayakumaran, M., and Rajagopalan, M. 1984. Yolk utilization in the egg of the olive ridley *Lepidochelys olivacea*. CMFRI Bulletin 35:22-35.

Wyneken, J. and M. Salmon. 1992. Frenzy and postfrenzy swimming activity in loggerhead, green, and leatherback hatchling sea turtles. Copeia 1992:478-484.

Wyneken, J. 1996. Sea turtle locomotion: mechanisms, behavior, and energetics. In: P. Lutz and J. Musick, eds. The Biology of Sea Turtles. CRC Press, Boca Raton. p. 165-198.

Table 1. Wet mass (WM), Dry mass (DM), percentage of water (% Water) in sample, and energy in KJ per gram DM in whole hatchlings and yolk of leatherbacks. Measurements taken during emergence, 1 week, and 4 – 6 weeks of age. (*sample was a combination of three animals due to small sample size).

Sample	Sampling time	WM	DM	% Water	KJ/g DM
Hatchling	Emergence	28.09	10.52	62.55	23.42
		29.22	10.33	64.64	22.51
		21.34	10.22	52.11	25.48
mean		26.21	10.36	59.77	23.80
S.E.		2.01	0.07	3.17	0.23
Hatchling	1 Week	35.30	9.43	73.29	22.76
		35.65	8.74	75.48	22.49
		33.77	9.74	71.16	23.22
mean		34.91	9.30	73.21	22.82
S.E.		0.47	0.24	1.02	0.21
Hatchling	4-6 Weeks	57.87	9.48	83.62	21.10
		53.76	10.12	81.18	19.80
Yolk	Emergence	7.32	3.74	48.91	29.64
		4.50	2.31	48.67	28.46
Yolk	1 Week	2.13	0.96	54.93	
		1.18	0.40	66.10	
		1.59	0.62	61.01	
mean		1.63	0.54	60.68	30.71*
S.E.		0.22	0.15	2.59	
Yolk	4-6 Weeks	0.48	0.17	64.58	
		0.22	0.06	72.73	

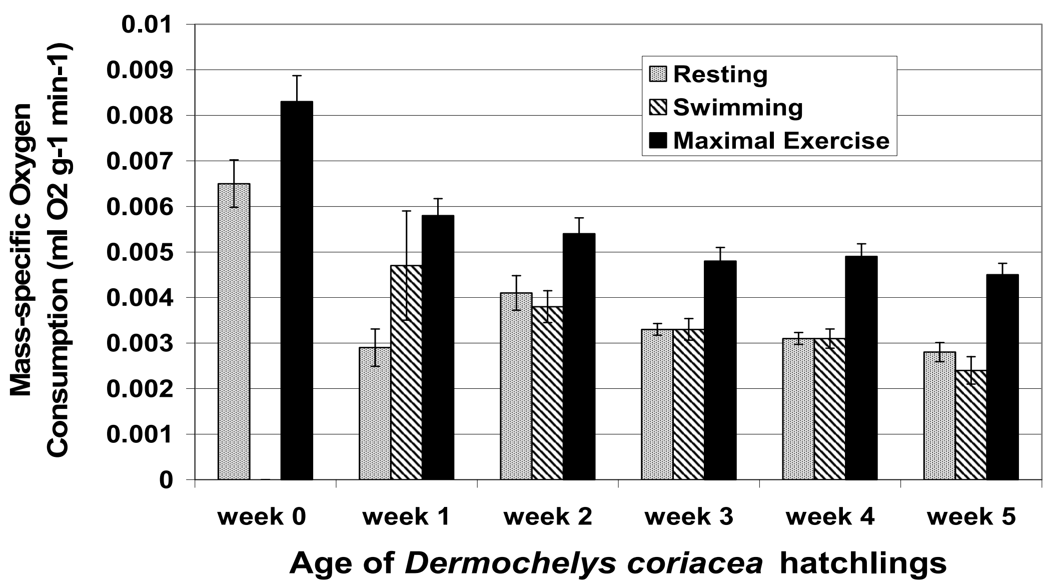

Fig. 1. Oxygen consumption of leatherback hatchlings during resting, swimming, and maximal exercise. Turtles were tested from emergence until their 5th week of age. Bars depict oxygen consumption in ml of oxygen per gram body mass per minute + 1 S.E.

Beach renourishment and sea turtle nest microenvironments

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INTRODUCTION

Marine turtles deposit their clutches in nests excavated in sandy beaches. These clutches undergo embryonic development for nearly two months, after which time the hatchlings emerge and crawl to the sea. During the course of incubation, the egg exchanges heat, CO_2, O_2, and H_2O with other eggs in the clutch and with the beach surrounding the clutch. In order for this successful reproductive cycle to occur, marine turtles must find suitable nesting habitats. With the constant threat of nesting habitat loss throughout the world's beaches, this task is becoming increasingly difficult. In Florida, beaches are naturally eroding and accreting. Erosion is exacerbated during the tropical hurricane season and beaches are often artificially nourished to protect coastal properties. Beach nourishment involves the replacement of native beach sands with foreign sand, usually dredged from an offshore location. This foreign sand is often spread and shaped to mimic native beach slopes. However, even though an effort is made to imitate natural characteristics, nourished beaches still differ from native in a multitude of properties. Some of these differences are in topography, compactness and hardness of sand, shear resistance, grain size, temperature, moisture content, and gas concentrations. These differences affect the microenvironment of developing sea turtle clutches, and can have a positive or negative influence on hatching success. A review of recent literature shows that research has been done on a myriad of these factors, however, very little literature exists on clutch gas concentrations, particularly in relation to differences between native and nourished beaches. This study looks at differences in the gas concentrations of oxygen, carbon dioxide, methane, hydrogen sulfides, and volatile organics between clutches deposited in native and renourished beaches. Furthermore, it also looks at the physical properties (grain size and composition, moisture content, compactness, sand color, and reflectance), inherent to these two very different types of beaches and aims to relate them to gas concentrations, embryonic development and hatching success.

METHODS

The renourished beach chosen on the east coast of Florida was located at Patrick Air Force Station in Brevard County, where an extensive renourishing project was done. The native beach chosen was inside Kennedy Space Center property. Nests were chosen on both the nourished and native beach at the same time or alternately so that the treatments were interspersed throughout the experimental period. Because of several problems that will be discussed later, the total number of marked nests was limited to ten for the treatment, and twelve for control. Nightly surveys were conducted to find nesting females that were allowed to excavate and deposit their clutches. Eggs were counted and at approximately the 50th egg, a 5 mm Teflon® air sampling tube was positioned in the middle of the clutch. A StowAway Tidbit temperature datalogger was also positioned in the middle of some clutches to record temperature. The depth of the tube, as well as the nest chamber dimensions were measured to the sand surface. The air-sampling tubes were labeled, capped, and their standing air volume calculated. They were buried and extended to a distance of approximately one meter from the clutch site. Weekly 20cc samples were pulled from each sampling tube using a 20cc gas tight syringe. The samples were transferred to 3" X 5" gas sampling Call-5 Bond™ 'pillows' made of five layers. The bags were fitted with a Luer stopcock for easy connection to the sampling syringe. For analysis by gas chromatography, 0.5mm septa were inserted into the sample pillow stopcocks. The extracted air was analyzed for carbon dioxide, oxygen, hydrogen sulfide, methane and volatile organics. Carbon dioxide analysis was completed with the 6890 Hewlett Packard Gas Chromatograph with Thermal Conductivity Detector and a 30m x 0.53 HP-Plot-Q column. Oxygen was analyzed on the 5880 Hewlett Packard Gas Chromatograph with Thermal Conductivity Detector and a packed, 9'X 1/8" molecular sieve column. Methane analysis was completed with the 5880 Hewlett Packard Gas Chromatograph with Flame Ionization Detector and a 6m x 18" PoraPlot-Q column. Hydrogen sulfide analysis was performed on the portable Photovac 10S Plus Gas Chromatograph with Photoionization Detector and a 15m x 0.53mm KCl/Al2O3 column. Air samples from both natural and renourished beaches were preconcentrated cryogenically and analyzed on the 5972 Hewlett Packard Mass Selective Detector using a 100m X 0.32mm HP-1 column for Volatile Organics in Air Analysis, EPA TO15 Method. Data were concurrently collected for air and sand temperatures, wind speed and direction, sand moisture content, grain size, compactness, calcium carbonate, and total organic carbon, at the native and renourished beaches. After emergence, nests were excavated and the percentage of unhatched and successfully hatched eggs calculated.

RESULTS AND DISCUSSION

Oxygen concentrations in both types of sands and beaches were very similar to atmospheric levels and averaged 21.0%. Similarly, hydrogen sulfide remained fairly constant on both beaches and averaged 5 ppm. These averages remained consistent regardless of nest location that varied from being low by the water, on a scarp, or high on a dune. Carbon dioxide concentrations on the native and renourished beach nests remained relatively uniform with perhaps a gradual increase during the first four weeks. At approximately the fifth week of incubation a dramatic rise was recorded in CO_2 levels. These levels continued to rise during the next two weeks, reflecting the increased metabolic activity. This increase in CO_2 levels were similarly recorded in the renourished beach, however, these concentrations were much lower than those of the native beach. The increase in carbon dioxide concentrations is indicative of embryonic development. Methane concentrations were also measured in clutches from native and renourished beaches. Results show that the renourished beach had higher concentrations than the native until approximately the fifth week. These levels remain high (1.5 vs. 1.2 ppm, respectively), throughout incubation until the sixth week when the methane levels of the native beach rose to an average of 1.6 ppm while those of the nourished beach dropped to an average of 1.1 ppm. Volatile Organic air analyses of samples from the native beach detected high levels of 2-butenoic acid, dimethyldisulfide, and 2-Butenoic acid, methyl ester in clutches. These analyses were measured from the seventh week samples and these tentatively identified compounds indicate an increase in metabolic activity and the production of blood cells. No samples were analyzed from the renourished beach because the nests were destroyed before sampling could be done. It will be very interesting to see if similar gases and levels were also detected there. Grain size differed slightly between the two beaches in that the nourished beach had 4% greater amount of coarser sand (1mm diameter). This nourishing sand came from an offshore reef and included lots of shell fragments that accounted for this grain size class. The majority (50%) of the sand from both beaches had a diameter of 0.5mm. Grain Composition showed statistically significant differences ($a < 0.01$), in the percentage composition of Total Organic Content and $CaCO_3$ between the two sand types. The moisture content of both nesting beaches differed significantly (a< 0.01), with the nourished beach containing a greater percentage of water. Beach compaction was measured with a vane shear penetrometer and no significant difference was found between the two beaches. The softness of the renourished sand was due to the unique pre-nesting season preparation the Army Corps did. The renourished sand was tilled at least twice (some areas more) to assure that it would be soft for sea turtle nesting. There were obvious differences in sand color and reflectance. The renourished sand used at Patrick Air Force Beach was relatively darker than the native at KSC. This physical feature allowed it to retain more heat, and subsequently reduced the average incubation time (Table 1). After emergence, nests were excavated and the percentage of unhatched and successfully hatched eggs calculated. Experimental clutches from the native beach at KSC had a hatching success of 73.6% (n=5) while non-experimental nests used as control had a hatching success of 76.0% (n=32). In the renourished beach at PAFB, experimental clutches had a hatching success of 78.6% (n=3) while non-experimental nests used as control had a hatching success of 85.8% (n=10). The lack of hatching success data from all experimental nests is primarily because of the destruction caused by Tropical Storm Gabrielle that lashed the area with 70 mph winds, fierce waves and rain. Gabrielle passed directly through this portion of East Coast of Florida destroying over 90% of all marked nests, as well as tragically eroding a vast majority of the beach. The terrorist attacks of September 11th put the final end to this project. Because both the treatment and control beaches are part of military installations, these areas were immediately closed off and remain inaccessible. Approximately two weeks after this event, restricted access was allowed to these areas, but this was mainly to retrieve the monitoring equipment that survived the wrath of Gabrielle. The renourished beach at Patrick Air Force Station suffered more damage than the native at Kennedy Space Center.

CONCLUSION

In conclusion, the native and renourished beaches are two distinct environments that share many similarities as well as differences in gas concentrations. Many factors such temperature, humidity, total organics, calcium carbonate, and relative distance to vegetation can be contributing factors to these differences. Data show that clutches from both types of beaches have oxygen concentrations that are similar to atmospheric levels. Carbon dioxide concentrations in the native beach were higher than those of the renourished and increased as incubation progressed. Methane gas increased slowly throughout incubation on both beaches with the levels of the renourished beach slightly higher than those of the native. Hydrogen sulfide remained fairly constant on both beaches and averaged 5 ppm. Volatile organics in air samples from the native beach showed the presence of acids that are known to aid healthy bacteria produce folic acid, aid the formation of red blood cells, and have sun screening properties. These gases could have adaptive and evolutionary advantages for hatchlings success. Unfortunately, due to unforeseen events such as hurricane Gabrielle and the terrorist attacks of September 11th, this study was stopped suddenly and was limited to a very small sample size. Research needs to be done to gather additional data to allow for sound statistics. The relationships between the different physical properties of these two types of beaches and their respective gas concentrations need to be elucidated.

LITERATURE CITED

Ackerman, R. 1977. The respiratory gas exchange of sea turtle nests (*Chelonia*, *Caretta*). Respiration Physiology 31:19-38.

Ackerman, R. 1981. Growth and gas exchange of embryonic sea turtles (*Chelonia*, *Caretta*). Copeia 1981:757-765.

Broadwell, A.L. 1992. Effects of beach renourishment on the survival of loggerhead sea turtle nests. In: M. Salmon and J. Wyneken, comps. Proceedings of the Eleventh Annual Workshop on Sea Turtle Biology and Conservation. NOAA Tech. Mem. NMFS-SEFSC-302. p. 21-23

Cornelisen, E. 1990. Effects of beach renourishment on physical attributes of a sea turtle nesting beach. M.S. Thesis. Florida Institute of Technology, Melbourne, Florida. 175 p.

Crain, D.A., A.B. Bolten and K.A. Bjorndal. 1995. Effects of beach nourishment on sea turtles: review and research initiatives. Restoration Ecology 3:95-104.

EAI (Ecological Associates, Inc). 1999. Martin County Beach Nourishment Project, Sea Turtle Monitoring and Studies, 1997 Annual Report and Final Assessment. Ecological As sociates, Inc., Jensen Beach, Florida.

Table 1. Differences between the various physical characteristics of the native and nourished beaches * indicates significance <0.01; **<0.05.

		Native Beach	Nourished Beach
Beach Sand	% Organic Content *	0.68	1.28
	% $CaCO_3$ *	4.75	9.09
	% Water Content *	4.13	5.78
	Compactness	0.9	0.8
Grain Size (mm)	1	0%	4.24%
	0.5	50.05%	54.70%
	0.25	31.05%	27.35%
	0.125	22.45%	11.95%
	0.088	0.92%	0.57%
	0.066	0.05%	0.05%
Nest Chamber (cm)	Depth of Chamber	49.6	53.4
	Bottom Diameter	27.1	23.8
	"Neck" Depth	29.3	30.4
	"Neck" Diameter	16.7	17.2
	Surface to top of Clutch	38.9	33.9
Gas Concentrations	Oxygen	21 ppm	21 ppm
	Hydrogen Sulfides	5 ppm	5 ppm
	CO_2 Week 1-4	1774.5 ppm	1634.5 ppm
	Week 5-7	13348 ppm	7454.4 ppm
	Methane Week 1-5	1.2 ppm	1.5 ppm
	Week 6-7	1.6 ppm	1.1 ppm
Clutch	Clutch Size	97.3	102.8
	Egg Weight *	38.0 g	40.6 g
	Min Diameter *	38.2 mm	38.8 mm
	Max Diameter **	40.7 mm	41.1 mm
	Incubation Time (days)	60	54
	Hatching Success	73.6%	78.6%

Fertility in Kemp's ridley sea turtles (*Lepidochelys kempii*) nests at Rancho Nuevo, Tamaulipas, Mexico

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INTRODUCTION

Efforts to protect the Kemp's ridley sea turtle on the beach of Rancho Nuevo, Tamaulipas, Mexico began with the translocation of nests to a protected "corral" for incubation and later release of the hatchlings after emergence from the nests. This practice has proven to be the most appropriate action as part of the recovery of the population of nesting Kemp's ridley (*Lepidochelys kempii*) sea turtles. However, the extraction and collection of eggs from the nesting cavity and the translocation of eggs to the protected "corral" can generate a decline in the number of hatchlings that develop and hatch.

Flores (1987) determined that there was a difference in the survival ratio for *L. kempii* nests left in situ (83.3%) compared to those nests that were translocated to a protected "corral" (87%). However, a study by Garduño and Cervantes (1996) on the survival of turtle nests by both incubation practices shows a survival ratio difference of 84.1 for the nests left in situ and 63% for those nests taken to a protected "corral".

Although there may be a lower survival ratio due to human manipulation and handling of the eggs, the biotic and abiotic conditions were also considered to be a factor that can affect the results of hatching . Therefore, egg fertility can be affected by the interference of human nest protection. It is believed the "pink" tone eggs do not present embryonic development and are infertile. However, there is a difference in the eggs that have a "white spot" and those that are considered fertile.

At the protected "corral" at Kemp's ridley nesting beach at Rancho Nuevo, Tamaulipas, Mexico, observations were made every 12 hours during the study to determine the total calcification of eggs in the nests that were translocated. Observations show the presence of embryonic development in eggs that exhibited a "white point" or "pole" and advanced calcification of the eggs until completely calcified. The process of egg calcification was evident in all the eggs, with the exception of those that took a "pink" tone. The "pink" eggs that did not take a "white point" or "pole" within hours of deposit and did not modify were believed to not be fertile. The goal of this project was to determine egg fertility percentages from those nests that are extracted and collected from nesting cavity and translocated to a protected "corral".

METHODS

During nesting seasons 1994 to 1998, samples were collected from nests that were incubated in the protected "corral". After hatching occurred in individual nests, the unhatched eggs were collected and classified visually not microscopically, in the following stages identified in Table 1. The percentages of each stage were obtained in each nest and the results were determined by using the One-Way Variable Analysis (ANOVA) to show the global survival of eggs throughout the sampled seasons. A multiple comparison of Tukey was applied to find differences among the global survival (1st stage + 2nd stage + 3rd stage – normal + 3rd stage -abnormal +dead hatchling + live hatchling) of the seasons.

RESULTS

The One-Way Variable Analysis applied to the global survival of eggs throughout the sampled seasons resulted in a F (4,513, 0.5%) = 6.13, which indicates that the fertility between the seasons is statistically significant and that there are differences in the survival index.

CONCLUSION

The Kemp's ridley nests at the beach of Rancho Nuevo, Tamaulipas, Mexico, has an 80% fertility in eggs. The current fertility in the Kemp's ridley nests appears to be sustainable in the recovery of the population at the beach of Rancho Nuevo, Tamaulipas, Mexico. It is important to continue to protect the Kemp's ridley nests in a protected "corral" at the beach of Rancho Nuevo, Tamaulipas, Mexico.

Table 1. Description of stages in egg development

Stage	Description
Pink eggs	Pink colored shell, generally absorbed and with the yolk in the form of a yellow mass
1st stage	Completely white colored shell, generally inflated, with liquid and yolk and in occasions a point is present and/or threads of blood.
2nd stage	Embryos with formation of eyes but still without a complete formation of the shell
3rd stage – normal	Completely formed embryo that did not hatch
3rd stage – abnormal	Completely formed embryo with some abnormality and did not hatch
Dead Hatchling	Hatchling totally formed and hatched from the egg, died during the emerge.
Live Hatchling	Hatchling totally formed, hatched from the egg and is emerging from the nest

Table 2. Development status of eggs deposited at Rancho Nuevo from 1994 to 1998

	Season				
Stage	1994	1995	1996	1997	1998
Number of nests	110	107	106	109	86
Pink Eggs	9.3	17.7	19.9	12	13.4
1st stage	1.9	1.9	1.4	2.3	1.8
2nd stage	0.6	0.9	0.7	0.7	0.5
3rd stage normal	1.6	2.2	3.6	3.3	0.3
3rd stage abnormal	0.3	0.7	2.2	0.8	6.7
Dead Hatchlings	4.8	1.2	3.5	7.6	17.7
Live Hatchlings	81.4	75.4	68.7	73.2	59.5
Global Survival	90.7[c]	82.3[ab]	80.1[a]	88.0[bc]	86.6[abc]

(*)The cells with one or two super indexed letters indicate that there are no significant differences between them and different letters indicate a significant difference applying the multiple comparison test of Tukey.

Does beach crawl width correlate with carapace size in loggerhead sea turtles (*Caretta caretta*)?

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Carapace lengths and widths of nesting loggerhead sea turtles (*Caretta caretta*) were measured at Pompano Beach and Fort Lauderdale Beach, Florida to determine if plastron and/or track crawl widths were predictive of carapace size. Straight and curved carapace measurements were taken. Plastron and track crawl widths were measured at four points on each crawl: 1) emerging at the tide line; 2) mid-way to the nest; 3) mid-way returning to the surf; and 4) at the tide line returning to the surf. All four measurements were significantly different from each other (P<0.005) along each crawl. Crawl width was the most variable factor in all comparisons. Maximum straight carapace length correlated with emergent track crawl width at the tide mark (R= 0.8464, P<0.001), indicating that track width was predictive of carapace length (+/- 3.95 cm standard error of estimate). Clutch size correlated to notch-to-tip straight carapace length (R=0.6635, P<0.0005) and to emergent track crawl width measured mid-way to the nest (R=0.5735, P<0.005). Carapace and crawl width measurements were predictive of clutch size (+/- 21 eggs and 23 eggs standard error of estimate, respectively).

Insulation effect on the temperature of hawksbill turtle nests and the influence of artificial shading on sex determination

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INTRODUCTION

The coastal environment is one of the places most exposed to human development. The study of this resource can help to identify the problems and prevent future or irremediable damages (Hernández 1991). Buildings can degrade the coast and limit the quantity of beaches suitable for future marine turtles nesting (Steinitz et al. 1998). Some hotels and residences on the coasts, clear vegetation to "improve" the appearance of the beach. Clearing vegetation can cause changes in beach sand temperature and in the incubation temperature of nests (Hall 1994, NMFS and USFWS 1993). Some investigations have show that development and beach modification are incompatible with the nesting activity of sea turtles. Those alterations that affect drainage, inclination, the vegetation or lightning can affect egg development success (MTSG 1994).

Sex determination in sea turtles is temperature dependent (Standora et al. 1985) and changes in the environment during incubation can affect the sexual ratio (Bull et al. 1982). According to Ackerman (1997), the hawksbills have a pivotal temperature of 29.32ºC and the ideal incubation temperature is between 25ºC and 35ºC. Embryos incubated over 29.32ºC will tend to develop as females, and under 29.32ºC will tend to be males (Standora et al. 1985, Mrosovsky et al. 1992). The critical stage, when the embryos are most sensitive to temperature change, is after the third week of incubation (van Dam et al. 1994).

METHODS

This investigation took place in the Reserva Natural de Caja de Muertos. It is located in the Caribbean Sea, 8.5km from the south coast at Ponce, Puerto Rico. Playa Larga is an area protected for nesting activity. The beach is marked every 50 feet (33 stations) to identify nest location for ease of reference.

Nest temperature was determined using data loggers (HOBO-Temp) from Onset Computer Corporation programmed to register the temperature (ºC) each hour from September to November. Loggers were placed in a waterproof case inside the nest chamber and nest locations were marked with a flag. Each nest was identified with date and nesting time, station number and distance to the high tide line and to vegetation.

Control Nests. Nest monitoring was performed each night following the techniques of patrol established by the Department of Natural Resources of Puerto Rico (DNR). The control nests were identified as C1, C2 and C3 and dataloggers were placed inside nest chamber during egg laying.

Artificial Nests. Ten nests were constructed following the dimensions of Márquez (1973). Nine of them were under different lightning intensity: nest under total sun exposure (1,2,3), nest under 53% lightning (4,5,6) and nest under 27% lightning (7,8,9). A box that shadowed 18 feet^2 with a screen of known porosity covered nests with 53% and 27% insolation. Each artificial nest had 120 biodegradable latex balloons (Pioneer Balloon Company) filled with water, weighed about 25g and was 35mm in diameter (FAO 1990). Those balloons represent the average of eggs in hawksbill nests incubated at Caja de Muertos.

Last nest was constructed 2m from the natural nest C2, and was called the Blank nest. This one had no balloons inside, only a datalogger, to record the temperature of the empty nest during the natural nests incubation. Based on temperature differences between the metabolic heat generated by the embryos, it was estimated and used to correct the artificial nest exposition temperature.

RESULTS AND DISCUSSION

Nests C2 and C3 had an incubation time of 57 days, while C1 was 63 days. C1 was located in a heavily vegetative area and rocky soil, maybe reduced lightning extended its incubation. Based on the average temperature difference between natural nests (C2 and C3) and Blank nest, metabolic heat was estimated in 0.904ºC. This difference was used to correct the temperature of the artificial nest. As shown in Fig. 1, during Stage I (days 1-19) drastic changes in temperature were registered because of rain between days 7 to 9 and 16 to 18. On Stage II (days 20-39) the temperature of control and artificial nest were inside the range needed to successful eggs incubation (25-35ºC), but over pivotal temperature (29.32ºC), indicating female bias. C1 was the only one that did not shows this behavior (indicating male bias), maybe because of the vegetation that permanently covers it and soil characteristics. ANOVA showed that there are significant differences (p<0.05) during Stage II between average temperature of nests exposed to 100% (30.75ºC), 53% (30.07ºC) and 27% (29.70ºC) of insolation. The average temperature registered in C1 (27.67ºC) was significant different (p<0.05) to C2 (30.62ºC), C3 (30.65ºC) and the artificial nests (100%, 53% and

27% insolation). The average temperature of C2 and C3 was not significant different (p>0.05) comparing it between them or with constructed nests exposed to 53% and 100% lightning, but are different (p<0.05) to nests exposed to 27% lightning. On Stage III (days 40-57) the artificial nest temperature was about 30.5ºC, while the incubation temperature of C2 and C3 (next to eclosion) increased to an average of 33.1ºC. This behavior would be related with energy released by embryos prior to hatching that is absent in artificial nests.

Based on the information recollected from this nesting season the average time of nests incubated in Caja de Muertos is about 57 days. During this season (limited to the sampling days) nesting success was estimated in 83%. According to nesting reports of Caja de Muertos during four years beach monitoring (1996-2000) nesting success was about 80%, higher than that reported in 1992 (69%).

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LITERATURE CITED

Ackerman, R. 1997. The nest environment and the embryonic development of sea turtles. In: P. Lutz and J. Musick, eds. The Biology of Sea Turtles. CRC Press, Boca Raton. p. 83-104.

Bull, J., R. Vogt, and M. Bulmer. 1982. Sex determining temperatures in turtles: a geographic comparison. Evolution 36:326-332.

FAO Species Catalogue. 1990. Sea turtles of the world an annotated and illustrated catalogue of sea turtle species known to date. Fisheries Synopsis. No.125, Vol. 11.

Hall, K. 1994. Marine turtle nesting in western of Puerto Rico. Final Report for the Cooperative Agreement Between the U. S. Fish and Wildlife Service Caribbean Field Office and Sea Grant College Program, University of Puerto Rico, Mayagüez Campus.

Hernández, M. 1991. Overview of coastal management and development problems in the Caribbean (Abstract). Symposium of the Mediterranean Seas-2000. p. 137-157.

MTSG. 1994. Manual Sobre Técnicas de Investigación y Conservación de las Tortugas Marinas. 1994. 2nd ed.

Márquez, R., A. Villanueva and J.L. Contreras. 1973. Dimensiones de los nidos artificiales por especie para la protección de las tortugas marinas. Apéndice 1. Programa Tortugas Marinas. Instituto Nacional de Pesca, Subsecretaria de Pesca. México. 33 p.

Mrosovsky, N., A. Bass, L. Corliss, J. Richardson, and T. Richardson. 1992. Pivotal and beach temperatures for hawksbill turtles nesting in Antigua. Canadian Journal of Zoology 70:1920-1925.

National Marine Fisheries Service and U.S. Fish and Wildlife Service. 1993. Recovery Plan for Hawksbill Turtle *Eretmochelys imbricata* in the US Caribbean Sea, Atlantic Ocean and Gulf of Mexico. 52 p.

Standora, E. and J. Spotila. 1985. Temperature dependent sex determination in sea turtles. Copeia 1985:711-722.

Steinitz, M., M. Salmon and J. Wyneken. 1998. Beach renourishment and loggerhead turtle reproduction: A seven-year study at Jupiter Island, Florida. Journal of Coastal Research 14:1000-1013.

van Dam, R. and C. Diez. 1994. Hawksbill nesting on Mona Island, Puerto Rico. Research report for 1994 to USFWS.

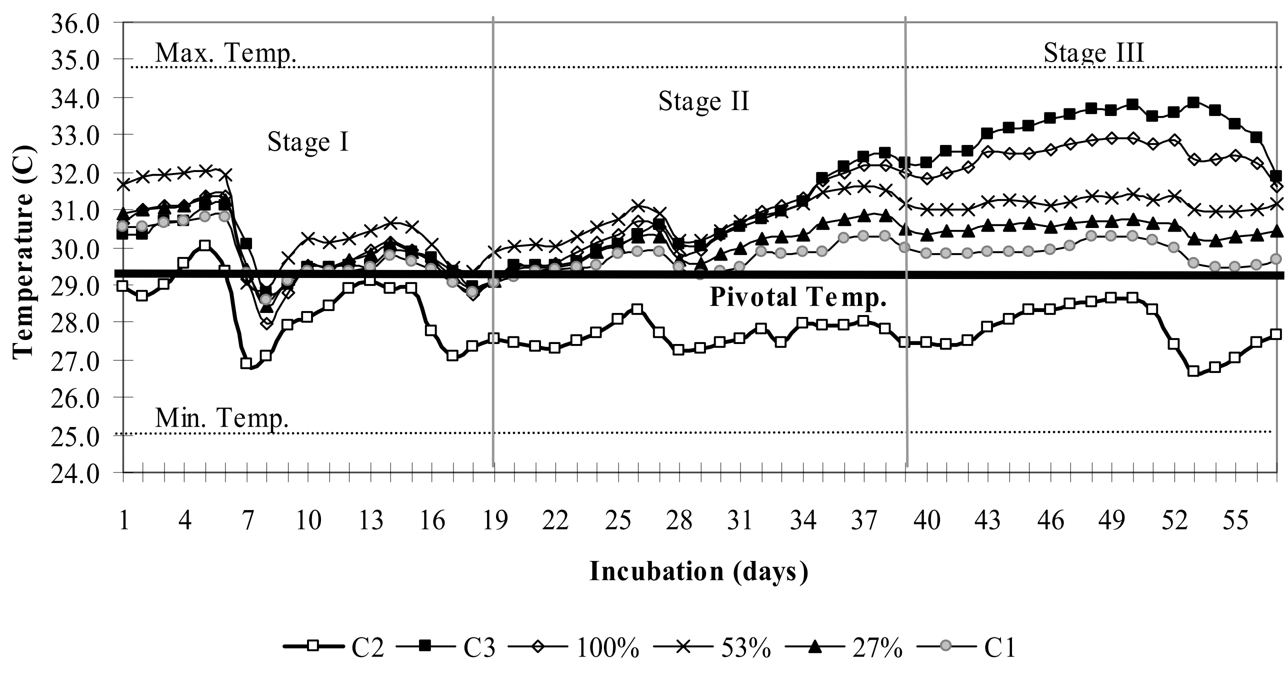

Fig. 1. Temperature of control and artificial nests during sampling days.

The importance of egg position and clutch metabolism in leatherback turtle nests

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INTRODUCTION

The physical environment of sea turtle nests has a considerable impact on egg development. Incubation temperature determines hatchling sex (Binckley et al. 1998). The clutch oxygen consumption (VO_2) relates to clutch metabolic mass and embryonic growth rate (Ackerman 1981a). Sand grain size and type determine both water and gas potential (Ackerman 1980). Oxygen utilized in embryonic metabolism is obtained by passive diffusion from the atmosphere through the sand surrounding the nest (Prange and Ackerman 1974), which can be almost 1 m below the beach surface in the case of leatherback turtles. During its peak metabolic activity, the clutch consumes oxygen faster than it can be replenished through diffusion, resulting in a relatively anoxic nest environment at the time of emergence (Ackerman 1977).

Leatherback nests are unique because they are the deepest and contain the largest biomass of eggs of any living reptile. These factors would make oxygen more limited to developing leatherback embryos than other sea turtle embryos because diffusion from the atmosphere is more difficult with depth and competition for oxygen would be increased due to the increased biomass of leatherback clutches. However, it is unclear whether the extreme nature of the leatherback nest environment is responsible for its low average hatching success.

The position of an individual egg within the clutch and the nest chamber determines the microenvironment within which the egg develops. Oxygen must diffuse from the atmosphere through the sand to reach the metabolizing embryos in a leatherback nest, thus creating a gradient of decreasing oxygen gas tensions from the top toward the bottom and from the periphery toward the center of the nest (Ackerman 1980). The amount of oxygen available to an egg will depend upon whether it is in the center of the clutch surrounded by other metabolizing eggs or on the periphery in direct contact with the sand. These factors will result in intensified competition for oxygen between eggs in the nest.

The objective of this study was to test the conclusions about gas exchange and embryonic development in sea turtles nests (Prange and Ackerman 1974, Ackerman 1977, 1980, 1981) for leatherback nests. We used highly sensitive, real-time oxygen sensors to measure the oxygen concentration within developing leatherback clutches throughout incubation. We also recorded the three-dimensional position of individual eggs and determined their developmental outcomes by excavation after the clutch hatched. Thus, we were able to provide new information about the spatial and temporal development of leatherback eggs by better understanding the internal environment of the nests in which they develop.

METHODS

We translocated clutches of leatherback turtle eggs to a beach hatchery at Playa Grande, Costa Rica, in 2001-2002. We sampled O_2 concentrations from 21 developing leatherback clutches (and one control nest containing plastic golf balls) by constructing "Wiffle ports." Each Wiffle port consisted of a plastic Wiffle baseball as a sampling port, which was located in the center of the clutch upon burial in the hatchery. A thermocouple was also included in each port to record clutch temperature during development. We used a highly-sensitive oxygen sensor (Qubit Systems) for remote, real-time measurements of nest O_2. The measurements were archived by a data logger/computer interface (Vernier Software) and later analyzed on computer with the Logger Pro software (Qubit Systems). An DC pump powered by a 12V battery circulated nest gas from the Wiffle port past the sensor and back into the nest. Gas samples from each Wiffle nest were taken every second day throughout the incubation period until hatchling emergence.

For 22 clutches, we brushed the sand off all eggs and numbered them with a wax pencil. The three-dimensional position of each egg was then recorded relative to the bottom of the nest chamber and from the center of the level. The developmental outcomes of the numbered eggs were determined by excavation two days after the first hatchling emergence from the nest. Trends in developmental success and embryonic death were analyzed with the positional information for the eggs.

Eight nests contained four Wiffle (golf ball) ports each, one placed in the center of the clutch, one on the side, one on the bottom, and one on the top. The sampling apparatus was the same as for the Wiffle nest experiment described above, but the sampling protocol for the positional Wiffle nests differed in that gas samples collected from the positional ports were not recirculated to the nest, and only one of the four ports was sampled daily.

RESULTS

Incubation temperature increased and nest $\%O_2$ decreased as clutch metabolism accelerated during development. Oxygen curves indicate stable $\%O_2$ values similar to the control nest during the first half of development, followed by a rapid decrease in nest $\%O_2$ during the second half of development. Minimum $\%O_2$ in the nest decreased as the number of metabolizing embryos and hatchlings (determined by excavations of nests) increased.

Due to the humid conditions within the nest, many of the egg numbers were not legible upon excavation. We found no effect of egg position on hatching success. Embryonic death at all stages of development as well as hatching occurred at all locations in the nest.

The highest average $\%O_2$ for all nests was recorded in the side ports and the lowest was recorded in the center ports. The greatest average difference in minimum $\%O_2$ from the center reading was in the side of the nest.

DISCUSSION

Increased metabolic activity of developing embryos increased clutch incubation temperature and reduced nest oxygen levels during the second half of incubation, similar to results reported by Ackerman (1981b). As the number of metabolizing embryos increased, minimum $\%O_2$ decreased because proportionally more developing embryos were utilizing oxygen. Ackerman (1980) measured O_2 concentrations as low as 12% in green turtle (*Chelonia mydas*) nests and reported that VO_2 was directly related to clutch mass. Clutch mass is directly related to the number of eggs in a clutch for the leatherbacks at Playa Grande (P. Sotherland unpubl. data).

We found that hatching and embryonic death at all developmental stages occurred throughout the nest. We were unable to determine any spatial patterns in developmental success because many of the egg numbers were not legible when the nests were excavated.

Oxygen levels were highest in the side and top of the nest because oxygen was diffusing from the surface of the sand down to the nest. Oxygen concentrations were most depleted in the center and bottom of the nest because those locations were furthest from the atmospheric source of oxygen and were surrounded by metabolizing embryos. Ackerman (1980) reported a similar pattern of O_2 concentration gradients in sea turtle nests.

We will investigate the interaction between O_2 levels, development, and hatching success of individual eggs at different positions in the nest.

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LITERATURE CITED

Ackerman, R.A. 1980. Physiological and ecological aspects of gas exchange by sea turtle eggs. Am. Zoologist 20:575-583.

Ackerman, R.A. 1981a. Growth and gas exchange of embryonic sea turtles (*Chelonia*, *Caretta*). Copeia 1981:757-765.

Ackerman, R.A. 1981b. Oxygen consumption by sea turtle (*Chelonia*, *Caretta*) eggs during development. Physiological Zoology 54:316-324.

Binckley, C.A., J.R. Spotila, K.S. Wilson, and F.V. Paladino. 1998. Sex determination and sex ratios of Pacific leatherback turtles, *Dermochelys coriacea*. Copeia 1998:291-300.

Prange, H.D. and R.A. Ackerman. 1974. Oxygen consumption and mechanisms of gas exchange of green turtle (*Chelonia mydas*) eggs and hatchlings. Copeia 1974:758-763.

Reproductive biology and endocrine cycling of the diamondback terrapin, *Malaclemys terrapin*, in South Carolina estuaries

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The diamondback terrapin, *Malaclemys terrapin*, is the only truly estuarine turtle of North America. Found along the eastern and Gulf of Mexico coasts of the United States, it shares a portion of the same habitat with three species of sea turtles (*Caretta caretta*, *Chelonia mydas*, *Lepidochelys kempii*). The long-lived diamondback terrapin is therefore a model for coastal estuarine system health, and this dynamic could be important as it affects the species of sea turtles that also frequent those systems. After near depletion, Malaclemys terrapin has made a strong recovery throughout much of its range. However, due to increasing anthropogenic impacts, terrapin populations are declining in some states. Increasing coastal development, commercial and recreational crabbing, and elevated boat and vehicular traffic can bring about increased mortality in terrapins. Objectives of this study were as follows: (1) to develop baseline information regarding the annual cycle of the reproductive hormone testosterone in South Carolina diamondback terrapins, and (2) to compile information on male and female diamondback terrapin annual gonadal cycles including morphological and histological changes in reproductive anatomy. Combining ultrasonography, laparoscopy, and testosterone radioimmunoassays, annual gonadal changes and testosterone levels of diamondback terrapins were monitored in four regions of the Charleston Harbor Estuarine System in coastal SC: Ashley River, Cooper River, Wando River, and Charleston Harbor proper. Terrapins were captured as bycatch using trammel nets. Ten to thirty samples were collected monthly from April 2001-May 2002 from each of the four estuaries.

Identification of estrone as the major circulating estrogenic steroid in marine turtle plasma

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INTRODUCTION AND METHODS

A survey of three species of marine turtle, green (*Chelonia mydas*), loggerhead (*Caretta caretta*), and flatback (*Natator depressus*) was performed to evaluate estrogen profiles in each species. Blood plasma samples were collected from adult female marine turtles during late vitellogenesis, courtship/mating and nesting during the 1992 to 1999 breeding seasons. Identification of endogenous estrogens in adult females is particularly important to our understanding of marine turtle and reptilian endocrinology. To accomplish this aim a method was developed to profile estrogens using High Pressure Liquid Chromatography (HPLC) with fluorescence detection. The isocratic system comprised of Waters 470 Scanning Fluorescence Detector (FL) and 490 Programmable Multi-wavelength Ultra-Violet/Visible Detector (UV) with Waters 510 Pump and U6K Manual Injection Port. The HPLC was fitted with a Waters Nova Pak Silica Steel Column (3.9mm x 150mm x 4mm) stationary phase and hexane: isopropanol (97:3) mobile phase. Samples or standards were injected using a 50ml Hamilton syringe (Waters). Prior to use, the system was thoroughly flushed with 500ml methanol (HPLC grade, Sigma-Aldrich) followed by 500 ml of the mobile phase, filtered and degassed hexane : isopropanol (97:3) (HPLC grade, Sigma-Aldrich) [1]. We used a normal phase elution, which allowed the least polar estrogens to elute first, followed by the more polar [2]. The UV detector was set at 280 nm and Fluorescence detector was set at 220/340 nm excitation/emission. The injection syringe was rinsed 3 times with mobile phase between each injection. Each sample was run in duplicate at an elution time of 30 min initially and shortened to 25 min thereafter. The total number of samples run on the HPLC was 36 in duplicate, which included *C. mydas* (n=19), *N. depressus* (n=9) and *C. caretta* (n=8).

Standards. By dissolving 2.5 mg pure estrogen in 50 ml methanol (HPLC grade, Sigma-Aldrich), 50 mg/ml of each estrogen standard stock solutions were made. Three estrogen standards used were: estradiol-17b (1,3,5[10]-Estratriene-3,17â-diol), estrone (1,3,5[10]-Estratrien-3-ol-17-one), and estriol (1,3,5[10]-Estratriene-3,16á,17â-triol) (Sigma-Aldrich Australia). From the stock solutions, a lower concentration of 1.00 mg/ml of each standard was made. Prior to HPLC injection, each standard was evaporated to dryness and re-dissolved in 600 ml mobile phase. Standards were injected in duplicate into the HPLC at a volume of 50 ml, and concentration of 1.67 ìg/ml. This allowed for exact elution time of each estrogen to be established for this method.

Purification and extraction of estrogens from plasma. Selected plasma samples were thawed at room temperature. Aliquots of 400 ml of plasma were mixed with 600 ml de-ionized water prior to extraction twice with 4 ml of ethyl ether. Organic extract was transferred to a glass test tube and evaporated to dryness at 40°C. The residue was dissolved in 600 ml mobile phase and transferred to sample vials for injection into the HPLC.

RESULTS

Elution profiles of estrogen standards. All estrogen standards were found to elute in less than 12 minutes (Fig. 1a, b). Identity of estrogens was confirmed by expected polarity of elution. The expected order of elution by polarity was estrone, followed by estradiol-17b and estriol, respectively. Estrone was eluted at time 3.45 minutes. The estrone peak was narrow to medium in width, with a height of 0.05. Estradiol-17b was eluted at time 5.1 minutes. The estradiol peak was narrow to medium width and two orders of magnitude higher than the estrone peak, at 0.975. Estriol did not elute with the present methods used. Estriol standard dissolved in hexane : isopropanol (97:3) (50 mg/ml) showed no peak that represented the presence of estriol.

Elution profiles of estrogen in plasma samples. Elution profiles of plasma samples were graphically represented. Five individual plasma samples that represent each group of animals analyzed were reported (Fig. 1 c-g). Based on peak distribution in for *N. depressus*, samples collected from Curtis Island in 2000 showed the major estrogenic sex steroid to be estradiol-17b. This sample (CI2020) showed a narrow to medium width peak at time 4.8 minutes. Peak height was 0.048. However, *N. depressus* samples collected from Curtis Island in 1995 (Fig. 1c) showed the major estrogenic sex steroid to be estrone. No evidence of estradiol could be seen in the 1995 samples. Sample CI954 showed a medium width peak at time 3.5 minutes. Peak height was 0.0062. Peak distribution for *C. caretta* (1992, n=2; 1999, n=2) and *C. mydas* (n=1) showed the major estrogenic sex steroid to be estrone. *C. caretta* sample MR92W56 (Fig. 1g) had an elution time of 3.5 and height of 0.00075. *C. caretta* samples MR9903 (Fig. 1e) had an elution time of 3.5 minutes. Peak height was 0.0029. *C. mydas* (HI98S153) (Fig. 1d) had an elution time of 3.5 and peak height of 0.0021.

DISCUSSION

In the present study, High Pressure Liquid Chromatography (HPLC) with fluorescence detection was successfully used to identify individual estrogens present in vitellogenic marine turtles. Estrone appears to be the major estrogenic sex steroid present in the plasma of female breeding *C. caretta* and *C. mydas*. However, estradiol-17b seems to be the major estrogenic sex steroid present in some of the plasma of *N. depressus*. In *N. depressus* samples (Curtis Island 2000), estradiol-17b was the major estrogenic peak as seen in Fig. 1f. The reason for a difference in estrogen detection in *N. depressus* between 1995 and 2000 is unclear. Samples that were collected in the 1995 and 2000 nesting seasons, were sampled in November and early December. This may indicate a difference between clutches in a single nesting season. More complete sampling is needed in order to confirm this speculation. Sampling before and after each clutch in a single nesting season would give data representative of specific hormone changes during this time. The estriol standard runs resulted in an absence of peaks or broad peaks that were unsubstantiated in plasma samples when spiking was used. The current method does not seem a useful method for detecting estriol. It is possible that the mobile phase solvents may have varying effects on the amount of pure estrogen standard that will dissolve into solution. These results represent the first qualitative analysis of estrogens in female marine turtles. The HPLC estrogen profile suggest that estrone, rather than estradiol-17b, should be monitored and studied as the primary estrogenic sex steroid present during breeding in adult female marine turtles.

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LITERATURE CITED

Venkatesh, B., et al. 1992. Steroid Metabolism in Teleost

Gonads: purification and Identification of Metabolites by high-performance Liquid Chromatography. Steroids. 57:276-281.
Kautsky, M.P. 1981. Steroid Analysis by HPLC. J. Cazes, ed. Vol. 16. Marcel Dekker. New York City: 396.
Licht, P., et al. 1979. Gen. Comp. Endocrinol. 39:274-289.
Licht, P., et al. 1980. Gen. Comp. Endocrinol. 40:116-122.
Whittier, J. et. al. 1997. Gen. Comp. Endocrinol. 106:39-47.
Wibbels, T., et al. 1990. Gen. Comp. Endocrinol. 79:154-164.
Wibbels, T., et al. 1992. Gen. Comp. Endocrinol. 87:71-78.

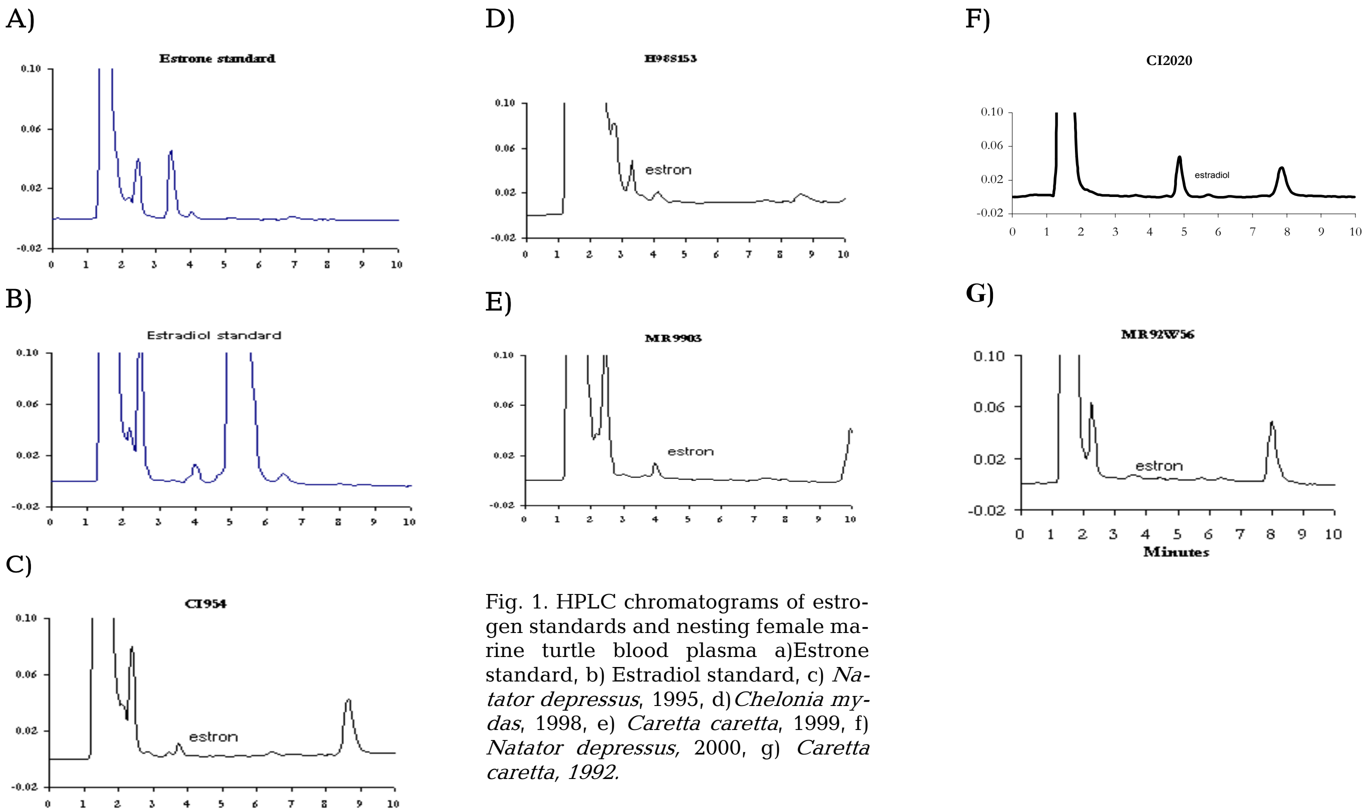

Fig. 1. HPLC chromatograms of estrogen standards and nesting female marine turtle blood plasma a)Estrone standard, b) Estradiol standard, c) *Natator depressus*, 1995, d)*Chelonia mydas*, 1998, e) *Caretta caretta*, 1999, f) *Natator depressus,* 2000, g) *Caretta caretta, 1992.*

The effect of the toxic cyanobacteria *Lyngbya majuscula* on marine turtles

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The toxic cyanobacteria *Lyngbya majuscula* occurs in tropical and subtropical marine habitats worldwide and potentially has a negative impact on marine turtles. *L. majuscula* contains a suite of toxins including tumour promoters and immunosuppressants. It grows on seagrass and therefore may pose a threat to the Green turtle, *Chelonia mydas*, an herbivorous marine reptile. The carnivorous Loggerhead turtle, *Caretta caretta*, feeds on crustaceans and may also be at risk from biomagnification of the *L. majuscula* toxins. Tumour promoting toxins from marine organisms have been implicated in the aetiology of the debilitating neoplastic disease fibropapillomatosis. The following proposed project will form the basis of a 3 year Ph.D. study. Our aim is to observe the effects of *L. majuscula* blooms on marine turtles in Moreton Bay, Australia. In particular, we will investigate whether green turtles are ingesting the cyanobacteria; whether the cyanobacteria and its toxins are assimilated by either species of turtle; and whether such blooms deter green turtles from feeding. Both live and dead green and loggerhead turtles will be sampled from Moreton Bay. Stomach contents of green turtles will be assessed and skin samples will also be removed for stable isotope analysis. The assimilation and/or breakdown of toxins in both species of marine turtle will be monitored using HPLC/mass spectral analysis of blood and fat samples. Finally, the plasma triglyceride levels of green turtles will be examined to give an indication of their feeding status: if a cyanobacterial bloom causes the animals to cease feeding then there will be an increase in mobilised lipids in the form of raised plasma triglyceride levels.

Internesting diving behavior of loggerhead turtles (*Caretta caretta*) in southwest Florida

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INTRODUCTION

While considerable research has been conducted on sea turtle nesting biology, significantly less data has been compiled on diving behavior and habitat utilization during internesting periods. Additional information on this aspect of sea turtle life history would be useful in evaluating management alternatives in the coastal zone in relation to impacts on sea turtles during the reproductive season. Time-depth recorders (TDRs) have proven to be useful in obtaining data on diving behavior and activity patterns. Internesting diving behavior of hawksbill (*Eretmochelys imbricata*), leatherback (*Dermochelys coriacea*), and green turtles (*Chelonia mydas*) has been investigated with TDRs. (Storch et al. 1999, Hochscheid et al. 1998, Eckert et al. 1996, Eckert et al. 1986). TDRs have also been used to study internesting diving behavior of loggerhead turtles (*Caretta caretta*) (Sakamoto et al. 1993, Sakamoto et al. 1990). Tanaka et al. (1995) used time temperature recorders to investigate the possibility of feeding by loggerhead turtles during internesting periods. Addison et al. (in press) used sonic and radio telemetry to investigate the movements of nine post-nesting loggerheads during the initial 3-8 hrs after leaving the beach. This study used TDRs to determine diving behavior of loggerhead turtles during entire internesting periods.

MATERIALS AND METHODS

This study was conducted on Keewaydin Island, Florida in 2002. Loggerhead nesting begins in May and continues through August in this region. No TDRs were applied to nesting females prior to mid-June, thereby minimizing the probability of male turtles damaging tags during copulation. Reproductively mature females have strong fidelity to specific nesting beaches. Only those turtles that had been flipper-tagged earlier in the nesting season were selected, thus increasing the chance of TDR recovery during subsequent nesting events.

Prior to deployment, each TDR (Lotek LTD 100) was set to take a pressure reading every 60 sec. Thin stainless steel wire was threaded through holes at each end of the TDR and larger gauge stainless steel wire was used to fabricate a harness to which the smaller wire was attached. A nylon tie-wrap was also used to cinch the TDR to the harness. Before attaching a TDR to a turtle, the carapace was scrubbed with a brush and washed with betadyne. The nylon tie-wraps were threaded through pieces of surgical tubing and wiped with Neosporin prior to insertion to prevent infection. During the attachment process, the turtles were restrained in a portable plywood box held in place with 1.25 m lengths of steel reinforcing rod pushed in the sand. Holes were drilled through the posterior-most post-marginal scute and the TDRs were attached by threading nylon tie-wraps through the holes and around the harness. Attachment required ~10 minutes. Turtles were released immediately afterwards.

Internesting intervals for the loggerheads that nest on Keewaydin Island typically range from 9-14 days (Addison 1996). Beach patrols frequency was increased nine nights after release to improve the chances of encountering an instrumented turtles so the TDR could be removed. If a turtle was missed during this period, the procedure was repeated starting nine nights after the first night of the initial period of increased beach patrols.

RESULTS

Four TDRs were deployed on the nights of 17-18 June. All the tagged turtles were later encountered on the Keewaydin Island beach. On 27 June, two of the turtles were observed nesting, but one of them had lost the TDR. The third TDR was recovered from a nesting turtle the following night. The fourth TDR was recovered on 12 July during a non-nesting emergence. This TDR encompassed two internesting periods. The diving data it recorded was selected for discussion here.

The diving behavior could be divided into two general categories based on the patterns of diving activity. Dive profile 1 (P1) activities were defined as frequent shallow dives of short duration with long periods spent in the upper 1 m of the water column. Dive profile 2 (P2) activities were defined as deep dives of long duration with the turtle apparently spending the majority of the time at the bottom. Brief cycles of P1 diving behavior were the most prevalent activity recorded during the first 50.8 hrs after nesting. The turtle then entered into a prolonged phase of P2 behavior (20-25 June) during which the dive lengths and depths were longer and consistent over time. The maximum dive duration during these activity cycles was 51 min. This pattern of activity suggests that the turtle was resting on the bottom and probably remained in a specific location. The turtle then exhibited an extended period (26-29 June) of P1 behavior. Sixty-two surface cycles were recorded and ranged from 20 to 188 min. The mean duration of these cycles was 50.5 min. Throughout this period, the turtle spent 72.1% of the time at depths of 1 m or less. However, dive depths also increased to a maximum of 13 m, suggesting the turtle was moving offshore to deeper waters. Dive depths decreased to 8 m at the end of this period and were followed by a rapid decrease on 30 June. The data indicate the turtle emerged from the water and spent 106 minutes on the beach, during which time she probably nested. The patterns of P1 and P2 behavior followed a similar sequence during the second internesting interval: an initial period of P1 behavior form 30 June to 3 July; followed by an extended period of P2 behavior from 3 July to 9 July; and P1 behavior from 9 July to 11 July prior to returning to the beach. During the final phases of the second internesting interval, a series for relatively brief non-nesting emergences were documented just prior to the recovery of the TDR.

DISCUSSION

The diving behaviors documented provide insight into several aspects of loggerhead turtle activity during internesting periods. Based on the available data, it is evident that P1 diving behavior was the dominant activity during the first 49-58 hrs after nesting. However, it is not apparent how much of this time was spent swimming away from the beach or basking on the surface. The extended period of time spent in the upper portion of the water column during the cycle of P1 behavior suggested that the turtle may have been basking near the surface. The time spent in the warm surface waters and the exposure to radiant energy from the summer sun may have permitted the turtle to increase her core temperature and hasten egg development. With the onset of P2 diving behavior, the regularity of the dives and the consistent depths to which the turtle descended suggest that the turtle was sedentary. This "resting" behavior would conserve energy for egg production and subsequent nesting.

Radio and sonic tracking data indicated that turtles reach the depths observed in the present study during the first 4-8 hrs after nesting (Addison et al. 2002). However, it is not known how far turtles are moving before entering the extended P2 phase. The use of flowmeters in conjunction with TDRs would provide information on rates of movement and distances traveled and swimming activities could then be inferred. Tagging turtles with radio transmitters and tracking them using aerial receivers or tagging with both sonic and radio transmitters and tracking with a boat capable of extended periods at-sea are viable methods to monitor offshore movements. Although satellite telemetry may provide useful data while turtles are basking, it may not provide the locational accuracy needed to define "resting" areas given the limited time spent on the surface during the P2 phase. Regardless of the method, the offshore areas inhabited by internesting turtles need to be identified and subsequently incorporated in conservation and management plans.

Acknowledgements. The authors express their sincere thanks to The Ocean Conservancy, especially David Guggenheim, Vice President for Conservation Policy, for providing funding for this study. Thanks for thinking of us, David! We also extend our thanks to the 2001 field technicians, Tricia Clune, Lisa Fairchild, Christina Hodge, and Kristi McKee, for their tireless efforts on the beach looking for turtles, especially turtles bearing expensive scientific jewelry. A special thanks to Lisa for the bath she took with XXM499 while recovering the TDR used for this presentation.

LITERATURE CITED

Addison, D.S., J.A. Gore, J. Rider, and K. Worley. 2002. Tracking post-nesting movements of loggerhead turtles (*Caretta caretta*) with sonic and radio telemetry on the southwest coast of Florida, USA. Marine Biology 141:201-205

Addison, D.S. 1996. Mean annual nest frequency for renesting loggerhead turtles (*Caretta caretta*) on the southwest coast of Florida. Marine Turtle Newsletter 75:13-15.

Eckert, S.A., D.W. Nellis, K.L. Eckert, and G.L. Kooyman. 1986. Diving patterns of two leatherback sea turtles (*Dermochelys coriacea*) during internesting intervals at Sandy Point, St. Croix, U.S. Virgin Islands. Herpetologica 42:381-388.

Eckert, S.A., H.C. Leiw, K.L. Eckert, and E.H. Chan. 1996. Shallow water diving by leatherback turtles in the South China Sea. Chelonian Conserv. and Biology 2:2237-2243.

Hochscheid, S., B.J. Godley, A.C. Godley, and R.P. Wilson. 1998. Green turtle (*Chelonia mydas*) inter-nesting behaviour in the eastern Mediterranean determined using data-logging devices. In: F.A. Abreu-Grobois, R. Briseno-Duenas, R. Márquez-Millan, and L. Sarti-Martinez, comps. Proceedings of the Eighteenth International Sea Turtle Symposium. NOAA Tech. Mem. NMSF-SEFSC-436. p. 99-100.

Sakamoto, W., K. Sato, H. Tanaka, and Y. Naito. 1993. Diving patterns of two loggerhead turtles during internesting. Nippon Suisan Gakkaishi 59:1129-1137.

Sakamoto, W., Y. Naito, I. Uchida, and K. Kureha. 1990. Circadian rhythm on diving motion of the loggerhead turtle *Caretta caretta* during inter-nesting and its fluctuations induced by the oceanic environmental events. Nippon Suisan Gakkaishi 56:263-272.

Storch, S., Z.M. Hillis-Starr, and R.P. Wilson. 1999. Turtles in the reef: A closer look at the activities of hawksbill turtles in a Caribbean internesting habitat. In: H. Kalb and T. Wibbles, comps. Proceedings of the Nineteenth Annual Symposium on Sea Turtle Conservation and Biology. NOAA Tech. Mem. NMSF-SEFSC-443. p. 33-35.

Tanaka, H., K. Sato, Y. Matsuzawa, W. Sakamoto, Y. Naito, and K. Kuroyanagi. 1995. Analysis of possibility of feeding of loggerhead turtles during internesting periods based on stomach temperature measurements. Nippon Suisan Gakkaishi 61:339-345.

Stomach content analysis of stranded juvenile green turtles in Uruguay

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INTRODUCTION

The Uruguayan coastline, about 700 km, is bounded in the west by Río de la Plata at the border with Argentina, and in the east by Chuy rivulet at the border with Brazil. The seaweed flora of Uruguay is a reflection of the abiotic features that characterize the Uruguayan coast, a dynamic interaction of the water from a large river with that of the open ocean with its contrasting temperature, salinity and nutrients (Coll and Olivieira 1999). The green turtle, *Chelonia mydas*, is the only herbivorous sea turtle and is the most abundant large vertebrate consumer of seagrasses and algae in the world (Ogden et al. 1980). The green turtles spend the first few years of their life in oceanic habitat and they then move to shallow seagrasses or algae habitats (Brand-Gardner et al. 1999). The studies of foraging areas of sea turtles are important (Bjorndal et al. 1999) and they are a priority considering they are an essential part of the sea turtle life. Green turtles are the most common sea turtle species in Uruguay. Strandings of green turtles occur along the coast throughout the year. There have been no detailed analyses of the foods eaten by green turtles in Uruguay. This study is an attempt to identify the diet of the green turtles that inhabit our waters.

METHODS

A stranding network was created in 1999 by the Karumbé group to monitor the stranding events of sea turtle throughout the Uruguayan coast. As of September 2001 a total of 61 green turtles were stranded or captured. Among all the *C. mydas* stranded, in which necropsies were performed, it was in 7 juvenile green turtles that the digestive tracts were sufficiently intact to allow examination. The stranding sites of these sea turtles are shown in Fig. 1. Most of these strandings occurred in the Atlantic coast during Spring and Summer.

The entire contents of the stomachs were removed and preserved in a solution of 8% formalin. The identification of algae was made following the classification done by Coll and Oliveira about the marine algae of Uruguay. The frequency of occurrence was calculated for each algae item.

RESULTS

The size of the 7 juvenile green turtles examined ranged from 37.9 to 62.5 cm of curved carapace length, CCL (X= 44.8 cm; SD=8.6 cm). A qualitative analysis of the component present in the diet samples was done. In few opportunities mollusks and plastic debris were found in small quantities in the digestive tracts (Table 1). Algae appeared in all the samples. Rhodophyta was represented by 9 genera, Chlorophyta by 2 genera and Phaeophyta by 1 genus. It should be noted that 84% of the algae material was identifiable to species, the remainder was differentiated to the level of genus (Fig. 2).

Although the most commonly represented algae were from the Rhodophyta, the most common food item by frequency of occurrence was *Ulva* (Chlorophyta, fo= 1). Although a quantitative analysis could not be done in all samples, *Ulva lactuca* was the most abundant algae. Of the remaining 10 genera of algae presented in the specimens the red algae *Chondracanthus* was the most common followed by *Polysiphonia*. The only brown algae genus found in one of the samples was *Levringia*, which is really scarce in our waters.

DISCUSSION

The green turtle is the only herbivorous sea turtle feeding on either seagrasses or algae (Bjorndal 1985). In Uruguay the marine flora is not rich or luxuriant (Coll and Olivieira 1999). It is represented by algae and no seagrass is found. Green turtles are, therefore, able to modify their diets to meet local conditions (Ross 1985).

We found that red algae dominated the diet in number of species, but the green algae dominated the frequency of occurrence. However, when data on frequency of occurrence are not coupled with a quantification of the amount present (either mass or volume), the results can be misleading. In this case it is possible that the feeding selectivity of green turtles, based mainly on Ulva lactuca, an algae with low nutritional value, is related to its condition of dominant species with a large biomass in the feeding areas.

The type and amount of mollusks and plastic debris that were found in the samples indicated incidental ingestion. There should be not dismissed the ingestion of small amounts of debris as harmless (Bjorndal et al. 1994). What remains to be elucidated is the effect of debris ingestion on sea turtles.

Further knowledge about the diet of the sea turtle population in Uruguay will allow conservation efforts to be aimed to protect the areas that provide their food.

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LITERTURE CITED

Bjorndal, K.A. 1999. Priorities for research in foraging habitats. In: K.L. Eckert, K.A. Bjorndal, F.A. Abreu-Grobois, and M. Donnelly, eds. Research and Management Techniques for the Conservation of Sea Turtles. IUCN/SSC Marine Turtle Specialist Group Publication No. 4. p. 12-14.

Bjorndal, K.A., A. Bolten, and C.J. Lagueux. 1994. Ingestion of marine debris by juvenile sea turtles in coastal Florida habitats. Marine Pollution Bulletin 28:154-158.

Bjorndal, K.A. 1985. Nutritional ecology of sea turtles. Copeia 1985:736-751.

Brand-Gardner, S.J., J.M. Lanyon, and C.J. Limpus. 1999. Diet selection by immature green turtles, *Chelonia mydas*, in subtropical Moreton Bay, south-east Queensland. Australian Journal of Zoology 47:181-191.

Coll, J. and E.C. Oliveira. 1999. The benthic marine algae of Uruguay. Botanica Marina 42:129-135.

Odgen, J.C., S. Tighe, and S. Miller. 1980. Grazing of seagrasses by large herbivores in the Caribbean. American Zoologist 20:949.

Ross, J.P. 1985. Biology of the green turtle, *Chelonia mydas*, on an Arabian feeding ground. Journal of Herpetology 19:459-468.

Table 1. Components present in the diet samples of the 7 juvenile green turtles examined.

General categories of diet component	Number of C. mydas
Algae	7
Mollusk	1
Synthetic debris	1

Fig. 1. Stranding sites of the 7 juvenile green turtles.

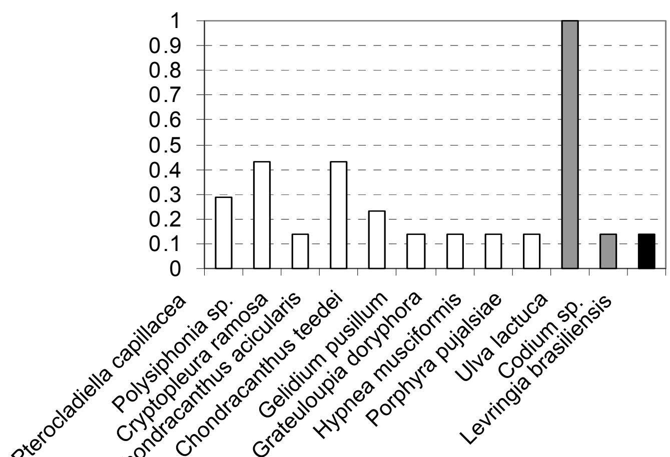

Fig. 2. Description of algae items and their frequency of occurrence.

Feeding ecology of the green turtle, *Chelonia mydas*, at Ra's Al Hadd, Arabian Sea, Sultanate of Oman

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INTRODUCTION

Ra's Al Hadd area, the eastern-most point of Oman's coast, is internationally important as a feeding and nesting ground for green turtles and covers an area of approximately 70 km stretch of coast from Khawr Al Jaramah to Ra's Al Ru'ays. The majority of nesters are concentrated along this area, were between 6,000 to 18,000 females nest annually (Ross 1979, IUCN 1986). The ability to sample the diet of sea turtles allows studies of the feeding ecology and physiology of these animals. Data from such studies can provide insight into questions relating to habitat utilization, digestive physiology, energetics, diet contaminants, trophic ecology, endoparasites, and the relative health of an individual turtle (Léon 2000). Additionally, knowledge of the diet composition of a turtle population allows conservation efforts to be directed to protect important feeding grounds, information that is essential for planning conservation or management actions for animals and their selected resources. This study focuses on the diet selectivity of the green turtles *Chelonia mydas*, listed as endangered in the IUCN Red Book of Reptiles and Amphibians (Meylan and Donnelly 1999) in the area of Ra's Al Hadd, a Nature Reserve internationally important as feeding and nesting grounds for this species.

MATERIAL AND METHODS

Between July and August 2001, during the nesting season, 15 dead juvenile and adult green turtles were found during the day on the beach from Ra's Al Hadd to Ra's Al Ru'ays. Whenever possible, we determined the cause of death. The carapace length and width, the plastron length, the sex and site of recovery of all the turtles were known. Stomach contents of dead turtles were removed. The stomach contents were analyzed using simple methods (gravimetric and frequency of occurrence), combined (IRI, Index of Relative Importance), and some complementary indices and measures (emptiness index, E.I.). The method of Rosecchi and Nouaze (1987) was used to establish prey groups. The diversity was calculated with the Shannon index, the species richness with the Margalef index and equitability with the Pielou index. The overlap between diets was determined with the Schoener index. The diets were statistically compared with the CLUSTER (hierarchical clustering into sample (or species) average groups) and MDS tests (ordination by non-metric multidimensional scaling) using the PRIMER program.

In the present study, some of the calculated indices were applied separately to two groups: algae/seagrasses and animal classes. This separation was made to emphasize the importance of both groups in the green turtles diet. It is believed that green turtles feed only on algae and/or seagrasses, and that the animal matter several times founded on green turtles diet, could be ingested accidentally. And there importance in the gravimetric composition could be sometimes extrapolated by their dry weight, sometimes higher than algae and seagrasses dry weight.

RESULTS AND DISCUSSION

In decreasing order of importance (dry weight), the remaining food items comprised algae (54%), animal matter (25%), seagrass (11%), litter (7%), and benthic substrate (3%) as presented in Fig. 1. Green turtles feeding along the shores of Ra's Al Hadd area in the Sultanate of Oman exhibit a strong tendency toward herbivory, once they forage primarily on marine algae. The brown algae *Nizamudinnia zanardinii* was the most commonly ingested food item among the examined turtles (see Table 1). The prevalence of *N. zanardinii* among the diet samples reflected its great abundance in the Arabian Sea coasts. In shallow waters, from Ra's Al Hadd to Salalah (south of Oman), *N. zanardinii* is a dominant specie, which provides important feeding grounds for fish, green turtles and the economically important abalone *Haliotis mariae* (Jupp 2000).

It was observed in this diet study that green turtles eat both seagrass and algae. However algae could be the mainstay of the diet, due to lack of seagrass. The summer southeast monsoon, prevailing conditions which allow the growth of algae kelp, are not well suited for the habitat requirements of larger-bodied tropical seagrasses (Jupp et al. 1996). The seagrasses species *Halophila ovalis* and *Halodule uninervis*, were abundant in the diet samples, being both preferred species of the green turtles, as reported in other green turtle diet studies, in Oman by Ross (1985) and in India and Yemen by Bjorndal (1997). These species are found along the north coast of Oman, being limited to sandy/silty areas such as Ra's Suwadi, Bandar Jissah and Sur Harbour (Jupp et al. 1996), in the north of Ra's Al Hadd beach.

Green turtles in Arabian Sea supplement their diet with animal matter. Small invertebrates, including polychaete worms and tubes, small gastropod and bivalve shells, hydrozoans and bryozoans, were found in almost all samples. The relative importance of animal matter, especially the gastropods, is believed to be exaggerating due to the use of dry weight as an index of measurement. Rigid invertebrate parts have overestimated weights compared with algal and seagrasses specimens, and soft bodied invertebrates, like cephalopods, since they are completely digested and leave no identifiable remains behind. So, with the exception of the gastropods, the species richness and abundance of non-algal species recovered in this study are likely underestimate. The frequent occurrence of substrate particles, comprised of sand, pebbles and shell fragments, in dietary samples from all sites suggests that feeding turtles may be ingesting this material incidentally as they closely crop seagrasses and algae. Substrate may also be ingested as turtles feed on Sabellid worms and other benthic organisms. Green turtles at the water's surface have also consumed plastic bags, nylon chord, mesh bags, and tarp fragments where it collects in drift lines or convergences. Still, there is no evidence to suggest this as a cause of death, specially, because they represent a small gravimetric percentage of the total diet. The amount of debris and other plastic materials ingested is usually small, but it is important to put these apparently small percentages in perspective.

Areas like Oman are good feeding grounds for this marine turtles species. Therefore, diet should be an important component of any understanding for a conservation plane for these endangered reptiles. It is necessary to obtain information from the feeding grounds of each discrete *C. mydas* population to interpret its biology and to eventually manage its population in balance with human pressures.

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LITERATURE CITED

IUCN. 1986. IUCN Red List of threatened animals 1986. IUCN Publications. Cambridge.

Jupp, B.P. 2000. Studies on the macroalgae of the Sultanate of Oman. In: Coastal Habitats. 2nd Arab International Conference and Exhibition. Arab Envirotec – 2. Abu Dhabi, UAE.

Jupp, B.P., M.J. Durako, W.J. Kenworthy, G.W. Thayer, and L. Schillak. 1996. Distribution, abundance, and species composition of seagrasses at several sites in Oman. Aquatic Botany 53:199-213.

León, Y. 2000. Selective feeding in the hawksbill turtle, an important predator in coral reef ecosystems. Ms. Thesis. University of Florida. 75 p.

Meylan, A. and M. Donnelly. 1999. Status justification for listing the hawksbill turtle (*Eretmochelys imbricata*) as Critically Endangered on the 1996 IUCN Red List of Threatened Animals. Chelonian Conservation and Biology 3:200-224

Rosecchi, E. and Y. Nouaze. 1987. Comparison de cinq indices alimentaires utilisés dans l'analyse des contenus stomacaux. Rev. Trav. Inst. Peches Marit. 49:111-123.

Ross, J. 1979. Sea turtles in the Sultanate of Oman. Muscat: Manuscript Report of IUCN/WWF Project 1320.

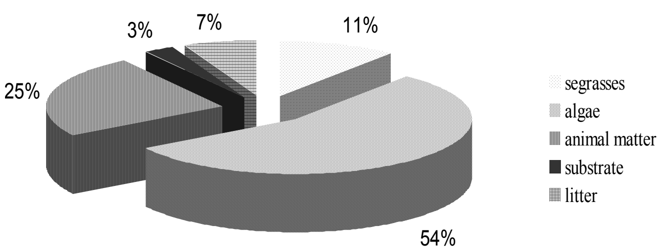

Fig. 1. Gravimetric percentage of animal matter, algae, seagrasses and detritus (substrate and litter), found in the diet samples of green turtles (*Chelonia mydas*).

Table 1. Quantitative description of green turtle (*Chelonia mydas*) diet. %FO=frequency of occurrence; %W=weight percentage.

	Specimens	% FO	% W
Seagrasses	*Halophila ovalis*	40	12.29
	Halodule uninervis	50	2.42
Brown Algae	*Nizamuddinia zanardinii*	70	13.03
	Hormophysa triquetra	10	8.32
	Stoechospernun marginatum	10	4.49
	Lobophora variegata	10	0.53
	Spatoglassum asperum	10	0.47
	Padina tetrastromatica	10	0.07
Green Algae	*Cladophoropsis javanica*	50	10.61
	Codium dwarnkense	10	0.68
	Ulva rigida	30	0.50
	Codium arabicum	10	0.18
Red Algae	*Ahnfeltia plicata*	10	2.10
	Gracilaria canaliculata	20	2.04
	Rhodymenia sp.	10	0.96
	Grateloupia sp.	20	0.44
	Unidentified Algae	20	4.98
Animals	Gastropoda	70	17.06
	Cephalopoda	70	2.02
	Polichaeta	20	4.38
	Bivalvia	20	2.07
	Hydrozoa	50	0.40
	Bryozoa	40	0.02
Detritus	Litter	40	6.75
	Substrate	30	3.19

Interannual variability as a mechanism for male and female hatchling production

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Population ecologists have identified a number of conditions which may skew sex ratios in natural populations away from 1:1. However, the highly biased sex ratios reported for sea turtles remain puzzling. For example, studies from the eastern seaboard of the United States, Brazil and the Mediterranean have all suggested an extreme bias towards female hatchling production. This raises interesting questions about the maintenance of sex ratios within sea turtle populations in general. One possible explanation could be regional variability in sexual biases with previously un-examined rookeries countering the areas of predominant female production. Such counteraction might take the form of either cooler, more peripheral sites characterised by male producing incubation conditions or by sites prone to variable incubation conditions whereby temperatures conducive to male production occur periodically. To explore this, we examined the incubation durations from a site located towards the northern periphery of the Mediterranean over 4 nesting seasons. Incubation duration was used as a proxy for incubation conditions, and subsequently sex ratios. This revealed pronounced variation in incubation duration both within and between nesting seasons with atypical seasons characterised by predominately male producing conditions. Following this, the implications of both atypical seasons and nesting sites prone to variable incubation conditions are explored for sea turtle populations in general, and consideration is given to regional averages for sex ratios which may dilute or shroud the importance of such anomalies.

A comparative diet assessment of *Chelonia mydas* in captivity

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Meeting the highly specialized dietary needs of the green turtle, *Chelonia mydas*, remains a challenge for many zoos and aquariums. Although the diet and foraging behavior of the green turtle is better understood then any other species of sea turtle (Mortimer 1995), the appropriate food types are not necessarily accessible to sea turtle caretakers. Mature green turtles are primarily herbivorous, feeding on turtle grass, *Thalassia testudinum* and/or variants of algae, depending on geographical location. While these food types are abundant in most tropical and subtropical marine environments, harvesting is not always feasible, particularly for aquariums and zoos that are not in tropical regions. Although farming *T. testudinum* is an option, due to the lengthily maturation period (approximately four years seed to seed), and the extremely slow growth rate (2-4 mm/blade per day) (IRL 1998), this technique can prove to be costly in terms of time and money.

As an alternative to farming and harvesting grasses, many institutions have incorporated terrestrial produce into the daily diet of their captive green turtles. In an effort to determine the most appropriate terrestrial products, we have compared the nutritional analysis of *T. testudinum* to the analysis of foods commonly fed to captive green turtles. We accomplished this by first surveying approximately fifty institutions that exhibit sea turtles. The survey included questions regarding species, age, diet, vitamin supplements, and fasting cycles. We then created a master list of vegetables, fish, and commercial diets fed by the participating caretakers. Using the tables in Composition of Foods, we composed a data bank of the chemical composition of many of the food items offered at each institution. We then compared that table to the nutritional analysis of *T. testudinum.* Predictably, the nutritional composition of the vegetable products is most comparable to that of *T. testudinum*, while most of the fish products and commercial diets are much higher in fat and protein. However, there are some exceptions (see Table 1).

In choosing specific food types, there is of course the question of palatability. Individual animals may or may not consume the food type offered. Some caretakers have had success in masking the taste of one food type with another that has proven to be more palatable. For example, while most commercial gel products tend to be rather high in protein and/or fat, they are often readily consumed by sea turtles, and as a result can be extremely useful as a masking agent. Various vegetables can be finely ground and added to a gel product before it solidifies. Depending on the amount of vegetable matter used, the final product can consist largely of the targeted food type.

Obesity in captive sea turtles, especially greens, is often a problem for public aquariums and zoos. Approximately four years ago at the New England Aquarium in Boston, a diet consisting primarily of terrestrial produce that is closely correlated with *T. testudinum* was initiated for a female green turtle with a history of obesity. In an effort to slowly acclimate her to the new diet, various vegetable products were gradually introduced, as animal protein products were gradually eliminated. A measured process as opposed to an immediate diet change is important in ensuring proper digestion. Although this case is a work in progress, this diet has resulted in significant weight loss, as well as a vast improvement in the animal's overall health. In addition, we have discovered that many of the produce products offered tend to promote a slow and meticulous feeding behavior as opposed to rapid ingestion, which is typical of many of the commercial and fish diets. Obviously this "grazing behavior" is a more natural and healthy feeding process for a green turtle.

How the foods were ranked relative to Thalassia. Each item in table (1) was correlated with *Thalassia* by measuring the distance between it and *Thalassia*. The items were then ranked according to their distances, with the smallest distance at the top of the chart and the largest at the bottom. We used a familiar distance measure known as Euclidean distance, which is easily illustrated when the data has only two dimensions. In this comparison, in the interest of readability, the items were not ranked strictly according to their distances. Rather, the food groups—lettuce, peppers, etc. were first ranked amongst themselves. (The individual food items in each group were averaged, and the average item was used to measure the group's distance from *Thalassia*.) Once organized by group, the individual items were ranked within their respective groups to produce the final comparison.

The purpose of this paper is not to dictate what is, or is not a suitable diet for captive green turtles. Instead, this comparative analysis is intended to be used in conjunction with other available dietary information. Factors such as natural light exposure, photo period, palatability, animal age, vitamin and mineral requirements, calcium/phosphorus ratio, geographical origin (algae or grass consumer), animal activity, and product availability are all important considerations when establishing a healthy diet for the green turtle in captivity.

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LITERTURE CITED

IRL. 1998. Species Inventory Report: *Thalassia testudinum*. Smithsonian Maine Station. Fort Pierce, FL.

Mortimer, J.A. 1995. Feeding ecology of sea turtles. In: K.A. Bjorndal, ed. Biology and Conservation of Sea Turtles. Smithsonian Institution Press, Washington D.C.

Table 1. Comparison of *Thalassia testudinum* and some captive green sea turtle foods

			Prep	Water (%)	Pro-tein (g)	Fat (g)	Carbs (g)	Fiber (g)	Ash (g)	Ca (mg)	P (mg)	Fe (mg)	Na (mg)	K (mg)
	Thalassia			12.9	1.5	0.35	3.8	0	4.78	50	40	1.65	75	165
HIGH	**Peppers**	Green im.	Raw	93.4	1.2	0.2	4.8	1.4	0.4	9	22	0.7	13	213
		Red m.	Raw	90.7	1.4	0.3	7.1	1.7	0.5	13	30	0.6	---	---
	Peas		Frozen	80.7	5.4	0.3	12.8	1.9	0.8	20	90	2	129	150
			Raw	78	6.3	0.4	14.4	2	0.9	26	116	1.9	2	316
	Cucumber	Not pared	Raw	95.1	0.9	0.1	3.4	0.6	0.5	25	27	1.1	6	160
		Pared	Raw	95.7	0.6	0.1	3.2	0.3	0.1	17	18	0.3	6	160
	Cabbage		Raw	92.4	1.3	0.2	5.4	0.8	0.7	49	29	0.4	20	233
		Chinese	Raw	95	1.2	0.1	3	0.6	0.7	43	40	0.6	23	253
	Shrimp		Raw	78.2	18.1	0.8	1.5	---	1.4	63	166	1.6	140	220
			Frozen	65	12.3	0.7	19.9	0.1	2.1	38	111	1	---	---
	Lettuce	Crisphead	Raw	95.5	0.9	0.1	2.9	0.5	0.6	20	22	0.5	9	175
		Cos	Raw	94	1.3	0.3	3.5	0.7	0.9	68	25	1.4	9	264
		Looseleaf	Raw	94	1.3	0.3	3.5	0.7	0.9	68	25	1.4	9	264
		Butterhead	Raw	95.1	1.2	0.2	2.5	0.5	1	35	26	2	9	264
	Carrot		Raw	88.2	1.1	0.2	9.7	1	0.8	37	36	0.7	47	341
	Broccoli		Frozen	90.7	3.3	0.2	5.1	1.1	0.7	43	60	0.7	13	244
			Raw	89.1	3.6	0.3	5.9	1.5	1.1	103	78	1.1	15	382
	Cauliflower		Raw	91	2.7	0.2	5.2	1	0.9	25	56	1.1	13	295
	Endive		Raw	93.1	1.7	0.1	4.1	0.9	1	81	54	1.7	14	294
Correlation with *Thalassia*	**Clams**	Soft	Raw	80.8	14	1.9	1.3	---	2	---	183	3.4	36	235
		Hard	Raw	79.8	11.1	0.9	5.9	---	2.3	69	151	7.5	205	311
	Perch	Yellow	Raw	79.2	19.5	0.9	0	0	1.2	---	180	0.6	68	230
	Mazuri Gel		Herbivore	---	30.3	4.5	---	4.9	12.3	2.52	1.6	0.52	0.9	0.85
			Omnivore	---	40.7	12.7	---	1.9	10.9	2.72	1.44	0.47	0.9	0.85
	Squid		Raw	80.2	16.4	0.9	1.5	---	1	12	119	0.5	---	---
	Scallops		Raw	79.8	15.3	0.2	3.3	---	1.4	26	208	1.8	255	396
	Spinach	Chopped	Frozen	91.6	3.1	0.3	3.8	0.8	1.2	113	45	2.1	57	354
		Leaf	Frozen	91.3	3	0.3	4.2	0.8	1.2	105	45	2.5	53	385
			Raw	90.7	3.2	0.3	4.3	0.6	1.5	93	51	3.1	71	470
	Herring		Raw	69	17.3	11.3	0	0	2.1	---	256	1.1	---	---
			Canned	62.9	19.9	13.6	0	0	3.7	147	297	1.8	---	---
	Brussel Sprouts	Raw	85.2	4.9	0.4	8.3	1.6	1.2	36	80	1.5	14	390	
	Mustard Greens	Raw	89.5	3	0.5	5.6	1.1	1.4	183	50	3	32	377	
	Mackerel		Raw	67.2	19	12.2	0	0	1.6	5	239	1	---	---
	(Atlantic)		Canned	66	19.3	11.1	0	0	3.2	185	274	2.1	---	---
	Kale		Raw	82.7	6	0.8	9	---	1.5	249	93	2.7	75	378
	Smelt		Raw	79	18.6	2.1	0	0	1.1	---	272	0.4	---	---
	(Atlantic, jack, bay)		Canned	62.7	18.4	13.5	0	---	5.4	358	370	1.7	---	---
	Collards		Raw	85.3	4.8	0.8	7.5	1.2	1.6	250	82	1.5	---	450
	Yam		Raw	73.5	2.1	0.2	23.2	0.9	1	20	69	0.6	---	600
	Sardines	With liquid	Canned	50.6	20.6	24.4	0.6	---	3.8	354	434	3.5	510	560
		No liquid	Canned	61.8	24	11.1	---	---	3.1	437	499	2.9	823	590
	Seaweed	Agar	Raw	16.3	---	0.3	---	0.7	3.7	567	22	6.3	---	---
		Irishmoss	Raw	19.2	---	1.8	---	2.1	17.6	885	157	8.9	2892	2844
		Kelp	Raw	21.7	---	1.1	---	6.8	22.8	1093	240	---	3007	5273
LOW		Dulse	Raw	16.6	---	3.2	---	1.2	22.4	296	267	---	2085	8060

KEY

(shaded)	High in fat
--------	Not Measured

Epizoic algae of nesting loggerhead sea turtles, *Caretta caretta*, on Masirah Island, Arabian Sea, Oman

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Although epizoic organisms occur on all seven species of marine turtles, loggerhead sea turtle, *Caretta caretta* (Linnaeus 1758), hosts the largest and most diverse communities (Frick et al. 1998). The present investigation notes the first report of algal species from nesting loggerheads in Oman, Indian Ocean, giving a detailed list of epizoic algae
found on these hosts.

Algae were collected from 47 individuals of *C. caretta*, nesting on Masirah Island, placed South-eastern Coast of Arabian Peninsula. Samples were obtained during the 2001 nesting season (May-July). All visible areas of the turtle were examined and sampled where epibiota were most prevalent, by scrapping the carapaces and plastrons with a small knife and/or pair of forceps. Once collected, samples were placed in containers of 4% formalin in seawater. Sampling was conducted while the turtle was nesting or covering the nest site. No samples were included from dead turtles because epizoic attachment may have occurred "post-mortem" and may not reflect the true nature of the observed relationship. 27 taxa were found in this study (Table 1).

The relationship between marine turtles and their epizoan and commensal organisms remains a poorly studied aspect of sea turtle natural history (Dodd 1988). The occurrence of particular epibionts species may ultimately help to clarify certain questions about sea turtle movements, habitat preference, juvenile and subadult activities, and many other aspects of their life history away from the nesting beaches (Caine 1986). The carapaces often encrusted with large algae, suggests that this is evidence of a sedentary life (Carr et al. 1966). Nevertheless, nothing is known of the periods of time that loggerheads spend in several disparate habitats, of their propensity to move from one to another, or about the transition from sub adult to adult foraging areas (Magnusoan et al. 1990). Several species of organisms are attracted to these epizoan for grazing purposes, suggesting a symbiotic behaviour. Surface characteristics of the shell, skin texture, as well as behavioural and ecological habits of the hosts, are likely to relate to the epizoic associations.

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LITERATURE CITED

Caine, E.A. 1986. Carapace epibionts of nesting loggerhead sea turtles: Atlantic coast of U.S.A. Journal of Experimental Marine Biology and Ecology 95:15-26.

Carr, A., H. Hirth, and L. Ogren. 1966. The ecology and migrations of sea turtles, 6. The hawksbill turtle in the Caribbean Sea. American Museum Novitates 2248:1-29.

Dodd, C.K. 1988. Synopsis of the biological data on the loggerhead sea turtle. U.S. Fish and Wildlife Service Biological Report 88:1-110.

Frick, M.G., K.L. Williams, and M. Robinson. 1998. Epibionts associated with nesting loggerhead sea turtles (*Caretta caretta*) in Georgia, U.S.A. Herpetological Review 29: 211-214.

Magnuson, J.J. et al. 1990. Decline of sea turtles. Causes and prevention. Natural Academy Press, Washington, D.C. 259 p.

Table 1. Algae taxa found on *Caretta caretta* nesting on the Northeast of Masirah Island, Oman, during the 2001 nesting season from May to July.

Cyanophyceae	
	Anacystis dimiata (Kützing) Drouet et Daily
	Entophysalis deusta (Meneghini) Drouet et Daily
	Schizothrix calcicola (C. Agardh) Gomont
Chlorophyceae	
	Chaetomorpha linum (Müller) Kützing
	Chaetomorpha indica Kützing
	Chaetomorpha sp.
	Enteromorpha clathrata (Roth) Greville
	Enteromorpha flexuosa (Wülfen ex Roth) J. Agardh
	Enteromorpha sp.1
	Enteromorpha sp.2
	Ulva rigida C. Agardh
	Ulva sp.
Phaeophyceae	
	Padina sp.
Rhodophyceae	
	Centroceras clavulatum (C. Agardh) Montagne
	Ceramium cingulatum Weber-van Bosse
	Ceramium flaccidum (Kützing) Ardissone
	Ceramium diaphanum (Lightfoot) Roth
	Corallinaceae n.i.
	Gelidiopsis intricata (C. Agardh) Vickers
	Jania adhaerens Lamouroux
	Jania sp.
	Leveillea jungermannioides (Hering et Martens) Harvey
	Liagora sp.
	Lomentaria corallicola Börgesen
	Polysiphonia sp.1
	Polysiphonia sp.2
	Spermothamnion sp.

The first report on epizoic algae of nesting green turtles, *Chelonia mydas*, at Ra's Al Hadd Turtle Reserve, Arabian Sea, Oman

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A variety of organisms occur as epizoa on the shells on marine turtles (Caine 1986, Frazier et al. 1992). The present investigation notes the first report of algal species from nesting green turtles, *Chelonia mydas* (Linnaeus 1758) in Oman, Indian Ocean, giving a detailed list of epizoic algae found on these hosts.

Algae were collected from 42 individuals of *C. mydas*, nesting at Ra's Al-Hadd Turtle Reserve (Fig. 1): Ra's Al-Hadd Beach (n=25) and Ra's Al-Junays Beach (n=17). Samples were obtained during the 2001 nesting season (July-August). All visible areas of the turtle were examined and sampled where epibiota were most prevalent, by scrapping the carapaces and plastrons with a small knife and/or pair of forceps. Once collected, samples were placed in containers of 4% formalin in seawater. Sampling was conducted while the turtle was nesting or covering the nest site. No samples were included from dead turtles because epizoic attachment may have occurred "post-mortem" and may not reflect the true nature of the observed relationship. 10 taxa were found in this study (Table 1).

The occurrence of particular epibionts species may ultimately help to clarify certain questions about sea turtle movements, habitat preference, juvenile and sub adult activities, and many other aspects of their life history away from the nesting beaches (Caine 1986). The number of epizoic algae is related to the feeding and nesting behaviour of *C. mydas* (Sentíes et al. 1999), this turtle species occupy three habitat types: high-energy beaches, convergence zones in pelagic habitat, and benthic feeding grounds in relatively protected waters (Magnuson et al. 1990): it preferentially feeds extensively in coastal waters on sea grasses and on the algal turfs that grow on shallow rock platforms (Jupp et al. 1996). Green turtle maintains a relatively clean carapace, even when exposed to a high number of potential colonizing algae. Small and filamentous algae were the dominant form found, these individuals, and are considered to be primary colonizers in stressful habitats due to the instability of a mobile substrate such as the sea turtle carapace, which imposes changes in temperature and light (Sentíes et al. 1999). During the 2001 nesting season, visual observations of hundreds of green turtles, in Oman, clearly indicate a less colonized carapace than that of loggerhead sea turtles, *Caretta caretta* (Linnaeus 1758). Several species of organisms are attracted to these epizoan for grazing purposes, suggesting a symbiotic behaviour. Surface characteristics of the shell, skin texture, as well as behavioural and ecological habits of the hosts, are likely to relate to the epizoic associations.

Acknowledgements. We are grateful to the Directorate General of Nature Conservation/Ministry of Regional Municipalities and Environment of the Oman We also thank the David and Lucile Packard Foundation and the Sea Turtle Symposium for travel support.

LITERATURE CITED

Caine, E.A. 1986. Carapace epibionts of nesting loggerhead sea turtles: Atlantic coast of U.S.A. Journal of Experimental Marine Biology and Ecology 95:15-26.

Frazier, J.G., J.E. Winston, and C.A. Ruckdeschel. 1992. Epizoan communities on marine turtles. III. Bryozoa. Bulletin of Marine Science 51:1-8.

Jupp, B.P., M.J. Durako, W.J. Kenworthy, G.W. Thayer, and L. Schillak. 1996 Distribution, abundance and species composition of seagrasses at several sites in Oman. Aquatic Botany 53:199-213.

Magnuson, J.J. et al. 1990. Decline of sea turtles. Causes and prevention. Natural Academy Press, Washington, D.C. 259 p.

Sentíes, G.A., J.E. Avalos and J.C. Zurita. 1999. Epizoic algae of nesting sea turtles, *Caretta caretta* (L.) and *Chelonia mydas* (L.), from the Mexican Caribbean. Bulletin of Marine Science 64:185-188.

Table 1. Algae taxa found on *Chelonia mydas* nesting at Ra's Al-Hadd Turtle Reserve, Oman, during the 2001 nesting season from July to August.

Cyanophyceae	
	Anacystis dimiata (Kützing) Drouet et Daily
	Entophysalis deusta (Meneghini) Drouet et Daily
	Schizothrix calcicola (C. Agardh) Gomont
Chlorophyceae	
	Chaetomorpha gracilis Kützing
	Chaetomorpha indica Kützing
	Enteromorpha clathrata (Roth) Greville
	Enteromorpha flexuosa (Wülfen ex Roth) J. Agardh
	Ulva sp.
Rhodophyceae	
	Ceramium flaccidum (Kützing) Ardissone
	Polysiphonia sp.

The influence of embedded roadway lighting on the orientation of hatchling sea turtles (*Caretta caretta*)

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Artificial light interferes with hatchling orientation ("seafinding"). In Boca Raton, Florida, U.S.A., State Road A1A parallels the beach in front of two city parks and an incomplete vegetation barrier backs the beach. High-pressure sodium vapor (HPS) cobrahead streetlights on 11 m tall poles are often visible from nest sites. This 1.0 km length of roadway was modified by installing embedded lighting (light emitting diode [LED] "smartstuds") in the roadway, and low mounted, louvered 100-watt HPS luminaries on each side of the road. Existing cobrahead streetlights were extinguished. During the 2001 sea turtle nesting season, we did "arena" experiments (simulated hatchling emergences from a nest) on the beach when (i) only the filtered HPS streetlights were on, (ii), only the embedded/louvered lights were on, and (iii) all lights were turned off. Hatchling orientation was disrupted when the streetlights were on, but not when the embedded/louvered lights were on. Hatchling performance when all lights were off matched their performance when the embedded/louvered lights were on. However even under the best of conditions (all roadway lights off), hatchling orientation was less accurate than at a totally dark beach, probably because of extraneous lighting from developed areas inland, and to the North and South. We conclude that embedded/louvered lighting is superior to HPS-filtered lighting as a method to protect sea turtle hatchlings at nest sites near coastal roadways.

Magnetic orientation behavior of hatchling loggerheads disrupted by magnets that produce distortion weaker than the geomagnetic field strength

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Laboratory experiments have revealed that sea turtles can garner both directional and positional information from the earths magnetic field. Recent experiments have shown that a magnet with an intensity stronger than the earths ambient field can disrupt this ability in hatchling loggerheads; it is believed that this behavioral change is the result of a disruption in the direction-finding sense of these turtles. In the current study, the orientation ability of loggerhead hatchlings bearing magnets which produced distortions at least an order of magnitude less than the strength of the earths field at various possible locations of a putative magnetoreceptor were tested. Control turtles which bore magnetically-inert brass bars were significantly oriented in the predicted eastward direction whereas turtles which bore magnets on the head, mid-carapace, or posterior carapace were randomly orientated. These results indicate that even a relatively small magnetic field distortion can disrupt normal magnetic orientation behavior; this change in behavior may be the result of an influence on the position-finding sense of these turtles.

Impact of fire ant stings on sea turtle hatchling survival

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INTRODUCTION

The most destructive exotic ant species in the United States is the red imported fire ant, *Solenopsis invicta*, which arrived in Alabama by ship from South America less than 80 years ago. This predaceous ant has spread across the southeast US from Texas to North Carolina, killing off native invertebrates and vertebrates and causing tremendous economic damage. *S. invicta* has a growing reputation as a killer of hatchling birds and ground-nesting reptiles. Allen et al. (1997, 1998, 2001) found increased mortality and detrimental effects on hatchling alligators, red-eared sliders, and red-bellied turtles when exposed to fire ants.

Most sea turtle nesting areas on the East Coast of the US are now infested to varying degrees with *S. invicta* (Allen et al. 2001). Hatching sea turtles are particularly vulnerable to attack by ants after pipping but before complete emergence from the nest. Fire ants respond rapidly and aggressively to food source cues such as mucus and moisture and often invade nests and attack the emerging hatchlings. The venom injected results in formation of a white pustule within 24-48 hours. Alkaloids and proteins present in the fire ant venom cause a local sting site reaction and may cause subsequent allergic responses. In humans, the venoms also display vasoactive, hemolytic and neurotoxic properties. Lesions may lead to skin necrosis, secondary infections and sepsis (Goddard et al. 2000).

A study of ant distribution and within-nest mortality during year 2000 nesting season at Juno Beach, Florida, found ant infestations at 62.5% of marked nest sites, with a significant correlation of ant infestation with proximity to dune vegetation. Four species of predatory ants were identified in nest areas: *S. invicta*, *Pheidole megacephala*, *S. geminata*, and *Wasmannia auropunctata*. Nests with more than 100 ants at the bait had 57% more dead hatchlings (pipped or hatched) found within the nest during post-emergence monitoring, compared to nests without ants (Wetterer et al., in press).

The impact of ants on hatchlings, however, is not limited to within-nest mortality. Hatchlings stung while pipping or emerging may suffer increased mortality directly due to envenomization and subsequent infection, or indirectly via misorientation and increased beach and at-sea predation due to decreased vigor. Our study is the first to examine this source of mortality in sea turtles.

METHODS

From August through October 2001, we studied hatchling loggerhead turtles (*Caretta caretta*) obtained either by opportunistic collection on Juno Beach (n=72) or via the hatchling rehabilitation tank at Marinelife Center of Juno Beach (n=35). Hatchlings were weighed, measured (straight carapace length), marked with nail polish for identification, and examined for lesions caused by ant stings, which began to be visible within 24-48 hours of collection. We recorded lesion locations and photographed them. Hatchlings displaying physical or neurological defects were excluded from the analysis. All hatchlings were maintained in a common outdoor seawater pool at the Marinelife Center in Juno Beach. Hatchlings were monitored every other day during their study periods for weight, length, survival, and changes in locations and severity of lesions. After ten days in the study, all hatchlings in apparent good health were scheduled for release (delivery to offshore feeding grounds via boat). The minimum number of monitoring days experienced for released hatchlings was twelve days.

RESULTS

Ants on nests. Twelve of nineteen excavated nests (63%) had ant activity in the nest area during excavation; eight (42%) had *S. invicta* present. Other, non-predatory ant species included *Dorymyrmex bureni* and *Paratrechina bourbonica*. All three ant samples taken on dead hatchlings contained only S. invicta. Lesions developed only on hatchlings taken from nests with *S. invicta* present.

Number and location of ant stings. We noted 139 separate white lesions apparently due to fire ant stings, on 50 hatchlings (mean=2.8 per hatchling). Overall, 82% of the stings were on rostral parts of hatchlings: snout, chin, head, eye, neck, and leading edge of the foreflippers ("wrist"). Only 18% were found on caudal areas: rear flipper, feet, axillae, tips of foreflippers (see Fig. 1). This pattern is consistent with ant attacks at the beach surface as hatchlings vertically migrate from the egg cavity.

Mortality of stung hatchlings. We found increased mortality in stung (n=50) versus unstung (n=57) hatchlings, a difference that increased over the 12 day rehab period: at four days (20% vs. 9%; p=0.1); at six days (28% vs. 12%; p<0.05);and at 12 days (77% vs. 44%; p<0.025).

DISCUSSION

Our analysis suggests that ant predation is a significant contributor to hatchling mortality during the first twelve days of post-nest life. The marked increase in mortality noted for stung hatchlings between six and twelve days may be the result of infections secondary to the ant lesions. Additional data from siblings with known history is needed to confirm the study's findings.

During the next nesting season, we plan to continue this research and obtain larger samples of sibling hatchlings for comparisons of vigor, orientation and survival. In the future, we wish to investigate other possible sources of post-emergence mortality related to fire ant stings, evaluating whether: (1) invasion of nests by ants may induce premature or diurnal emergence of hatchlings seeking to escape, increasing risk of hyperthermia and predation; (2) ant stings and soft tissue damage may disrupt normal visual orientation and/or divert attention from orientation to escape activities; (3) damage to soft tissues and flippers may decrease hatchling vigor and negatively affect navigation once hatchlings are launched into the waves; (4) feeding behavior may be impacted, lowering growth and vigor; and (5) there is increased risk of secondary infections and necrotic lesions.

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LITERATURE CITED

Allen, C.R., et al. 1994. Red imported fire ant impact on wildlife: an overview. Texas J. Sci. 46:51-59.
Allen, C.R., et al. 1995. Red imported fire ant impact on Northern Bobwhite populations. Ecol. Appl. 5:632-638.
Allen, C.R., et al. 1997. Effect of red imported fire ant envenomization on neonatal American alligators. J. Herp. 31:318-321.
Allen, C.R., et al. 2001. Effects of fire ants (Hymenoptera: Formicidae) on hatching turtles and prevalence of fire ants on sea turtle nesting beaches in Florida. Flor. Entom. 84:250-253.
Goddard, J., et al. 2000. Evolution of the Fire Ant Lesion. JAMA 284, No.17.
Moulis, R.A. 1997. Predation by the imported fire ant (*Solenopsis invicta*) on loggerhead sea turtle (*Caretta caretta*) nests on Wassaw National Wildlife Refuge, Georgia. Chel. Conserv. Bio. 2:433-436.
Regan, S.R., et al. 2000. David and Goliath retold: fire ants and alligators. J. Herp. 34:475-478.
Wetterer, J.K. and L.D. Wood. In press. Distribution and impact of ants on a sea turtle nesting beach in Palm Beach County, Florida. In: M. Coyne, comp. Proceedings of the Twenty-first Annual Symposium on Sea Turtle Biology and Conservation. Philadelphia, Pennsylvania.
Wilmers, T.J., et al. 1996. Imported fire ants (*Solenopsis invicta*): a growing menace to sea turtle nests in Key West National Wildlife Refuge. In: J.A. Keinath, D.E. Barnard, J. Musick, and B.A. Bell, comps. Proceedings of the Fifteenth Annual Symposium on Biology and Conservation. NOAA Tech. Memo. NMFS-SEFSC-387. p. 341-343.

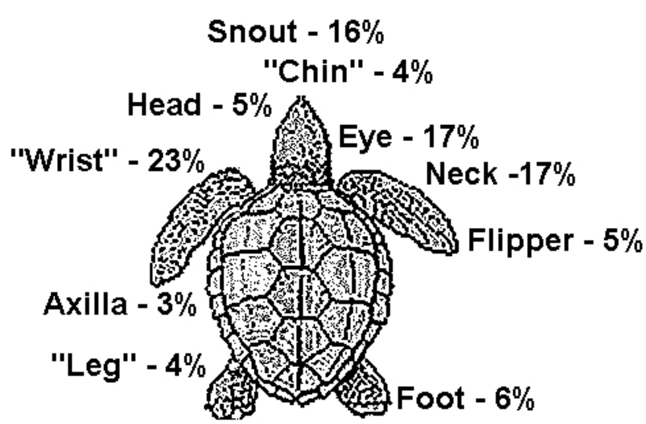

Fig. 1. Percent of total stings observed by location.

Feeding ecology of the East Pacific green turtle (*Chelonia mydas agassizii*), in Bahía Magdalena, B.C.S. México

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INTRODUCTION

Numerous studies have suggested that lagoons of the Baja California peninsula are important area for the feeding and development of East Pacific green turtles, (black turtles; *Chelonia mydas agassizii*) (Cliffton et al. 1982, Márquez 1990, Seminoff 2000, Seminoff et al. 2002). However, to date most of the information available on black turtle feeding habits comes from studies conducted in the Gulf of California, and generally these data only represent collections from one season (summer). Very little information is available comparing turtle feeding habits in different regions, and no studies have established whether there are seasonal changes in the turtle's use of available food resources. This information is needed to better interpret the biology and ecology of *C. m. agassizii* throughout the region and can promote a better understanding of which resources are most important to the species thereby facilitating identification of its critical habitats.

The objectives of this study were to (1) determine variation of feeding habits among different geographic locations, (2) monitor fluctuation in feeding habits with season, and (3) determine whether turtles are feeding selectively or opportunistically on the available resources within the region.

MATERIALS AND METHODS

Study Site. Bahía Magdalena, a 1390 km^2 bay is located on the Pacific coast of the Baja California Peninsula, Mexico (24°15'N- 25°20'N and 111°20'W-112°15'W). As a result of seasonal marine upwelling it is a highly productive lagoon that is sheltered from Pacific waters by two barrier islands, Magdalena Island and Margarita Island (Sanchez-Rodriguez 1996). In this area, large seagrass meadows and macroalgae beds are thought to provide a wide variety of food resources for mature and immature black turtles.

Stomach Content Analyses. The feeding habits of black turtles in Bahía Magdalena and the adjacent waters of the Pacific were assessed by analyzing turtle stomach contents obtained as a result of incidental fishing mortality. Comparisons of the stomach contents were performed among locations and seasons. Seasons were defined as follows: Winter- December 21 to March 20; Spring- March 21 to July 20; Summer- July 21 to September 20; Fall- September 21 to December 20. Volume percentages were arcsine square root transformed for statistical analyses and then a two-way ANOVA was conducted between localities and principal diet components. A Tukey HSD multiple comparison test was used when significant differences were detected from the ANOVA.

Vegetation Transects. Each season (summer, fall and winter), the percent bottom cover of the marine vegetation was estimated along three 50-m transects (perpendicular to the coast) at two different locations in a region known as Banderitas, where turtles were commonly present. Along each transect, the vegetation was collected from five randomly selected 0.25 m^2 quadrants. The biomass and relative percent volume of each plant species was recorded for each quadrant.

Gastric Lavage Samples. In order to confirm that the feeding areas of the turtles caught incidentally by fisheries were similar to the region were the transects were conducted, gastric lavage samples were collected from a small number of live turtles captured in Banderitas in winter as part of a larger monitoring study. Nets were set during a 24-h period once per month from January to March at the same location and physical data were recorded for each turtle captured. The esophageal flushing of recently ingested food items was performed immediately after capture following protocols described by Forbes and Limpus (1993). All dietary samples were fixed in a 4% formalin solution in clean seawater.

RESULTS AND DISCUSSION

Stomach Content Analyses. Digestive tract contents of 17 black turtles were analyzed; 9 from turtles captured within Bahía Magdalena and 8 from the adjacent waters of the Pacific. Table 1 shows the composition of the diet of each turtle stomach analyzed. The diet of these turtles was made up of 13 different plant species and 1 crustacean species. Similar species of algae were commonly indistinguishable due to maceration so the Gracilariaceae grouping was composed of *Gracilariopsis lemaneiformis* and *Gracilaria pacifica*.

Location Comparison. The stomachs contents from turtles captured in different regions (Pacific and Bahía Magdalena) tended to have different characteristic assortments of species. Significant differences were detected in the mean relative volumes of different food items at the two localities ($F=8.72$, $P<0.0001$). In Bahía Magdalena the stomach contents were dominated by the red algae of the family Gracilariaceae (60% of the mean volume of stomach samples), which was absent on the stomachs analyzed from the Pacific. Stomachs collected from turtles in the Pacific waters were dominated by *Phillospadix torreyi* and the red alga *Gelidium robustum* which accounted for an average of 58.3% and 25.7% respectively (Table 1). Stomach samples from the Pacific waters had significantly greater amounts of the sea grass *P. torreyii* (Tukey HSD test, $p=0.005$) than samples from Bahía Magdalena, while *Zostera marina* was only found in turtles stomachs from Bahia Magdalena. One of the noteworthy findings from a turtle collected in this region was a stomach that contained more than 82% red crabs (*Pleuroncodes planipes*) (Table 1). To our knowledge, this is the first record of a black turtle (SCL=54.4 cm) is feeding predominantly on crustaceans.

Comparing these findings with data from diet samples of black turtles from the Gulf of California (Bahía de los Angeles and the Infiernillo Channel) we can see that Pacific turtles captured outside Bahía Magdalena fed primarily on seagrass similarly to those from the Infiernillo Channel (Felger and Moser 1973). Turtles in the Infiernillo consume large quantities of *Z. marina*, whereas turtles feeding in the adjacent Pacific waters near Bahía Magdalena consume greater amounts of *P. torreyii*. Even though *Z. marina* is abundant in Bahía Magdalena, black turtles within this region fed predominantly on red algae of the family Gracilariaceae similar to turtles from Bahía de los Angeles in the Gulf of California (Seminoff 2000, Seminoff et al. 2002).

Seasonal Comparison. In stomach samples collected from turtles captured within Bahía Magdalena, Gracilariaceae red algae were the dominant food item in every season except Spring (Fig. 1), at which time Gracilariaceae was absent and *Z. marina* was the prevalent diet constituent. No evidence of differences in the consumption of Gracilariaceae was found between the other seasons. In the stomach contents from turtles of the Pacific waters, *G. robustum* was present with the highest relative volumes in Fall and was absent in the other seasons, while *P. torreyi* was the most prevalent species in Winter, Summer and Spring (Fig. 2).

Vegetation Transects. Fifteen plant species were identified along the transects belonging to 3 different taxonomic groups (Chlorophyta, Rhodophyta and Phaeophyta). *Amphiroa* sp. Was dominant during the three seasons, followed by *G. pacifica* during Fall (40%) and Winter (15%). The number of species was higher in Winter (11 species) in which the red algae was the dominant taxonomic group (*Amphiroa* sp., *G. pacifica*, *G. textorii* and *Aspagaropsis taxiformis*).

Gastric Lavage Samples. The dominant species collected in the gastric lavage samples of live turtles captured in the Banderitas channel was *G. textorii* and *G. pacifica*. This was consistant with the stomach contents recovered in winter from turtles captured incidentally in Bahía Magdalena (principally species of the family Gracilariaceae) and the dominant algae observed during the winter quadrants (*Amphiroa* sp., *G. pacifica* and *G. textorii*). Data from other seasons will help us to corroborate whether black turtles within the region are feeding selectively or opportunistically on the resources available.

CONCLUSIONS

Black turtles from Bahia Magdalena and adjacent Pacific waters consume different food resources. The diversity of species consumed in Bahía Magdalena was greater than that of turtles feeding in adjacent Pacific waters. Seasonal variation in the consumption of species was found in Bahía Magdalena and adjacent Pacific waters. Major food items recovered in gastric lavage samples from Banderitas during winter were similar to those found in stomachs from turtles captured incidentally within Bahía Magdalena and were consistent with the algae sampled from quadrants in Banderitas.

Acknowledgements. We would like to thank Rodrigo Rangel, WILDCOAST, and the monitoring group of San Carlos for their assistance with field work activities. We also thank Elisa Serviere, Litzia Chavez and Noe Santamaria-Gallegos for their assistance with the identification of vegetation samples. Financial support to attend the Symposium was generously contributed by The David and Lucile Packard Foundation and Centro de Investigaciones Biologicas del Noroeste, S.C (CIBNOR).

LITERATURE CITED

Ciffton, K., D.O. Cornejo, and R.S. Felger. 1982. Sea turtles of the Pacific coast of México. In: K.A. Bjorndal, ed. Biology and Conservation of Sea Turtles. Smithsonian Inst. Press, Washington, D.C. p. 199-209.

Felger, R.S. and M.B. Moser. 1973. Eelgrass (*Zostera marina*) in the Gulf of California: discovery of its nutritional value by the Seri Indians. Science 181:355-356.

Forbes, G. and C. Limpus.1993. A non-lethal method for retrieving stomach contents from sea turtles. Wildlife Research 20:339-343.

Márquez, M.R. 1990. FAO species catalogue. Vol.11: Sea turtles of the world. An annotated and illustrated catalogue of sea turtle species known to date. FAO Fisheries Synopsis. No 125, Vol. 11. Rome, FAO. 81p.

Sánchez-Rodríguez, I., C. Fajardo and O. Pantoja. 1989. Estudio florístico estacional de las macroalgas en Bahía Magdalena, BCS., México. Inv. Mar. CICIMAR 4:35-48.

Seminoff, J.A. 2000. Biology of the East Pacific Green turtle, *Chelonia mydas agassizii*, at a warm temperate feeding area in the Gulf of California, Mexico. Unpubl. Ph. D. Dissertation. University of Arizona. 249 p.

Seminoff, J.A., A. Resendiz, and W.J. Nichols. 2002. Diet of the East Pacific green turtle (*Chelonia mydas*) in the Central Gulf of California, México. Journal of Herpetology 36:447-453.

Table 1: Mean percent sample volume (%V) and frequency of occurrence (% F) of prey groups recovered from stomachs analyzed from Bahía Magdalena (n=9) and adjacent Pacific waters (n=8). (T=occurs in trace levels), (* grouping for *Gracilariopsis lemaneiformis* and *Gracilaria pacifica*)

Species	B. Magdalena			Pacific		
	%V	F	%F	%V	F	%F
Rhodophyta						
Gelidium robustum	-	-	-	26	3	38
Pterocladia sp.	-	-	-	10	3	38
Gracilariaceae *	**56**	**7**	**78**	-	-	-
Gracilaria textorii	1.3	1	11	-	-	-
Rhodymenia sp.	T	1	11	-	-	-
Gigartina sp.	3.3	1	11	-	-	-
Chlorophyta						
Codium sp.	6.3	5	56	5.4	2	25
Iridaea flaccida	2.7	1	11	-	-	-
Ulva sp.	T	1	11	T	1	13
Phaeophyta						
Sargassum sinicola	0.7	1	11	-	-	-
Seagrass						
Phyllospadix torreyi	1.4	1	11	**58**	**7**	**88**
Zostera marina	12	4	44	-	-	-
Mangrove						
Avicennia germinans	9.1	2	22	-	-	-
Crustaceans						
Pleuroncodes planipes	9.2	1	11	-	-	-
Unidentified matter	2.1	1	11	-	-	-

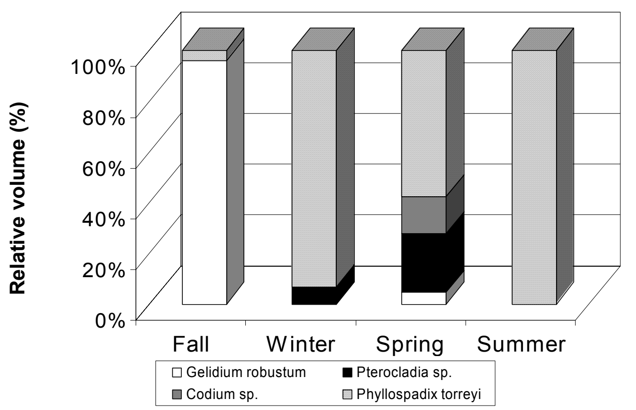

Fig. 1. Seasonal variation in the diet of black turtles captured along the Pacific coast adjacent to Bahia Magdalena, México. Values represent relative volume as a percentage of the total stomach contents. n= 2, 2, 3, and 1, in fall, winter, spring and summer, respectively.

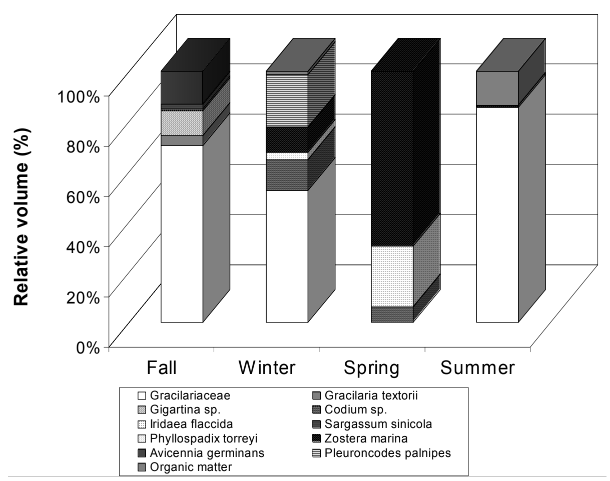

Fig. 2. Seasonal variation in the diet of black turtles captured within Bahía Magdalena, México. Values represent relative volume as a percentage of the total stomach contents. n= 3, 4, 1, and 1, in fall, winter, spring and summer, respectively.

Nesting activity of leatherback turtles (*Dermochelys coriacea*) in relation to tidal and lunar cycles at Playa Grande, Costa Rica

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INTRODUCTION

Sea turtles must select their nightly and monthly nesting times carefully in order to avoid dangerous and energy-wasting factors such as too much light (overheating, visibility to predators) or low tidal height (long distance to crawl). Using data from the 2000-2001 nesting season, we aimed to describe circatidal and circalunar nesting patterns of leatherback females at Playa Grande, Costa Rica (Parque Nacional Marino Las Baulas, Pacific coast). We hypothesized that nesting would be aggregated around the nighttime high tide, and that remigrant females (nested in a previous season) would select a more optimal time due to experience. Previous analyses show that for the '97-'98 and '98-'99 seasons, remigrants were significantly larger, laid more clutches per season and arrived earlier in the nesting period than new turtles (Reina et al. 2002). Costa Rican folklore holds that turtles are frightened of bright moonlight, and so avoid full moons. To the contrary, the only published study of the role of moon phase in leatherback nesting (from French Guiana, Atlantic coast) found the opposite trend: that there are more turtles during spring tides, i.e. new and full moon (Girondot and Fretey 1996). We tested for the effect of moon phase/spring tides at Playa Grande based on the methods used in French Guiana.

METHODS

From 4 October 2000 to 10 February 2001 we made nightly patrols of the beach, collecting a total of 2,835 observations of turtle activity. Eight years of PIT tag data allowed us to differentiate between new (untagged) and remigrant turtles.

RESULTS

Circatidal patterns. The relationship between nightly high tides and turtle nesting activity was flexible with a weak positive correlation when there was one tidal peak during the dark period and no correlation when two peaks occurred close to dawn and dusk (Fig 1). Crawling up the beach is a highly energy demanding activity (Paladino et al. 1996), and the effort expended increases with the distance the turtle has to crawl, which may be one reason why turtles avoid the low tide. Turtles emerged on average 52 minutes before high tide and laid 10 minutes before high tide, but these behaviors showed wide time distributions (Fig. 2). Turtles may be avoiding crowding, (which would have been more important in pre-disturbance, dense nesting populations) but we must also consider that they are not accurate at detecting high tide. New and remigrant turtles did not differ in their selection of emergence or laying time, nor was there a significant difference between a turtle's first and subsequent attempts, suggesting that timing in relation to high tide is not a behavior perfected with experience (Table 1).

Circalunar patterns. We tested for the effect of moon phase on internesting interval using the method employed by Girondot and Fretey (1996). Observations were divided into two groups: A, turtles having nested 14 to 11 days prior to a new/full moon, and B, 9 to 6 days before. The distribution of internesting intervals for each group was determined (truncated at 15 days to assure only successive nestings were included in the analysis) and means compared. Girondot and Fretey (1996) showed that leatherback females nesting in French Guiana adjust their internesting return date to be closer to full or new moons, which explained fortnightly peaks in nesting activity observed on Ya:lima:po beach. The mean internesting interval at Playa Grande is the same as that in French Guiana (9 days, Fig. 3), and yet our study found no alteration of individual nesting rhythms in relation to moon phase (G^2=11.63, p=0.07). At Playa Grande the spring tide can be offset from full/new moon by up to 2 days. We regrouped the data to account for this effect and also found no difference (G^2=7.2, p=0.3). Our sample size was 3.3 times smaller than in French Guiana. If the distribution for French Guiana is set up for the same number of observations as in Costa Rica, no significant trend is detected. The subtle but highly significant pattern exhibited in French Guiana was in fact only seen on a part of the beach where fluvial currents inhibit turtle arrival (Girondot and Fretey 1989). At Apo'tili, which is a beach exposed only to oceanic currents, like Playa Grande, the pattern was not recorded. We think that it is most likely that the higher number of turtles during full/new moon in French Guiana has to do with the stronger 'carrier effect' of the incoming spring tide (as posited by Girondot and Fretey 1989), rather than any active effort by turtles to seek a particular moon phase. More data from both these (and other) beaches will have to be analysed before anything definitive about circalunar behavior in leatherbacks can be said.

CONCLUSION

Our results showed that leatherback turtles exhibit a weak, but predictable positive response to nightly high tide time, but no circalunar behavior could be detected at Playa Grande.

LITERATURE CITED

Fretey, J. and M. Girondot. 1989. Hydrodynamic factors involved in choice of nesting site and time of arrivals of leatherbacks in French Guiana. In: S.A. Eckert, K.L. Eckert, and T.H. Richardson, comps. Proceedings of the Ninth Annual Workshop on Sea Turtle Biology and Conservation. NOAA Tech. Memo. NMFS-SEFSC-232. p. 227-229.

Girondot, M. and J. Fretey. 1996. Leatherback turtle, *Dermochelys coriacea*, nesting in French Guiana, 1978-1995. Chel. Cons. Biol. 2:204-208

Paladino, F., J. Spotila, M. Connor, and R. Gatten. 1996. Respiratory physiology of adult leatherback turtles (*Dermochelys coriacea*) while nesting on land. Chel. Cons. Biol. 2:223-229

Reina, R., P. Mayor, J. Spotila, R. Piedra and F. Paladino. 2002. Nesting Ecology of the Leatherback Turtle, (*Dermochelys coriacea*), at Parque Nacional Marino Las Baulas, Costa Rica: 1988-89 to 1999-00. Copeia 2002:653-664.

Table 1. Comparison of new and remigrant turtles: emergence and laying times in relation to high tide time and comparison of first and subsequent nestings within the group of new turtles in 2000-2001.

1a: New vs. remigrant turtles: Nesting times in relation to high tide compared

	TYPE	TIME*	n**	p-value***
EMERGENCE	New	-00:46:43	309	0.56
	Remigrant	-00:55:09	424	
	Overall	-00:51:33	733	
LAYING	New	-00:13:47	461	0.32
	Remigrant	-00:06:00	526	
	Overall	-00:09:38	987	

1b: New turtles: First time vs. subsequent nestings compared

	TYPE	TIME*	n**	p-value***
EMERGENCE	First time	-01:11:25	63	0.2
	Subsequent	-00:40:23	246	
	Overall (new)	-00:46:43	309	
LAYING	First time	-00:24:43	90	0.27
	Subsequent	-00:10:41	371	
	Overall (new)	-00:13:47	461	

* Mean time before high tide (hh:mm:ss)
** Number of observations of each nesting activity
*** Mann Whitney U

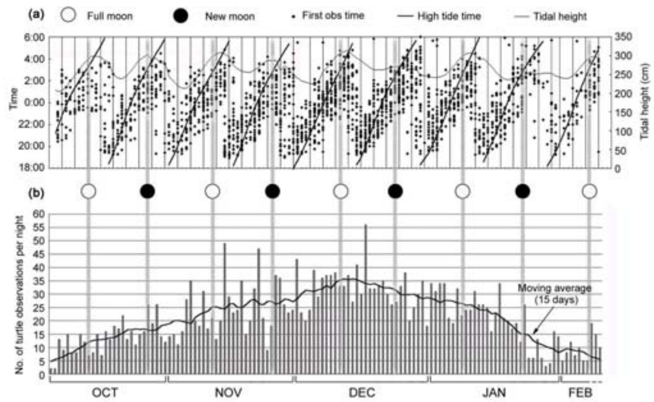

Fig. 1. Overview of leatherback nesting patterns for 2000-2001 season. The upper graph (a) shows turtle activity loosely clustered around high tide line. The lower graph (b) shows gradually increasing turtle activity until December, followed by a gradual decline, with no evident peaks on nights of full or new moon (indicated by thick vertical line).

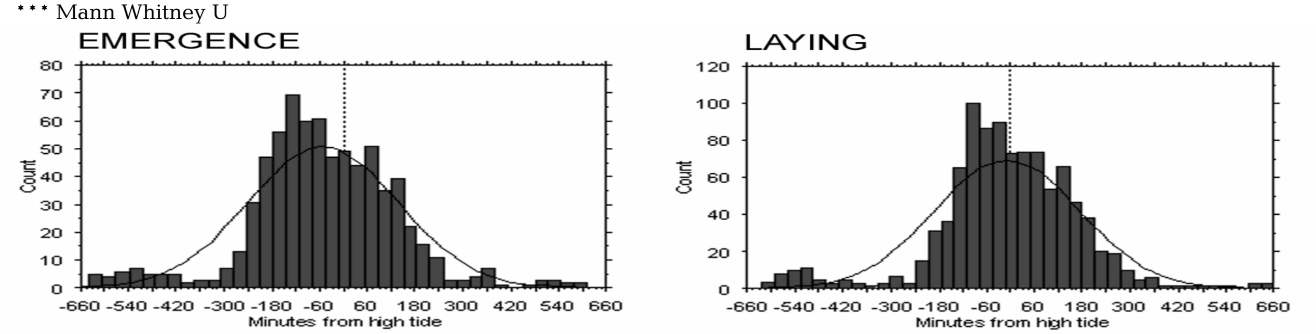

Fig. 2. Distribution of emergence (n=733, SD=189 min) and laying (n=987, SD=182 min) times according to high tide time.

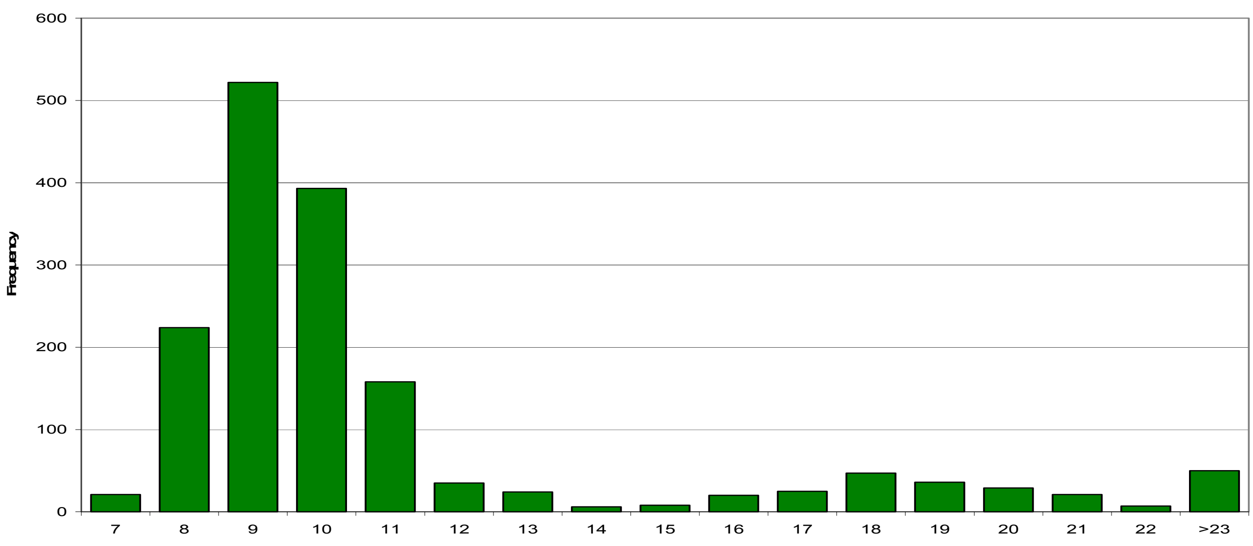

Fig. 3. Distribution of internesting intervals for 2000-2001.

Influence of tide variations on the emergences of *Caretta caretta* on the Island of Boavista (Cape Verde, West Africa)

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INTRODUCTION

The island of Boavista (Republic of Cape Verde, Western Africa) is located in front of Senegal (Fig. 1). Here we find one of the most important nesting colonies of *Caretta caretta* in North Atlantic Ocean (López-Jurado and Andreu 1998). Reproduction biology of this population is been a part of a conservation effort since 1998. Although the relationship between tides and emergences of sea turtles follows a pattern that depends on several factors as the slope of the beach (Frazer 1983, Le Buff 1990) we have tried to determine, as a preliminary approach, if the emergences of loggerheads in Boavista are influenced by the tidal stage, independently of the slope of the beach.

MATERIALS AND METHODS

Along 2001 nesting season, 1045 female loggerheads were sighted emerging from the sea for nesting during night patrols in the southeastern beaches of Ervatão and Ponta Cosme. Apart from data relative to other studies (biometry, clutch size and others) the time of emergence of each female was annotated. Data on tidal stages used in this work were provided by the Instituto Hidrografico Portugues (IHP 2001). The major port in Cape Verde archipelago is Porto Grande, located in the island of São Vicente (16º50′ N, 25º00′ W) so data were converted to establish the corresponding value for Boavista. On the other hand we categorized arbitrarily the tidal cycle in four stages of three hours each (based on Frazer 1983): low (minimum amplitude), rising (intertidal stage from minimum to maximum), high (maximum amplitude), and falling (intertidal stage from maximum to minimum).

RESULTS

In Fig. 2 we can see the total number of emergences, and the minimum and maximum levels of the sea during the whole nesting season. A high percentage of females emerge when the dead tides begin or finish. We used the period from 5th August to 3rd September to evaluate the possible influences of the tides in female emergences covering a moon cycle. The great number of turtles emerging from the sea occurs when the tide is high (X^2=14.705, df=3, p=0.002; see Table I and Fig. 3). Also the same patterns of emergences is observed in the two different beaches studies, emerging the females mostly on high tide (Table 1).

DISCUSSION

Although further studies must be done in Boavista concerning the influence of tides in female loggerhead emergences (attending factors as slope of the beaches, light intensity and others), as a general trend the results of this work shows us how female loggerheads in Boavista emerge preferably when the tide is high or rising. This agrees with Frazer (1983), working in beaches with a gently slope. We have not measure the slope of our beaches, but at first sight, they appear to have considerably distance between low and high tide lines. As other authors suggest (Carr 1952, Frazer 1983, Le Buff 1990) when the tide is high the distance a turtle travels to find the nest site is lower, with less expenditure of energy.

Acknowledgements. We thank all the volunteers and people from Boavista who helped in this work, especially Pedro López and Ana Pereira, and Angelo Santana del Pino for statistical advice.

LITERATURE CITED

Frazer, N.A. 1983. Effect of tidal cycles on loggerhead sea turtles (*Caretta caretta*) emerging from the sea. Copeia 1983:16-519.

Instituto Hidrográfico Portugues. 2001. Tablas de Mareas 2001 ara Paises africanos de lengua oficial portuguesa o macau puertos de Cabo Verde, Guinea-Bissau, S. Tomé y Principe, ngola y Mozambique).

LeBuff Jr., C.R. 1990. The loggerhead turtle in the Eastern Gulf of Mexico. Sanibel Island, Florida.

López-Jurado, L.F. and A.C. Andreu. 1998. *Caretta caretta* (Linnaeus 1758), In: A. Salvador, ed. Reptiles. Fauna Ibérica, Vol. 10. Museo Nacional de Ciencias Naturales, CSIC, Madrid. p. 44-56.

Carr, A. 1952. Handbook of Turtles. Cornell U. Press, Ithaca, New York.

Table 1. Number of emergences of *Caretta caretta* during 2001 season in Boavista by the four tidal stages established in the three beaches studied.

Tidal stage	Ervatão	Ponta Cosme	Total
Low	30	37	67
Rising	42	58	100
High	66	65	131
Falling	45	44	89
Total	183	204	387

Fig. 1. Map showing the location of the Cape Verde archipelago and Boavista.

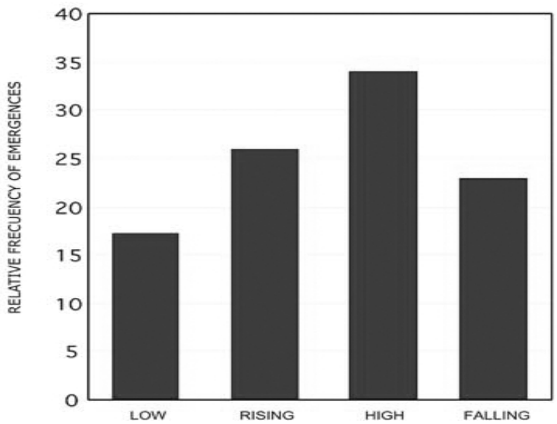

Fig. 2. Distribution of the emergences of *Caretta caretta* in Boavista during the 2001 nesting season and amplitude of the tides along the summer.

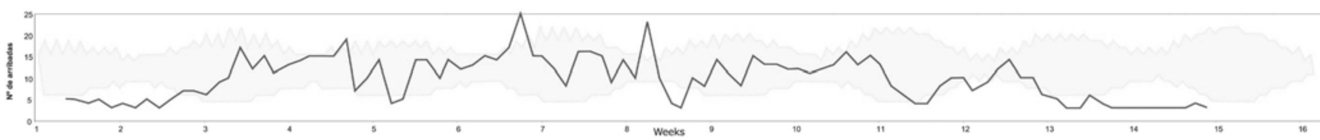

Fig. 3. Distribution of the emergences of *Caretta caretta* during 2001 season in Boavista by the four tidal stages established.

Disorientation of the green turtle, *Chelonia mydas*, during nesting exercise relative to some physical and human factors at Ras Al-Hadd Reserve, Oman

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INTRODUCTION

The mechanism of orientation relative to sea finding in sea turtles, especially in hatchlings has been studied under different experiments relative to light cues, wavelength, light angle and light intensity (Mrosovsky and Kingsmill 1985, Witherington and Bjorndal 1991a, 1991b, Witherington 1992, Lohmann et al. 1997). Many of the disorientation studies on hatchlings can also be related to adult turtles. For example, the use of artificial light during nesting can cause disorientation in adult turtles and also sea-finding behavior which is guided by light cues (Witherington and Martin 1996).

A five-year survey was conducted on the green turtles, *Chelonia mydas*, became disoriented while performing their nesting exercise, and consequently, were stranded on the beaches. The green sea turtles in Oman nest year-round, with a high density nesting period between June and October and low density period between November and May. The purpose of this study is to investigate the causes of disorientation in the nesting turtles at specific selected sites at Ras Al Hadd Reserve.

METHODS

Study Area. Ras Al-Hadd Reserve is a 45 km coastal strip on the Gulf of Oman and the Arabian Sea, with over 20 major beaches that extend from Al-Jarama Bay to Ras Ar Ruays (see Map 1). It is located between 22° 14`N and 22° 32`N and 59° 45`E and 59° 48` E. The majority of these beaches are isolated at the back and sides by rocky hills, with a crescent shape configuration. As a result, each beach is completely separated from the adjacent beaches. The dimensions of the major beaches ranges between 1.0-7.0 km shoreline length and 50-100 m in width, while the minor beaches have dimensions of 50-100 by 10-40 m. However, the turtles only use an area of about 50 m from the tidal zone for nesting. The beaches have deep and open sandy offshore approaches, which are free of submerged rocks except in a few areas. Most of the beaches consist of soft sand with gentle slopes (0.5-5.0 m), free of rocks or major barriers, and with sparse or no vegetation. The beaches are exposed to moderate or high energy wave action. The four selected sites are: Site 1. Is called Ras Al-Jinz, surrounded by rocky hills on back and sides of the beach. The back hills are about 100-150 m from the tide zone. The site is about 1 km where the shoreline is divided by rocky hills in the middle separating the site into north and south sectors. The depth of the nesting area is between 30 and 50 m. Commercial fishing is limited to the south sector and only during November to April. Site 2. Is also called Saih Al-Marai, and like site 1, is well isolated by hills. The depth of the nesting area is 50 m. Sites 3 and 4. These sites have unsheltered beaches, without any hills in back or sides of the beaches. The beaches slope gently from the shorelines and in certain areas, there are steep slopes toward the land sides obscuring the sea horizon completely from the turtle view. The vegetation is sparse or lacking. The shoreline length of both sites extends for 6.90 km and an average depth of 50 m nesting area. Commercial fishing is year-round and extensive.

Procedures. The disoriented turtles were collected around sunrise before temperature rises. A team of rangers from Ras Al-Hadd Reserve drove their vehicles on roads leading from the Reserve to pick up live or dead stranded turtles. The paired test was used to test the statistical significance of the differences between sample means.

RESULTS AND DISCUSSION

The number of disoriented turtles in sites 3 and 4 at Ras Al Hadd Reserve is significantly higher($P> 0.01$) than in sites 1 and 2 during high density nesting period (June-October) despite the higher number of nesting turtles in sites 1 and 2 (Figs. 1,2). A significant decrease in number of nesting turtles occurred in the four sites during low nesting density period (November-May) as the number of disoriented turtles also decreased. Isolated beaches with hills in the background and sides (sites 1 and 2) had significantly ($P> 0.01$) fewer disoriented or dead turtles than unsheltered beaches (sites 3 and 4) (Figs. 1,2). Topography of the beach plays a major role in causing disorientation in green turtles. Sites 3 and 4 are unsheltered beaches without dark barriers in the background and sides. This condition creates difficulties in distinguishing between seaward and landward relative to brightness cues that the turtles depend on in orienting themselves to sea-finding. Based on orientation mechanism for light detection, sea turtle hatchlings depend on wide horizontal range (~180o) and narrow vertical range (~10°) (Witherington 1992). In addition, the perception of brightness depends on wavelength and intensity, with short wavelength attracting a green turtle hatchlings more than long wavelength (Witherington and Bjorndal 1991a). In addition, sea-finding in turtles is based on light intensity discrimination (Witherington 1992).

Excessive use of artificial light particularly by fishermen in sites 2-4 is another major factor that triggers disorientation. Light sources from fishermen's shacks and from village of Ras Al Hadd contributed to the problem of disorientation. Studies on light pollution in other regions also reported that excessive artificial lighting is detrimental to sea turtles (Witherington and Martin 1996). Adult mortality is significantly higher in site 3 and 4 than the other sites (Fig. 2).

In summary, when mean values of the disorientated turtles in the four sites are compared (Table 1), it reveals that site 1 with sheltered beach and low human activity facilitate easier return of the nesting turtles to sea. Consequently, site 1 demonstrated the lowest number of disoriented turtles compared to the other sites. On the other hand, site 2, which has high human activity but with sheltered beach, follows site 1 in low number of disoriented turtles. However, sites 3 and 4, when compared with sites 1 and 2, have significantly higher number of disoriented turtles associated with unsheltered beaches and high human activity. Excess human presence, particularly the use of artificial lighting and lack of unsheltered beach, may have a detrimental impact on the nesting turtles, inflicting severe disorientation. Thus topography and human activity are highly correlated with number of disoriented or dead turtles.

Acknowledgements. This research is supported by grant (IG/SCI/BIOL/01/99), Deanship of Postgraduate Studies and Research, Sultan Qaboos University. Special thanks to Ms. Tanya Anderson, Public Affairs Officer for financial support from the U.S. Embassy, Muscat, Oman.

LITERATURE CITED

Lohmann, J., B.E. Witherington, C.M.F. Lohmann and M. Salmon. 1997. In: P. Lutz and J. Musick, eds. The Biology of Sea Turtles. CRC Press, Boca Raton. p. 107-135.

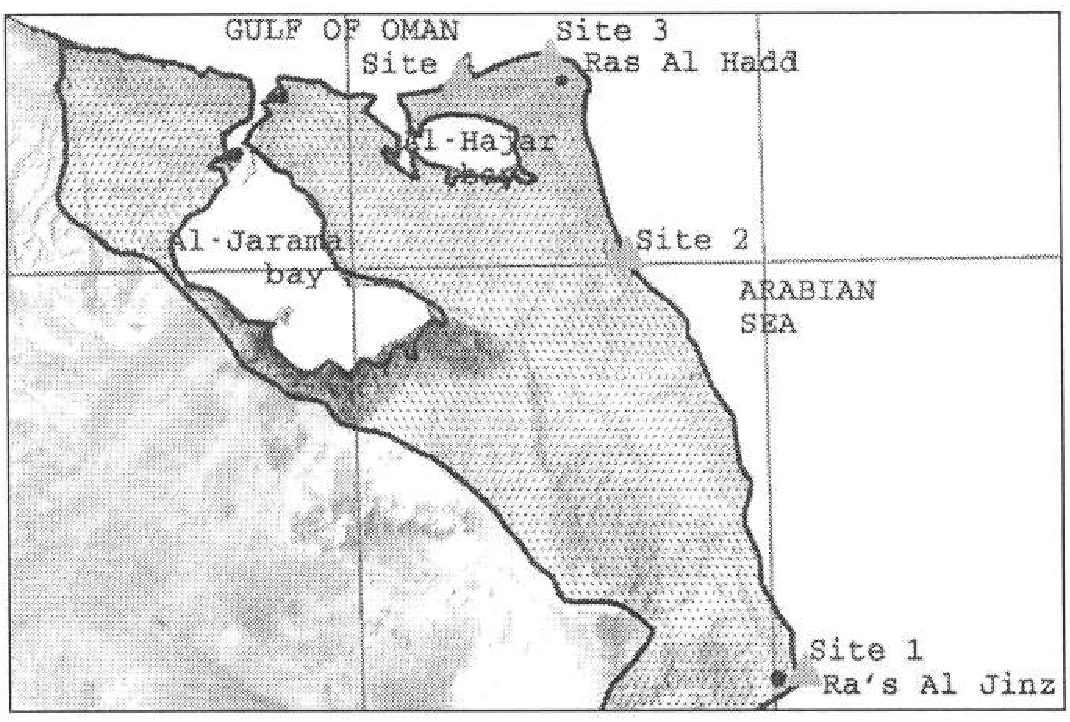
Mrosovsky, N. and S.F. Kingsmill. 1985. How turtles find the sea. Zeitschrift fuer Tierpsychologie 67:237-256.

Witherington, B.E. and K.A. Bjorndal. 1991a. Influences of wavelength and intensity on hatchling sea turtle phototaxis: implications for sea-finding behavior. Copeia 1991:1060-1069.

Witherington, B.E. and K.A. Bjorndal. 1991b. Influences of artificial lighting on the seaward orientation of hatchling loggerhead turtles (*Caretta caretta*). Biological Conservation 55:139-149.

Witherington, B.E. 1992. Behavioral responses of nesting sea turtles to artificial lighting. Herpetologica 48:31-39.

Witherington, B.E. and R.E. Martin. 1996. Understanding, assessing and resolving light-pollution problems on sea turtle nesting beach. FMRI-TR-2, Florida Department of Environmental Protection, St. Petersburg, Florida.



Map of Ras Al-Hadd Reserve

Table 1. Results of paired t-tests of monthly number of disoriented nesting turtles in the four sites relative to human activity and presence or lack of shelter at Ras Al Hadd Reserve, 1995-2000.

Paired sites	*Mean difference*	*SEM*	*P. value*	*Confidence Interval (95% C.I.)*
Site 1 (LHA, SB) vs. Site 2 (HHA, SB)	13.4	12	P<0.006	1.0-5.9
Site 2 (HHA, SB) vs. Sites 3&4 (HHA, UB)	40.6	73	P<0.001	26. 1- 55.1
Site 1 (LHA, SB) vs. Sites 3&4 (HHA, UB)	37.1	69	P<0.001	23.5- 50.8

Key: HHA – high human activity; LHA – low human activity; SB – sheltered beach; UB – unsheltered beach.

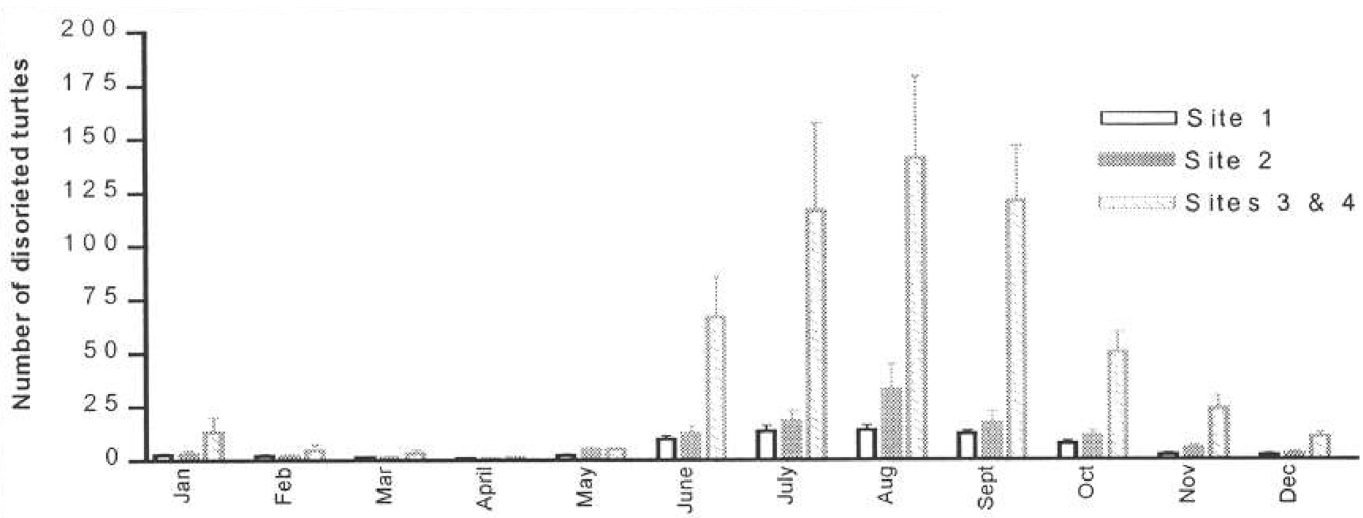


Fig. 1. Monthly average of disoriented green turtles in four sites at Ras Al Hadd Reserve, 1995-2000 (Lines=SE±).

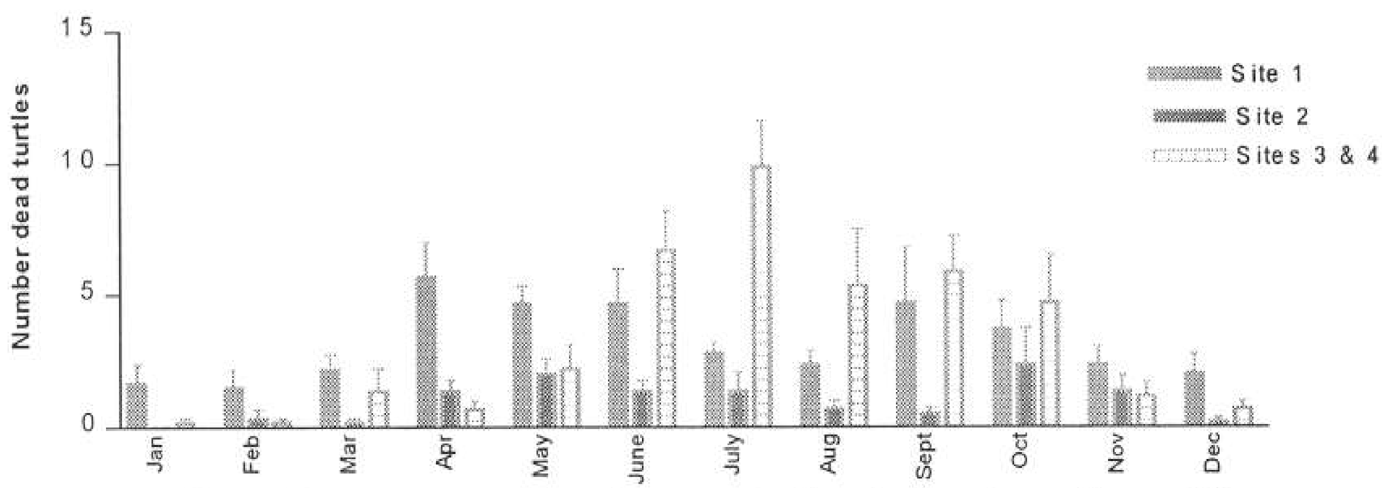


Fig. 2. Monthly average of dead green turtles in four sites at Ras Al Hadd Reserve, 1995-2000 (Lines=SE±).

Nest selection in green turtles, *Chelonia mydas*, relative to physical and biotic factors at Ras Al-Hadd Reserve, Oman

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INTRODUCTION

The major problems that confront the sea turtles the world over is the continuous destruction of major nesting grounds, due to the steady increase in human activities such as sand mining, dredging, beach armoring, fishing activities, beach erosion, pollution and excessive use of artificial light. Studies on nest selection in sea turtles, suggest that in addition to human factors, nesting frequency is influenced by physical and biotic factors. The physical factors include sand texture and softness (Stancyk and Ross 1978, Kikukawa et al. 1999), offshore accessibility to beach (Mortimer 1982), beach dimensions and geomorphology (Mortimer 1982, Johannes and Rimmer 1984) and biotic factors (AlKindi et al. 2001). The purpose of this study is to evaluate the strategy of nest selection by the green turtles at Ras Al-Hadd relative to physical and biotic factors, as well as human activities.

METHODS

Study Area. Ras Al-Hadd Reserve is a 45 km coastal strip on the Gulf of Oman and the Arabian Sea, with over 20 major beaches that extend from Al-Jarama Bay to Ras Ar Ruays (see Map). It is located between 22°32′ N and 22°14′ N, and 59°45′ E and 59° 48′ E. The majority of these beaches are isolated at back and sides by rocky hills, with a crescent shape configuration. As a result, each beach is completely separated from the adjacent beaches. Most of the beaches consist of soft sand with gentle slopes (0.5-5.0 m), free of rocks or major barriers, and with sparse or no vegetation. The beaches are exposed to moderate or high energy wave action. The selected sites of the study area are: Site 1: Is called Ras Al-Jinz, surrounded by rocky hills on back and sides of the beach. The back hills are about 100-150 m from the tide zone. The site is about 1 km where the shoreline is divided by rocky hills in the middle separating the site into north and south sectors. The depth of the nesting area is between 30 and 50 m. Commercial fishing is limited to the south sector and only during November to April. Site 2: Is also called Saih Al-Marai, and like site 1, is well isolated by hills, but the hills are located further back (300-400 m) from the tide zone. The depth of the nesting area is 50 m. Sites 3 and 4: these sites have unsheltered beaches, without any hills in back or sides of the beaches. The shoreline length of both sites extends for 6.90 km and an average width of 50 m nesting area. Commercial fishing is year-round and extensive. The shores of Al-Hajar and Al-Jarama Bays are rocky to sandy or mixed, and the depth of most of the shorelines are narrow, between 5-10 m.

Survey Procedure. Tracks of turtles that laid their eggs (true tracks) and of turtles that failed to lay their eggs (false tracks) were counted daily during early morning while the tracks were still fresh and undisturbed. The paired t-test was used to test statistical significance of the differences between sample means.

RESULTS AND DISCUSSION

The beaches at Ras Al-Hadd share unique physical features that attract thousands of turtles (Fig. 1) to nest year-round (see Description of Study Area under Methods). Based on the data presented in Table 1, the most important physical factor that attracts large numbers of turtles to nest on the beaches of Ras Al-Hadd is the presence of rocky hills in back and at the sides of each beach, sheltering for complete isolation. Population densit (number of turtles/1000 m^2) is significantly higher ($P < 0.001$) in sheltered beaches (sites 1 and 2) than in unsheltered beaches (sites 3 and 4) (Table 1, Fig. 2).

Beaches with excessive human activity (commercial fishing, artificial lighting, coastal development and beach traffic) appear to distract turtles from nesting. Site 1 has the lowest human activity than the other sites and also has significantly higher population density than the others ($P < 0.001$) (Figs 1 and 2). It has been reported that the presence of artificial lights near nesting beaches may deter turtles from nesting (Mortimer 1982, Witherington 1992, Witherington and Martin 1996).

When mean differences of population density between sites 1 and 2 are compared (Table 1), it appears that both sites are sheltered, but human activity is lower in site 1. The data reveal that lower human activity reflects higher population density in site 1 over site 2. However, when two negative conditions exist like the case in sites 3 and 4 (high human activity and unsheltered beaches) and compared to sites 1 and 2, it reveals that the mean difference for population density is significantly higher ($P < 0.001$) in sites 1 and 2 over the other two sites. Percentages of turtles that successfully oviposited their eggs before returning to sea are over 50% in sheltered beaches (sites 1 and 2) and under 50% in unsheltered beaches (sites 3 and 4).

During high density period (May-October), preference for nest selection is low, as high number of turtles (150-200/night in each of sites 1 and 2) compete for nest space and tend to choose any available site. However, during low density period (November-April), preference for nest selection is high, as smaller number of turtles (15-20/night in each of sites 1 and 2) choose the best nesting area without any population pressure. The present data reveal that nesting in sites 2-4 during low density period is significantly lower compared to site 1 (Table 1, Figs. 1,2).

The depth (width) of the nesting beach in each of the four sites is about 50 m and it starts 1-2 m from the tidal zone. Turtles very rarely travel to nest sites beyond 50 m from the tidal zone in both sheltered and unsheltered beaches. Nesting on the shores of the two bays (Al Hajar and Al Jamara) is lacking. The depth of these shores is very narrow (5-10 m) based on data on population density. The length of the shoreline has no significant effect on the population density. The green turtles apparently need wider beach width so the nest can be protected from sea water during high tide. Kikukawa et al. (1996) reported that there is a positive correlation between body pit frequency and beach width which may indicate that the width is important to prevent eggs from inundation.

Other physical features which are present in almost all of the beaches at the Reserve are deep, sandy offshore approaches, without submerged rocks; sandy beaches with gentle slopes without rocks or other barriers on the beach.

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LITERATURE CITED

AlKindi, A.Y.A., I.Y. Mahmoud, and H.R. Khan. 2001. The degree of crowding and its effect on the nesting behavior in the green turtle, *Chelonia mydas*, in Oman. SICB Annual conference, January 2001, Chicago, U.S.A.

Kikukawa, A., N. Kamezaki, and H. Ota. 1999. Factors affecting nesting beach selection by loggerhead turtles (*Caretta caretta*): a multiple regression approach. J. Zool. Lond. 249: 447-454.

Mortimer, J.A. 1982. Factors influencing beach selection by nesting sea turtles. In: K.A. Bjorndal, ed. Biology and Conservation of Sea Turtles. Smithsonian Institution Press, Washington, D.C. p. 45-51.

Stancyk, S.E. and J.P. Ross. 1978. An analysis of sand from green turtle nesting beaches on Ascension Island. Copeia 1978:93-99.

Witherington, B.E. 1992. Behavioral responses of nesting sea turtles to artificial lighting. Herpetologica 48:31-39.

Witherington, B.E. and R.E. Martin. 1996. Understanding, assessing and resolving light-pollution problems on sea turtle nesting beach. FMRI-TR-2, Florida Department of Environmental Protection, St. Petersburg, Florida.

Table 1. Comparison of paired monthly tests of population densities (number of turtles/1000 m^2) in the four sites relative to human activity and presence or lack of shelter at Ras Al Hadd Reserve, 1995-2000.

Paired sites	Mean difference	SEM	P value	Confidence Interval (95%)
Site 1 Site 2 (LHA,SB) vs. (HHA, SB)	17.4	1.72	P<0.001	1420.9
Site 2 Sites 3&4 (HHA, SB) vs. (HHA, UB)	35.6	5.14	P<0.001	25.4-45.9
Site 1 sites 3&4 (LHA, SB) vs. (HHA, UB)	53.0	6.38	P<0.001	40.3-65.8

Key: HHA – high human activity; LHA – low human activity; SB – sheltered beach; UB – unsheltered beach.

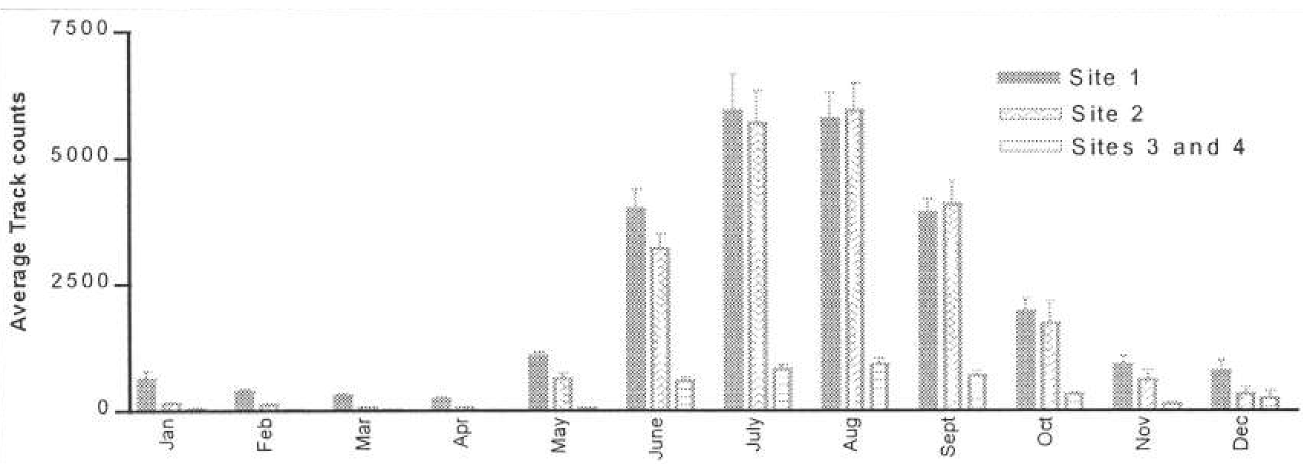

Fig. 1. Monthly average of green turtle tracks (true and false) in the four sites at Ras Al Hadd Reserve, 1995-2000 (Lines=SE±).

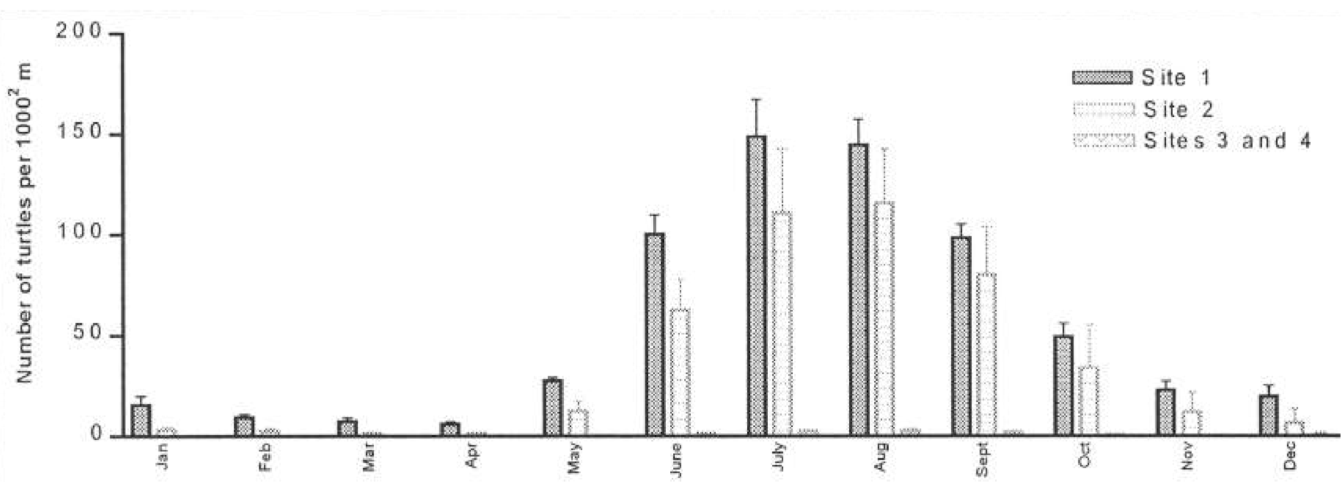

Fig. 2. Monthly densities of turtle tracks per 1000 m^2 for the four sites at Ras Al Hadd Reserve, 1995-2000 (Lines=SE±).

Evidence of homing behavior in juvenile green turtles in the northeastern Gulf of Mexico

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INTRODUCTION

In recent years, scientists have recognized the need to conduct in-water studies in order to better understand the biology of marine turtles. Instead of focusing only on nesting beaches, researchers have begun to focus on near-shore habitat use as well. It is now apparent that juvenile sea turtles rely heavily on the neritic environment as developmental habitat. However, knowledge regarding sea turtle behavior in these areas is lacking. Little is known about navigational abilities, homing tendencies and site fidelity of juvenile sea turtles, especially in the northeastern Gulf of Mexico. In January of 2001 the largest sea turtle stranding event documented in the United States occurred within St. Joseph Bay (Blackwelder 2001). A total of 403 juvenile green, Kemp's ridley, and loggerhead turtles were stranded when water temperatures dropped to 6 C (Summers et al., in press). All stranded turtles were found in the southwestern portion of the Bay. It was unclear if these turtles were residents of St. Joseph Bay or had moved into the Bay during a southerly migration. It was thought that the turtles entered the northern end of the bay during a southern migration and were trapped when no exit was found at the southern end (Foley, pers. comm.). Turtles were transferred to rehabilitation facilities throughout Florida (Summers et al., in press). Upon recovery, rehabilitated turtles were tagged and then released just south of St. Joseph Bay, into the warmer waters of the Gulf of Mexico, 2-16 km from the stranding site. This report summarizes the subsequent recapture of three juvenile green turtles that returned to St. Joseph Bay.

METHODS

Study Area. St. Joseph Bay is a unique coastal habitat located in the northeastern Gulf of Mexico. It is the only sizeable body of water that is not regularly influenced by the flow of freshwater in northwest Florida (Stewart and Gorsline 1962). The Bay encompasses just under 30,000 hectares along the coast of the Florida Panhandle in Gulf County (DEP 1997). St. Joseph Bay is approximately 21 km long with maximum width of 8km, and opens north to the Gulf of Mexico. St. Joseph Bay has a mean depth of 7 m, the greatest depth being 13.3 m in the northern end and the shallowest in the south at a depth of 1 m. St. Joseph Bay is considered a lagoon primarily because it functions as a closed system, and currents do not have any impact at depths greater than 1.7 m (Stewart and Gorsline 1962). Tidal range is 0.47 m with one tide cycle per day. This Bay is highly productive because of the high organic content in its sediments (Stewart 1962). Sea grass beds cover approximately one-sixth of the Bay and are most abundant in the shallow southern end (DEP 1997).

Turtle capture and measurement. This study was conducted from May 2001 through October 2001., In order to verify the presence and locations of sea turtles within St. Joseph Bay, visual observations were conducted from May through August. In-water capture procedures began in August 2001 and continued through October. Surveys for turtles were conducted using a 17-foot Boston Whaler with a 90-hp Yamaha outboard motor. Each turtle was caught using standard strike-netting techniques (Ehrhart and Ogren 1999). A 300 ft x 8 ft net (mesh=8″x 8″) was used to encircle the observed turtle during surveys. Nets were deployed from a small net-tender boat towed behind the Boston whaler. Once the turtle became entangled in the net, the net was pulled aboard the boat and was immediately removed from the net. Upon capture, turtles were weighed, photographed, and measured. Measurements included straight carapace length, (SCL) curved carapace length (CCL), straight carapace width (SCW), curved carapace width (CCW), plastron length, plastron width, head width, and body depth. Turtles were also flipper tagged with Inconel tags (Model No. 681, National Band and Tag Co., Newport, Kentucky) placed in the trailing edge of each fore flipper. Turtles were held for no more than one hour and released at the site of capture.

RESULTS

Three juvenile green turtles were recaptured bearing flipper tags, on three separate netting attempts. Two turtles (CM-2001-8-13-2 and CM-2001-10-20-1) were recaptured in the southern end of St. Joseph Bay on 13 August 2001 and 20 October 2001. The third turtle (CM-2001-8-25-5) was recaptured on 25 August 2001, northeast of the other recaptures, but still in the southern portion of St. Joseph Bay. Each turtle traveled 53-56 km (mean=54 km), with a minimum swim speed of 0.18 km/day to 0.23 km/day (mean=0.36 km/day). All were recaptured over shallow sea grass beds at depths ranging from 1.3 m to 2.3 m (mean=1.7 m). Each turtle experienced and increase in mass, SCL, and SCW. Increases in mass ranged from 1.1 kg to 1.4 kg (mean=1.2 kg). Increase in SCL ranged from 1.4 cm to 3.4 cm (mean=2.3 cm). Increases in SCW ranged from 0.6 cm to 2.1 cm (mean=2.0 cm). Original flipper tags were in good condition and clearly visible on all turtles.

DISCUSSION

The recapture of three immature green turtles in northwest Florida suggest that site-fidelity is present in juvenile green turtles of the Florida Panhandle. The three turtles recaptured in St. Joseph Bay returned to almost the identical portion of the Bay where the stranding occurred. Although it is impossible to verify that the juveniles primarily inhabited the southern end of St. Joseph Bay prior to the cold-stunning event, this recapture data may suggest that the turtles prefer this habitat. Site fidelity has previously been documented in juvenile green turtles in Mexico (Seminoff 2000), Hawaii (Balazs et al. 1998), and on the east coast of Florida (Bresette et al. 1996). Balazs found that 67.1% of juvenile green turtles in Kiholo Bay, Hawaii were captured two or more times, indicating that they consistently inhabit these waters. Marine turtles on the east coast of Florida have repeatedly been captured from the nearshore habitats of St. Lucie County (Bresette et al. 1998). Juvenile green turtles have exhibited similar homing behavior in various habitats throughout the world. Turtle fishermen of the West coast of Florida have long reported homing tendencies in green turtles of Cedar Key (Carr and Caldwell 1956). Ireland (1979) found that 12 out of 20 displaced juvenile green turtles in the Bahamas traveled 1.5-6.8 km to return to their original capture locale. Homing behavior has been observed in Brazilian green turtles when Luschi et al. (2001) conducted displacement experiments in order to test navigational abilities. These experiments documented that after being displaced 60-250 km, 14 out of 18 turtles returned to Ascension Island. Seminoff (2000) also documented homing behavior in juvenile turtles in the eastern Pacific Ocean. Here, turtles were found to return to certain sites, displaying site fidelity as well as homing abilities. Despite being released south of the Bay, several kilometers from their original stranding locale, the three juvenile green turtles were recaptured in the shallow seagrass beds of the southern end of St. Joseph Bay. Turtles remained at large for less than one year and traveled a minimum distance of 56 km, with an average minimum swim speed of 0.22 km/day. The assumption that these turtles were attempting to migrate through St. Joseph Bay may not be valid. After being released far from their stranding site, these turtles traveled substantial distances to return to St. Joseph Bay, indicating that they may be intentionally using this area.

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LITERATURE CITED

Balazs, G.H., M. Rice, S.K. Murakawa, and G. Watson. 1998. Growth rates and residency of immature green turtles at Kiholo Bay, Hawaii. In: F.A. Abreu-Grobois, R. Briseño-Dueñas, R. Márquez-Millan, and L. Sarti-Martinez, comps. Proc. of the 18th International Sea Turtle Sympsium. NOAA Tech. Memo. NMFS-SEFSC-436. p. 283-285.

Blackwelder, J. 2001. Cold-stunned turtles in St. Joseph Bay January 2001. FMRI oral presentation given at 2001 Florida Permit Holders Meeting. Gainesville, FL.

Bresette, M., J. Gorham, and B. Peery. 1998. Site fidelity and size frequencies of juvenile green turtles (*Chelonia mydas*) utilizing near shore reefs in St. Lucie County, Florida. Marine Turtle Newsletter 82:5-7.

Carr, A. and D.K. Caldwell. 1956. The ecology and migrations of sea turtles, results of field work in Florida, 1955. Amer. Mus. Novitates 1793:1-23.

Ehrhart, L.M. and L.H. Ogren. 1999. Studies in foraging habitats: capturing and handling turtles. In: K. Eckert, K.A. Bjorndal, F.A. Abreu-Grobois, and M. Donnelly, eds. Research and Management Techniques for the Conservation of Sea Turtles, IUCN/SSC MTSG Publication No. 4.

Florida Department of Environmental Protection. 1997. St. Joseph Bay Aquatic Preserve Management Plan: 109p.

Ireland, L.C. 1979. Homing behavior of immature green turtles. Amer. Zool. 19:952.

Ireland, L.C. 1980. Homing behavior of juvenile green turtles, *Chelonia mydas*. In: C.J. Amlaner Jr. and D.W. Macdonald, eds. A Handbook on Biotelemetry and Radio Tracking. Pergamon Press Ltd., Oxford, New York. p. 761-764.

Luschi, P., S. Akesson, A.C. Broderick, F. Glen, B.J. Godley, F. Papi, and G.C. Hays. 2001. Testing the navigational abilities of ocean migrants: displacement experiements on green sea turtles (*Chelonia mydas*). Behav. Ecol. Sociobiol. 50:528-534.

Seminoff, J.A. 2000. Biology of the east Pacific green turtle, *Chelonia mydas agassizii*, at a warm temperate feeding area in the Gulf of California, Mexico. Unpublished Ph.D. Dissertation, University of Arizona, 249 p.

Stewart, R.A. 1962. Recent sedimentary history of St. Joseph Bay, Florida. Unpubl. MS thesis, Florida State University.

Stewart, R.A. and D.S. Gorsline. 1962. Recent sedimentary history of St. Joseph Bay, Florida. Sedimentol. 1:256-286.

Summers, T.M., A.E. Redlow, A. Foley, K. Singel, and J. Blackwelder. In press. Hypothermic stunning of sea turtles in St. Joseph Bay, Florida. In: M. Coyne, comp. Proc. of the 21st Annual Symposium on Biology and Conservation.

Comparison of the green sea turtle to other species: the case of partial reinforcement effect

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The partial reinforcement effect is one of the most extensively studied phenomena in laboratory studies of animal behavior. It involves comparing the persistence of a behavior when the behavior has previously resulted in a reward on each of its occurrences, or a reward on only some of the occurrences (partial reinforcement). The persistence is measured by withholding the reward completely (known as extinction). When originally discovered, this effect generated controversy and altered existing theories of behavior. In the 60+ years since the original experiment, the effect has been documented in a wide range of mammals and birds, but its existence in reptiles has been inconsistent. Here we report a study using young green sea turtles biting a pipe for a small piece of fish reward. A robust partial reinforcement effect was found, suggesting that green sea turtles are comparable to a number of other species in this behavioral characteristic. We hypothesize that inconsistent findings with other reptiles may be due to the non-adaptability of those species to laboratory conditions, while the green sea turtle adapts well to such conditions. The brain structures responsible for the effect are found in the limbic system, an evolutionarily old part of the brain, and so it is not surprising that turtles might show the effect.

Basking, foraging, and resting behavior of two sub-adult green turtles in Kiholo Bay Lagoon, Hawaii

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INTRODUCTION

The green turtle (*Chelonia mydas*) is the only marine turtle species reported basking on land. One notable place where basking occurs is the Northwestern Hawaiian Islands (Whittow and Balazs 1985). Terrestrial basking in the main islands has increased dramatically since 1994. By using a combination of a field remote-controlled video camera, time-depth recorders (TDRs), and sonic tags the diel behavior of two habitually basking sub-adult green turtles was studied. Behaviors monitored included basking, foraging, and resting.

Green turtles are known to have been basking in Kiholo Bay, Hawaii, located at 19 52′N, 155 55′W on the Kona/Kohala coast, since 1994. The lagoon where they are seen basking has a shoreline consisting primarily of basaltic rock and consolidated pahoehoe lava. The south shore, which separates the lagoon from the ocean, is made of large rounded basaltic rocks, with a small gravel beach called "Turtle Beach." The lagoon is marine with substantial subsurface fresh water influx. The surface water (< 0.5 m) has a temperature between 20-22 C and a salinity of 8-15 ppt. The subsurface water (>0.5 m) has a temperature of 24-26 C and a salinity of 28-30 ppt. Sea water outside of the lagoon is 28 to 36 ppt (Rice et al. 2002).

There are several possible reasons why turtles bask. It was found that metabolic rates during basking in captivity were lower than during active behavior, implying an energy conservation benefit (Swimmer and Balazs 2000). Adding to the energy conservation theory, it is thought that basking is preferred over resting on the bottom because of the energy used to swim to the surface to breath. Basking also reduces exposure to marine predation (Green 1998). Thermoregulation is another possible benefit. Green turtles have been found to raise their body temperature while basking at the surface by as much as 5 C (Spotila and Standora 1985) and as much as 10 C more than ocean temperatures while basking on land (Whittow and Balazs 1985, Rice et al., in press). Body temperature is normally 1.0-2.5 C higher than the surrounding environment (Heath and McGinnis 1980). Basking behavior by Kiholo turtles is known to extend into the night most often until internal body temperature, Tb, drops to ~22 C at which point the turtles return to the water (Rice et al. 2000). However, for night baskers on Midway Atoll (Balazs et al., in press), energy conservation and safety might be primary factors since they most likely do not experience any warming affect at night. It is likely that basking behavior is exhibited for a combination of these and other unexplored benefits. For the Kiholo population, primary basking benefits most likely consist of thermoregulation and energy conservation.

In May 2000, two cameras were installed at Kiholo Bay lagoon. These cameras were used to observe turtle basking behavior for one month. Individual turtles were identified by their head scale patterns, as well as by moto-tool (MT) numbers lightly etched on their carapace to determine basking patterns (Quaintance et al., in press). More basking duration data has been collected for this study using one video camera. The camera was also used to correlate TDR data with observed basking behavior of the two TDR tagged sub-adult green turtles.

MATERIALS AND METHODS

On October 24, 2001, two sub-adult green turtles were hand captured while basking on Turtle Beach at Kiholo Bay lagoon. MT 53 and MT 94 were identified by their head scale patterns. These individuals were chosen because they met a predetermined set of criteria. They were 45 kg body weight, habitual baskers, and had a long tag history of residence at Kiholo. The TDRs (Wildlife Computers Inc. MK7) and sonic tags (Sonotronics CH-87-L) were attached to the right of MT 94 and the left of MT 53 on the second lateral scute. The procedure of the attachment of the TDR to the carapace, as well as the use of the sonic tags, are described in Rice et al. (2000). The TDRs were programmed to collect depth every minute and temperature every three minutes. On January 18, 2002, all data were successfully downloaded from MT 53 using a Sony™ laptop. The MK7 unit was then redeployed. On February 1, 2002, MT 94 was recaptured and all data were recovered in similar fashion. It was also redeployed.

The remote camera was not functional until November 20, 2001, so the TDRs were out for about one month without the camera. The camera feed was monitored fairly consistently during the week, but not the weekends. All basking episodes were recorded and later entered in a File Maker Pro database. Pictures of the turtles, as well as full motion and time lapse video clips, were captured using BTV Pro and a VCR.

RESULTS

TDR carapace temperatures above 28 C were considered to represent basking (highest ocean temperature was 27 C). It was determined that small regular fluctuations in temperature indicated resting behavior and relatively constant temperature was foraging behavior (Fig. 1). Several of these episodes were confirmed with data collected using the remote video camera. MK7 temperature data were correlated with external carapace temperature using an IR temperature gun. Both readings were found to be within 1 ?C of each other, which is within both instruments' error range.

From MT 53, a total of 85 days of data were recorded (10/26/01 to 1/17/02). For 60 of those days MT 53 came out to bask a total of 221h (11%) of the total time. The highest carapace temperature recorded while basking was 45 C for both turtles. The average time spent basking was 3.7h (S.E.=0.28) per basking episode with a range of 1.0-10.3h. MT 53 spent 728h (37%) of the time foraging, and 1040 h (52%) of the time resting.

Data from MT 94 showed similar percentages. During a 99-day period (10/25/01 to 1/31/02) it spent 41 days basking for a total of 239 h or 10% of the total time. MT 94 spent 975.5 h (41%) of the time foraging, 1,160.4 h (49%) of the time resting. MT 94 spent an average of 4.6 h (S.E.=0.57) basking per basking episode with a range of 0.3 h to 16.4 h. Both turtles most often came out to bask in the late morning and early afternoon with peaks at 1100 h and 1300 h. This is similar to previously observed behavior. MT 94 did not bask as often as MT 53, but on average it stayed out longer.

Some interesting behaviors were observed with the camera while turtles basked. They were often seen yawning and, less frequently, some aggressive biting and snapping was observed. Camera observations also showed that, for all turtles, basking was most often initiated in the late morning and early afternoon similar to MT 94 and MT 53.

Most commonly, turtles were observed basking in groups and sometimes they would climb over one another or bask on top of each other. The question asked to prove group basking was whether green turtles initiate basking closer to existing baskers or to a fixed point (A) on the beach. The null hypothesis was that turtles emerged at random locations on Turtle Beach. Data were gathered by estimating distances of emerging turtles from Point A and from the nearest currently basking turtle for 7 days of basking (N=81). A single factor ANOVA test was run on the data giving a P-value of <.001. The null hypothesis was rejected and it is assumed that the turtles were choosing emergence points closer to other basking turtles. The reasons for this possible aggregating behavior are not known but turtles may simply be choosing better basking areas and, therefore, ending up close together. As is the case with pinnipeds that bask, there may be a group protective factor involved in green turtles choosing to come out near other basking green turtles. In all likelihood, the aggregating behavior shown by the basking turtles at Kiholo results from a combination of the two factors mentioned above.

CONCLUSION

Habitually basking sub-adult green turtles basked an average of 3.7 to 4.6h per episode and stayed out as long as 16h. They spent an average 10% of their day basking, 39% foraging, and 51% resting. Basking turtles tend to initiate basking close to other basking turtles, which may offer added protection from terrestrial disturbance. Basking at Kiholo Bay is only initiated during daylight hours but extends into the night. Internal body temperatures of basking turtles are significantly above environmental temperatures up to 10 C, and slowly drop as external environmental temperature drops. Basking turtles return to the water at night when their internal temperature decreases to 22-24 C. Basking is most likely a way for turtles to conserve energy, decrease the probability of predation, and raise internal body temperature thereby increasing the rate of metabolism.

LITERATURE CITED

Balazs, G. H., M.R. Rice, N. Hoffman, S.K.K. Murakawa, D.M. Parker, and R.J. Shallenberger. In press. Green turtle foraging and resting habitat at Midway Atoll: significant finding over 25 years, 1957-2000. In: M. Coyne, comp. Proceedings of the Twenty-first Annual Symposium on Sea Turtle Biology and Conservation. Philadelphia, PA.

Green, D. 1998. Basking in Galapagos green turtles. In: S.P. Epperly, and J. Braun, comps. Proceedings of the Seventeenth Annual Symposium on Sea Turtle Biology and Conservation. NOAA Tech. Memo. NMFS-SEFSC-415. p. 60-62.

Heath, M.E. and S.M. McGinnis. 1980. Body temperature and heat transfer in the green turtle. Copeia 1980:767-773.

Quaintance, J.K., M.R. Rice, and G.H. Balazs. In press. Monitoring turtle basking behavior with remote cameras. In: M. Coyne, comp. Proc. of the Twenty-first Annual Symposium on Sea Turtle Biology and Conservation. Philadelphia, PA.

Rice, M.R., G.H. Balazs, L. Hallacher, W. Dudley, G., Watson, K. Krusell, and B. Larson. 2000. Diving, basking, and foraging patterns of a sub-adult green turtle at Punalu'u, Hawaii. In: F.A. Abreu-Grobois, R. Briseño-Dueñas, R. Márquez-Millán, and A.L. Sarti-Martínez, comps. Proceedings of the Eighteenth Annual Symposium on Sea Turtle Biology and Conservation. NOAA Tech. Memo. NMFS-SEFSC-436. p. 229-231.

Rice, M., G.H. Balazs, D. Kopra, and C. Whittow. 2002. Ecology and behavior of green turtles basking at Kiholo Bay, Hawaii. In: A. Mosier, A. Foley, and B. Brost, comps. Proceedings of the Twentieth Annual Symposium on Sea Turtle Biology and Conservation. NOAA Tech. Memo. NMFS-SEFSC-477.

Spotila, J.R. and E.A. Standora. 1985. Environmental constraints on the thermal energetics of sea turtles. Copeia 1985:694-702.

Swimmer, J.Y. and G.H. Balazs. 2000. The biology of basking in the green turtle (*Chelonia mydas*). In: F.A. Abreu-Grobois, R. Briseño-Dueñas, R. Márquez-Millán, and A.L. Sarti-Martínez, comps. Proceedings of the Eighteenth Annual Symposium on Sea Turtle Biology and Conservation. NOAA Tech. Memo. NMFS-SEFSC-436. p. 233-234.

Whittow, G.C. and G.H. Balazs. 1985. Basking behavior of the Hawaiian green turtle (*Chelonia mydas*). Pacific Science 36:129-139.

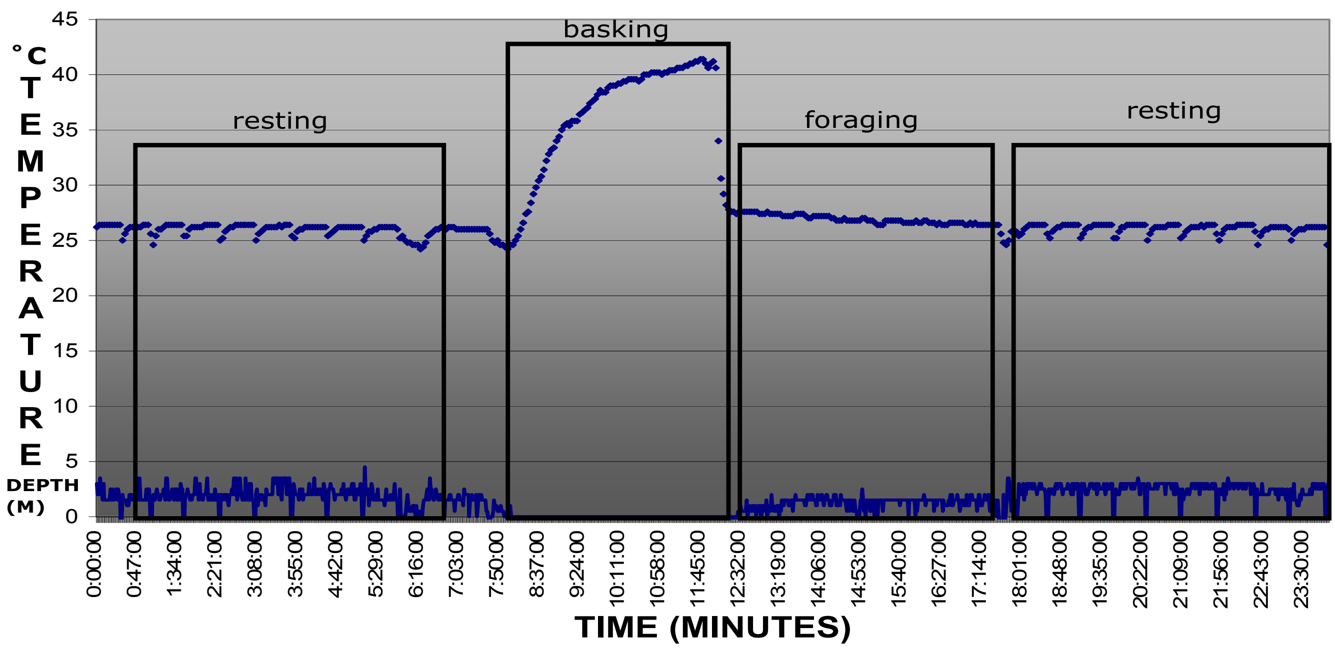

Fig. 1. MT 94 temperature data from 11-20-2001. Resting, basking, and foraging behaviors are indicated.

Loggerhead presence and seasonal variation in the Adriatic Sea (Italy)

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Data from 400 loggerheads were collected along the west coast of the Adriatic sea in Italy. The location and main measure of the specimens are here analysed in relation to dimensional classes. The distribution of turtles casualties is related to the temperature of the sea and the main streams. Age classes are mainly represented by subadults that are present throughout the year. Adults are sighted from the end of April to autumn with a lack in January-March. The sightings in June-September are 3 to 4 times the presence in the other months. The period from June to September covers 73% of all the data with July having about 21% and August 23%. Considering CCL classes of 10 cm, the main represented are that of 40-49 and 50-59 cm both with more of the 17% of the whole sample. The classes of less than 20 cm and more than 90 are of 2.8 and 2.6, respectively. Comparing this results with the Croatian and other Mediterranean literature suggest a new possible scenario: The use of north Adriatic as feeding ground by all the age classes is connected with nesting locations in Greece but the subadults can winter in the more warm Croatian waters. The adults seem to migrate to north to feed later.

Response of loggerhead hatchlings to filtered and non-filtered high-pressure sodium lighting

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During the 1998 nesting season, 21% of the reported disorientations of hatchlings in Florida were attributed, at least in part, to streetlights. The Florida Department of Transportation (FDOT) and the Florida Power and Light Company (FPL) have used acrylic filters to modify high-pressure sodium vapor (HPS) streetlight output. These filters exclude wavelengths of light that are most attractive to turtles (violet, blue, green) but transmit wavelengths that are less attractive (yellow, orange, red). Two acrylic filters have been developed. The #2422 excludes wavelengths below 530 nm, and the NLW excludes wavelengths below 570 nm. Currently, the #2422 filter is installed in many poled coastal roadways. Loggerhead hatchlings were presented in laboratory experiments with filtered and unfiltered HPS lighting to determine if the filtered light was turtle friendly. When presented with a choice, most of the turtles were attracted to (i.e., turned toward) the unfiltered light. This preference was reversed when the HPS light was diminished in radiance by three log units (1000x). When presented with #2422 and NLW, turtles were attracted to the #2422 source. Diminishing the #2422 radiance by 1.5 log units eliminated that response, and by 2.5 log units caused its reversal (NLW preferred). We conclude that neither filter renders transmitted lighting "turtle friendly", but that attraction is diminished as more of the shorter wavelengths are excluded. The use of filtered lighting at certain sites (i.e., where seaward-directing cues are strong) might be useful, especially at locations where pedestrian and/or vehicular safety is an important consideration.

A new view of dive performance and reproductive biology of the leatherback turtle using at-sea video monitoring

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Our understanding of sea turtle biology is typically obtained from adult females while they are on the nesting beach. The pelagic nature of leatherbacks and this bias towards beach-based studies has resulted in a very poor understanding of important areas of their biology, such as mating system, dive patterns, feeding patterns and general behavior at sea. We used innovative recording technology to obtain dive records and video recordings of the behavior of post-nesting adult female leatherbacks in the ocean. Our objectives were to: simultaneously obtain time depth records and video recordings of leatherbacks swimming and diving, observe the undersea habitat in the near-shore environment and any feeding, and determine if leatherbacks interact with each other in any observable way. Our major results were: (1) There were distinct phases in dive behavior; (2) female leatherbacks did not appear to feed in the 12 h after nesting; (3) male leatherbacks near the nesting beach attempted to mate with females; and (4) females prolonged dives and increased swim velocity to escape from males. Our results are important for the conservation of leatherbacks because male leatherbacks had never previously been observed near the nesting beach. Our results showed that they must migrate and hence are subject to the same risks as females during migration. The prolonging of dives by females in the presence of males means that regular dive durations recorded from post-nesting females probably do not show their full dive capacity. This is of importance in determining their ability to survive forced submergence by entanglement in fishing gear.

Diet of green turtles (*Chelonia mydas*) captured in the Robinson Point foraging ground, Belize

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INTRODUCTION

The extensive seagrass beds found within the Robinson Point foraging ground attract turtles from as far away as Costa Rica and the Cayman Islands. In 1999, Zenit, a green turtle nesting at Tortuguero, was tagged with a satellite transmitter and traveled non-stop to the Robinson Point foraging ground in less than one week. Other tags have also been returned to the Caribbean Conservation Corporation from turtles that nested at Tortuguero and were harvested in the Robinson Point area (Eliazar 2001). There are reports of fishermen with jars of tags recovered from harvested turtles and even a report of a tag from Cayman (BSTCN 2002). Hirth (1971 in ESIS 1996) correlates the distribution of green turtles with seagrass. The Robinson Point area supports the largest area of dense seagrass growth within the coastal lagoon inside the Belize Barrier Reef (Fig. 1). It appears that the dense seagrass beds found in the Robinson Point area do indeed support a large population of green sea turtles. In fact, thalass is Greek for the 'the sea,' and testudin is Latin for 'a turtle' (Borror 1971), suggesting when turtle grass was given it's scientific name by Linnaeus in 1758 these areas of extensive seagrass beds were once 'A Sea of Turtles.' The Sea Turtle Recovery Action Plan (STRAP) for Belize (Smith et al 1992) reports that the 1925 Handbook of British Honduras still described the number of sea turtles around Belize's cayes as inexhaustible. The Belize STRAP also reported that turtles migrate in during the winter and aggregate on the grassy banks near the Robinson Point area. Searle (in press) reported that fishermen also described an area east of English Caye that supported large numbers of turtles, and market surveys indicated that green turtles are being harvested in this area. The dense seagrass beds in the Robinson Point foraging ground provide important habitat for the endangered Western Caribbean green sea turtle. How many sea turtles does this area support? Is overfishing reducing their numbers? An examination of the diet of green sea turtles in the Robinson Point area may lead to a better understanding of how Belize can help protect these living aquatic dinosaurs from continued depletion of stocks, and enable us once again call turtle grass beds, "Turtle Seas."

Robinson Point or the Southern Triangles. Belize is located on the Central American isthmus facing the Caribbean Sea. The continental shelf is protected by the Belize Barrier Reef, which extends the entire length of the country. Inside these shallow, calm waters are extensive stands of seagrass beds, composed primarily of *Thalassia testudinum*. The Robinson Point foraging ground is located about 10 miles (15 km) southeast of Belize City. Robinson Point refers to the two dozen or so cayes that are in this area and include The Triangles, Spanish Caye, Crayfish Caye, and Grennel's Caye. In the late 1700s this area was called the Southern Triangles (the Northern Triangles being the Chinchorro Banks east of the Yucatan Peninsula, Mexico) (King 2002) and had been traditionally used to repair boats since the English Caye Channel came close to land.

Turtling in Belize. Turtling was an important industry in Belize, and the Southern Triangles or Robinson Point area has supported sea turtle harvest since the 1700s when the English and Spanish were occupying Belize. According to Belize historian Emory King (2002) the Treaty of 1783 specifically stated that the English were not allowed to fish or turtle in the waters between St George's Caye (then Belize's capital) and the Southern Triangles. In 1786 the Treaty was amended to allow for harvest of turtles since the Baymen, the early English settlers of Belize, had lobbied their government to negotiate the change with Spain. The Belize STRAP (Smith et al 1992) reports that in the 1860s, between 2,000-6,000 live turtles were exported annually. The Baymen even constructed craals, square penned enclosures at the end of a dock, that were used to store turtles until they were exported. Craals still exist in Belize only on St George's Caye, but today are used by people for wading. Fishermen are still reporting numerous turtles in this area, however one turtle fisherman reported that they are not as abundant as they once were. This particular turtle fisherman has only been harvesting turtles for about 20 years, so for him to notice a decline in such a relatively short period of time, has grave implications for the populations of green sea turtles in the Robinson Point foraging ground. Today, primarily three turtle fishermen families, or three groups, harvest sea turtles in the Robinson Point area and sell them at Belize City fish markets and restaurants. Two groups capture the turtles with nets and one group chases the turtles until they tire and then either catch them by hand, or spear them. Turtles harvested utilizing either method are brought in to Belize City either the same day as they are captured, or the next day. Once brought into Belize City they are most often slaughtered the same day.

Benthic habitat. Mumby and Harborne (1999) prepared a "Classification Scheme for Marine Habitats of Belize" which describe geomorphological and benthic categories. A map of the sea bottom was prepared from satellite images, and corresponding descriptions of habitat were included. Fig. 2 is an enlarged section of the marine habitat map that shows the Robinson Point area. That area between the Southern Grennel's Channel east of Robinson Point, and the Belize Barrier Reef is composed primarily of dense seagrass and medium density seagrass on a shallow lagoon floor. The primary constituent of the seagrass beds is reported to be *Syringodium* and *Thalassia*. Other organisms that are expected to be found growing in association with the seagrass beds include algae, corals, and gorgonians. A comparison of seagrass categories found in the Robinson Point area is listed in Table 1. Many other microorganisms including algae and sponges are also found in the seagrass ecosystem living on the seagrass blades.

Diet of green turtles in the western Caribbean. Mortimer (1981) and Bjorndal (1997) concur that Western Caribbean green turtles forage primarily on seagrass and (Bjorndal 1979 in Mortimer 1981, and Bjorndal 1997) describe how microbial fermentation is used to help herbivorous turtles digest the cellulose of *Thalassia*. Green sea turtles and manatees have been referred to as megaherbivores (Aragones 2001) since they consume large amounts of seagrass. It is estimated that manatees consume up to 10% of their body weight daily. If green turtles consume a similar amount, then a green turtle weighing about 300-500 pounds may consume 30 to 50 pounds of seagrass daily! Mortimer's (1981) diet composition study in Nicaragua recorded other organisms that were consumed by green turtles including 40 different species of algae, benthic substrate and animal matter. She reported finding no evidence that the diet of green turtles is augmented by the ingestion of invertebrate and plant material living on the seagrass blades. Terrestrial debris and water hyacinths were also found in the stomachs of migrating green sea turtles. This evidence suggests that green turtles choose to inhabit areas where there is dense turtle grass, and while migrating en route to the Tortuguero nesting beach, they consume what ever is available.

METHODS

The harvest of green turtles in Belize during the open sea turtle season from November 1 through March 31 provides an opportunity to gather important scientific data that would otherwise be unavailable. When the 2001-2002 sea turtle season opened, the two markets in Belize City were visited and the turtle retailers were asked to save the digestive tracts of the landed sea turtles for diet component analysis. Rainey (1982) was used as reference for identification of gastrointestinal tract components. The contents were qualitatively analyzed using Taylor (1986), Littler et al. (1989) and Romashko (1976). Specimen samples were stored in 10% formalin or frozen.

RESULTS

Four digestive tracts of green sea turtles landed in the Robinson Point foraging ground were analyzed. The first digestive tract received from the fish markets was the entire gastrointestinal tract and was over 50 feet (17 m) in length. Throughout the entire intestine were white substances that resembled digested sponge matter. Subsequent samples examined only the stomach from the esophagus to the pyloric valve. The predominant component within each digestive tract was *T. testudinum*. In 3 samples, other organisms including algae and invertebrates, were also found within the stomach contents. In the esophagus papillae of one sample were small pieces of *Halimeda* plates that had already become part of the benthic substrate. One sample appeared to be 100% new growth *Thalassia*; the semidigested blades were bright green and no other organisms were found in the sample.

DISCUSSION

Analysis of the digestive tracts of green sea turtles landed at Belize City fish markets indicate that the turtles in the Robinson Point foraging ground are consuming primarily *T. testudinum*. Other materials such as algae, shells, *Halimeda* fragments and the unidentified mollusk found within the stomachs of green turtles were most likely consumed incidentally since they grow in close association with *Thalassia*. However, two samples may indicate that green sea turtles can selectively harvest food materials. In the first sample, unidentified sponge material was found regularly throughout of the large intestine. This would indicate that either the density of the sponge was greater in the area where this particular turtle was feeding, or that *Chelonia* was selectively consuming sponge along with turtle grass. Acevedo et al. (1984) in Bjorndal (1997) reported green turtles feeding on the chicken liver sponge, *Chondrilla nucula*. Analysis of the unidentified sponge sample will determine whether the Western Caribbean green turtles in Belize also feed on this sponge. Similarly, the sample of pure *Thalassia* may have been selectively consumed by *Chelonia mydas*, a behavior described by Bjorndal (1980 in Mortimer 1985) and Mortimer (1985). Further investigations into the diet and population structure of the Western Caribbean green turtle in the Robinson Point foraging ground will be necessary to determine the importance of this area for the nesting colony at Tortuguero. It is hoped that continued studies in the Robinson Point area will one day lead to a protected area for sea turtles that will give a renewed meaning to the scientific name of turtle grass, *T. testudinum*.

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LITERATURE CITED

Acevedo, M., O. Gomez, and V. Berovides. 1984. Alimentacion de tres especies de quelonios marinos en la plataforma suroccidental de Cuba. Rev. Invest. Mar. 5(29).

Aragones, L.V. 2001. A review of the role of the green turtle in tropical seagrass ecosystems. ASEAN Review of Biodiversity and Environmental Conservation (ARBEC).

Belize Sea Turtle Conservation Network. 2002. Minutes of the Meeting held Jan 31, 2002.

Bjorndal, K.A. 1997. Foraging ecology and nutrition of sea turtles. In: P.L. Lutz and J.A. Musick, eds. The Biology of Sea Turtles. CRC Press, Boca Raton, Florida. p. 199-231.

Bjorndal, K.A. 1980. Nutrition and grazing behavior of the green turtle, *Chelonia mydas*. Marine Biology 56:147-54.

Bjorndal, K.A. 1979. Cellulose digestion and volatile fatty acid production in the green turtle, *Chelonia mydas*. Comparative Biochemistry and Physiology 63A:127-33.

Borror, D.J. 1971. Dictionary of word roots and combining forms. Mayfield Publishing, Palo Alto, CA. 134 p.

ESIS. 1996. DRAFT Taxonomy Green Sea Turtle.

Hirth, H.F. 1971. Synopsis of biological data on the green sea turtle, *Chelonia mydas* (Linnaeus 1758). FAO Fisheries Synopsis, No 85.

Littler, D.S. et al. 1989. Marine plants of the Caribbean: a field guide from Florida to Brazil. Smith. Inst. Press, Wash, DC.

Mortimer, J.A. 1981. Feeding ecology of sea turtles. In: K.A. Bjorndal, ed. Biology and Conservation of Sea Turtles, Smithsonian Institution Press, Washington D.C. p. 103-109.

Mumby, P.J and A.R. Harborne. 1999. Draft: Classification scheme for marine habitats of Belize. UNDP/GEF Belize Coastal Zone Management Project.

Rainey, W.E. 1982. Guide to sea turtle visceral anatomy. NOAA Tech. Memo. NMFS-SEFC-82.

Romashko, S. 1974. The Shell Book. Windward Publishing, Miami, FL. 64 p.

Searle, L. In press. A brief history of sea turtle communities, conservation and consumption in Belize. In: M. Coyne, comp. Proceedings of the Twenty-first Annual Symposium on Biology and Conservation. Philadelphia, Pennsylvania.

Smith, G.W., K.L. Eckert and J.P Gibson. 1992. WIDECAST Sea Turtle Recovery Action Plan for Belize, K.L. Eckert, ed. CEP Technical Report No 18. UNEP Caribbean Environment Programme, Kingston, Jamaica. 86 p.

Taylor, W.R. 1985. Marine algae of the eastern tropical and subtropical coasts of the Americas. Univ. Michigan Press, Ann Arbor, MI. 870 p.

Adult male hawksbills: breeding and diving behavior

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In-water observations, capture records and Crittercam deployments have shown that male hawksbills use the shallow-water reef areas adjacent to the nesting beaches of Mona Island to intercept females for mating. Individual males visit these areas annually for periods of about 2 months, feeding on sponges, principally *Geodia neptuni*. Year-long time-depth records were obtained for three turtles, yielding detailed data on diving behavior, and supporting the prior behavioral observations. After leaving the breeding areas, males take up residency in deeper foraging grounds. Geolocation through light-level measurement indicates that these foraging grounds lie <100 km from Mona Island. The low variation in night-time resting depths suggests that these turtles consistently used the same resting location throughout their ~10 month stay on the foraging grounds. The maximum recorded dive depth was 196 m.

Diet analysis of stranded loggerhead and Kemp's ridley sea turtles in Virginia, USA: 2001

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The Chesapeake Bay and coastal waters of Virginia, U.S.A. serve as seasonal foraging grounds for an estimated 5,000 to 10,000 sea turtles from approximately May to October each year (Bellmund et al. 1987, Keinath et al. 1987). These turtles are predominantly the loggerhead, *Caretta caretta*, and the Kemp's ridley, *Lepidochelys kempii*. Benthic-stage juvenile loggerheads account for roughly 95% of Virginia's sea turtles, but some adult-sized loggerheads are encountered each year, and juvenile Kemp's ridley numbers are likely in the low to mid hundreds during any given summer (Keinath et al. 1994).

From 1979 to 1984, the primary prey of loggerheads examined in Virginia was the Atlantic horseshoe crab, *Limulus polyphemus*, and the predominant prey of the Kemp's ridley was the blue crab, *Callinectes sapidus* (Bellmund et al. 1987, Keinath et al. 1987, Lutcavage and Musick 1985). Loggerheads were also known to consume various crustaceans and occasionally fish (Bellmund et al. 1987).

Whole digestive tracts were collected from 22 stranded loggerheads and seven stranded Kemp's ridleys in Virginia from May to September 2001. The contents were sieved (0.5 mm) and then preserved in 10% formalin followed by 70% ethanol. Prey items were identified to the lowest possible taxa, and numbers of prey individuals and dry weights were recorded.

The 22 loggerheads ranged from 53.0 to 102.3 cm curved carapace length (CCL) (mean=71.6 cm, SD=10.4 cm). Gut samples had dry weights of 8.5 g to 388.8 g (mean=91.4 g, SD=99.3 g) and contained two to 64 prey individuals (mean=13.1, SD=13.6). Fish (Table 1) were consumed by 18 of the loggerheads, and horseshoe crabs were consumed by only four (Table 2). Fish accounted for 29.07% of prey individuals and 71.81% of the total dry weight. Atlantic croaker (*Micropogonias undulatus*) and Atlantic menhaden (*Brevoortia tyrannus*) were the two most commonly encountered fish species (Table 1). An 89.5 cm-female that stranded in Hampton, VA, during late July, contained teeth from the sharpnose shark, *Rhizoprionodon terraenovae*, and tail spines from the clearnose skate, *Raja eglanteria*. The smallest loggerhead had consumed almost entirely crustaceans, and the largest contained 57 whelk opercula (*Busycon carica* and *B. canaliculatus*) and horseshoe crab. Mudsnails (*Nassarius* sp.) were encountered in seven turtles, four of which had also consumed fish.

The seven Kemp's ridleys ranged from 28.5 to 43.0 cm CCL. The gut samples contained four to 20 prey individuals, and total dry weights ranged from 30.7 g to 96.3 g. Crustaceans accounted for 98.98% of the total dry weight and 65.56% of prey individuals (Table 2). Among the individual ridleys, crustaceans comprised 94.05 to 100% of the sample dry weight. Crabs of the genus *Callinectes* were encountered in all samples, and blue crab was identified in six samples. The next most abundant prey, the purse crab, *Persephona mediterranea*, was consumed by four ridleys, all of which were from the southern Eastern Shore and stranded between mid-May and mid-June.

The large quantities of fish in the loggerhead samples from 2001 may indicate this species has responded to recent horseshoe crab declines (ASMFC 1998) by feeding opportunistically on discarded bycatch (Shoop and Ruckdeshel 1982) or by interacting with fishing gear (Bellmund et al. 1987). All of the finfish species identified are commercially important for Virginia's gillnet and poundnet fisheries (Virginia Marine Resources Commission data). The fish species composition, along with the fact that only four turtles had consumed both fish and scavenging mudsnails, suggests that these turtles were feeding primarily on live and fresh dead fish from nets. Because the majority of the samples were from the Western Bay, this increased reliance on fish may not apply to the whole state. Additionally, the presence of fish in the gut alone does not definitively implicate a fishery-related death, and many of the fish encountered were in later stages of digestion.

It appears that the blue crab is still a large component of Kemp's ridley diet, suggesting that Virginia's ridley population is small enough that it has not been severely affected by blue crab declines (Lipcius and Stockhausen 2002). The four ridleys that contained purse crab were separated temporally and spatially from the other three sampled. This suggests that the purse crab may serve as seasonally or regionally important prey for Kemp's ridleys, although various factors may cause the time and location of death to differ greatly from those of a stranding.

Various mollusc species were encountered in both species. With the exception of the adult-sized loggerhead, molluscs accounted for very small percentages of total dry weights. It is likely that many of the smaller molluscs were consumed incidentally, or possibly as the digestive tract contents of crustacean prey. The presence of the marine plants *Zostera marina* and *Ruppia maritima* reinforce previous conclusions that ridleys often forage in seagrass beds (Keinath et al. 1987), but also indicates that loggerheads forage in areas with seagrass.

Acknowledgements. Meredith Fagan, Katie Frisch, Mandy Karch, and AmberKnowles (sample collection/sieving); Virginia Marine Science Museum Stranding Team and Trish Bargo (digestive tract collection); Roy Pemberton (VIMS sampling protocol); Melanie Harbin (preservation supplies); Julia Ellis, Ken Goldman, Juli Harding, Beth Hinchey, and John Walter (prey identification). Special thanks to Jim Gartland for sharing his vast knowledge of gut content analysis.

LITERATURE CITED

Atlantic States Marine Fisheries Commission. 1998. Fishery Management Report No. 32 of the Atlantic States Marine Fisheries Commission: Interstate Fishery Management Plan for the Horseshoe Crab. 52 p.

Bellmund, S.A., J.A. Musick, R.C. Klinger, R.A. Byles, J.A. Keinath, and D.E. Barnard. 1987. Final Contract Report on the Ecology of Sea Turtles in Virginia. Virginia Institute of Marine Science Special Scientific Report No. 119, 48 p.

Keinath, J.A., D.E. Barnard, J.A. Musick, and B.A. Bell. 1994. Kemp's ridley sea turtles from Virginia water. In: K.A. Bjorndal, A.B. Bolten, D.A. Johnson, and P.J. Eliazar, comps. Proceedings of the Fourteenth Annual Symposium on Sea Turtle Biology and Conservation. NOAA Tech. Memo. NMFS-SEFSC-351, p. 71-73.

Keinath, J.A., J.A. Musick, and R.A. Byles. 1987. Aspects of the biology of Virginia's sea turtles: 1979-1986. VA J. Sci. 38:329-336.

Lipcius, R.N. and W.T. Stockhausen. 2002. Concurrent decline of the spawning stock, recruitment, larval abundance, and size of blue crab in Chesapeake Bay. Mar. Ecol. Prog. Ser. 226:45-61.

Lutcavage, M. and J.A. Musick. 1985. Aspects of the biology of sea turtles in Virginia. Copeia 1985:329-336.

Shoop, C.R. and C. Ruckdeshel. 1982. Increasing turtle strandings in the southeast United States: A complicating factor. Biol. Conserv. 23:213-215.

Table 1. Fish species identified in 18 of 22 loggerhead gut samples, Virginia, 2001.

Fish Species	Frequency	Number
Atlantic Croaker, *Micropogonias undulates*	12	40
Atlantic Menhaden, *Brevoortia tyrannus*	6	26
Clearnose Skate, *Raja eglanteria*	1	1
Sea Trout, *Cynoscion* sp.	3	3
Sharpnose Shark, *Rhizoprionodon terraenovae*	1	1
Striped Bass, *Morone saxatilis*	1	1
Unidentified Clupeid	3	3
Unidentified Teleost	3	9

Table 2. Composition of 22 loggerhead and seven Kemp's ridley gut samples, Virginia, 2001.

	Loggerhead (n=22)			Kemp's ridley (n=7)		
Prey Item	Frequency (Out of 22)	Number of Prey Items	Dry Weight (g)	Frequency (Out of 7)	Number of Prey Items	Dry Weight (g)
Chelicerates	4	5	85.4	--	--	--
Limulus polyphemus	4	5	85.4	--	--	--
Crustaceans	20	56	141.2	7	59	290.3
Callinectes sapidus	6	19	55.9	6	23	140.1
Callinectes sp.	--	--	--	1	11	1.5
Cancer irroratus	--	--	--	1	1	0.2
Libinia dubia	4	6	38.4	2	6	10.3
Libinia emarginata	--	--	--	3	4	25.5
Pagurus sp.	7	19	15.8	3	3	0.7
Persephona mediterranea	--	--	--	4	11	35.8
Unidentified crustacean	9	12	31.2	5	--	76.2
Fish	18	84	1443.6	--	--	--
Teleost	18	82	1312.6	--	--	--
Elasmobranch	1	2	5.4	--	--	--
Unclassified fish	1	0	125.6	--	--	--
Molluscs	18	139	146.6	5	31	2.6
Anadara sp.	2	2	0.6	--	--	--
Busycon carica/*B. canaliculatus*	2	58	125.2	--	--	--
Crassostrea virginica	--	--	--	1	1	0.2
Lunatia triseriata	1	1	0.4	--	--	--
Mytilis edulis	9	22	2.4	4	17	0.4
Nassarius sp.	7	31	6.4	3	12	1.95
Neverita duplicata	5	11	6.4	--	--	--
Urosalpinx cinerea	1	1	0.5	--	--	--
Unidentified mollusc	7	13	4.8	1	1	0.05
Plants	18	--	3.8	3	--	0.4
Fucus sp.	1	--	0.4	--	--	--
Ruppia maritima	2	--	0.3	1	--	0.05
Zostera marina	11	--	1.5	3	--	0.15
Terrestrial tree leaf	3	--	0.5	1	--	0.2
Unidentified plant matter	11	--	1.2	--	--	--
Tunicate	3	3	0.3	--	--	--
Molgula manhattensis	3	3	0.3	--	--	--
Other	15	2	190.0	--	--	--
Grasshopper (Insecta)	1	1	0.1	--	--	--
Sponge (Porifora)	1	1	0.4	--	--	--
Hook and line fishing gear	1	--	10.9	--	--	--
Rocks	8	--	4.0	--	--	--
Unidentified tissue	12	--	174.6	--	--	--
TOTAL	22	289	2010.8	7	90	293.3

Patterns in nest-site location of individual leatherback turtles (*Dermochelys coriacea*) nesting at Parque Nacional Las Baulas, Costa Rica

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Many animals exhibit some degree of nest-site selection that may enhance their fitness. Existence of nesting site preferences among female leatherback turtles, however, raises concerns about the merit of translocating poorly-located clutches to a safe hatchery if some females consistently nest in sub-optimal locations. Leatherback turtles nesting at Parque Nacional Las Baulas, Costa Rica, have been identified with PIT tags, and locations of their nests have been recorded, every nesting season since 1993. We analyzed data, collected from 1993-2001, on the spatial positioning of leatherback nests along the ocean-to-vegetation axis and along the coastal axis running from the northern to southern boundaries of the beach to ascertain whether nests laid by each female during a nesting season were clustered along the length of the beach and whether females tended to lay eggs in nests at similar locations along the ocean-vegetation axis of the beach. Transition matrix analysis of consecutive nestings of individuals uncovered clear tendencies for females to return to nest near sites of their previous nestings. Random effects models fit to data for nest-site locations along the north-to-south beach axis clearly demonstrated clustering of nest sites used by individual females. Nest site locations along the ocean-to-vegetation axis were mainly homogenous; all females nested in the open sand between the high-tide line and the vegetation, but occasionally nested outside of that zone. Thus, concerns about translocation of poorly located nests to a hatchery leading to selection of females that make poor choices of nest sites seem unfounded.

Internesting diving behavior in flatback sea turtles (*Natator depressus*)

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Eight flatback turtles (*Natator depressus*) were equipped with a Time-Depth Recorder (TDR) during the 2000/01 nesting season on Curtis Island, Queensland, Australia. The recorders were either LTD archival tags from Lotek Fish and Wildlife Monitoring, Canada, or TR miniloggers from Vemco Limited, Canada. The TDRs were attached under the rear marginal scutes of the carapace using bolts, washers and nylon threaded nuts, and stored in situ depth and temperature information. They were put on the turtles after they had finished laying their first clutch off eggs, and removed after they had laid their second clutch off eggs approximately 2 – 2 1/2 weeks later.

The turtles spent on average 93% of the time submerged. A majority of the time diving was apparently spent at the bottom, as their maximum dive depth coincides well with the maximum known depth of the waters surrounding the nesting beach. In addition the tides with its regular depth-fluctuations is apparent for many of the long dives, where the bottom part of the dives follows the same pattern as the tides, seen on several days in the example graph (Fig. 1).

Each of the eight turtles seemed to have a few depths where they spent the majority of the time when engaged in diving. This suggests that they either spend most of the time at a few selected spots or they move about but tend to choose spots that are at preferred depths. It might also be a result of uniform bottom topography, although each individual differs in its chosen depth at which to stay (Fig. 2, b and c).

The turtles spent 51% of the total time diving on dives of 30 - 60 minutes duration (Fig. 3). The many long dives and the relatively flat bottom part of these dives suggest that the turtles spend a great amount staying still at the bottom, apparently resting while preparing the next clutch of eggs for laying. All of the turtles seemed to have an increased activity the first days after leaving the beach, and the days before returning, probably due to traveling back and forth between the internesting habitat and the nesting beach.

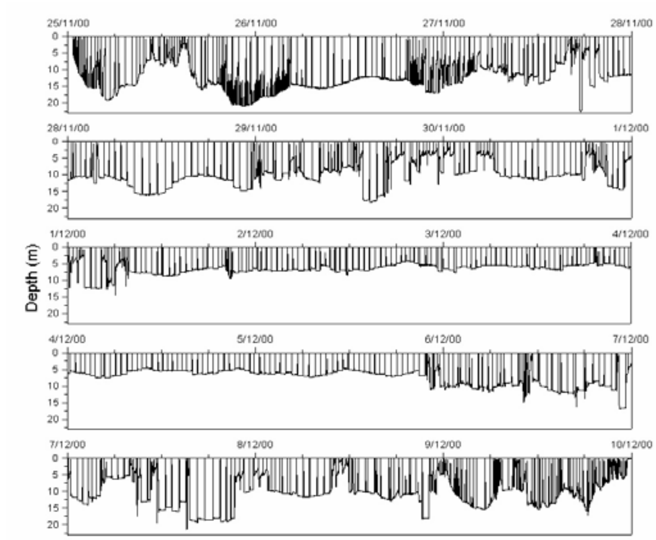

Fig. 1. Example of a full internesting dive profile from turtle K 18551 obtained with a Time-Depth recorder. The majority of the dives are rectangular in shape, where the turtles are apparently staying at the bottom. The bottom shape of these dives, most apparent for November 26, closely follows the tides and suggests that the turtles are lying still or moving around in depth-restricted area.

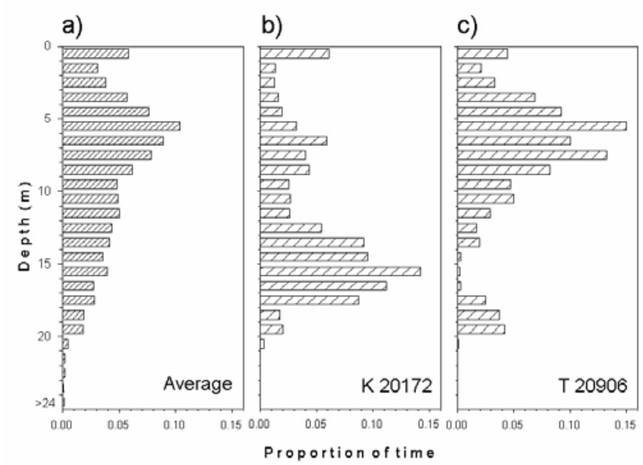

Fig. 2. The proportion of time spent at different depths for all eight turtles (a), turtle K 20172 (b) and turtle T 20906 (c).

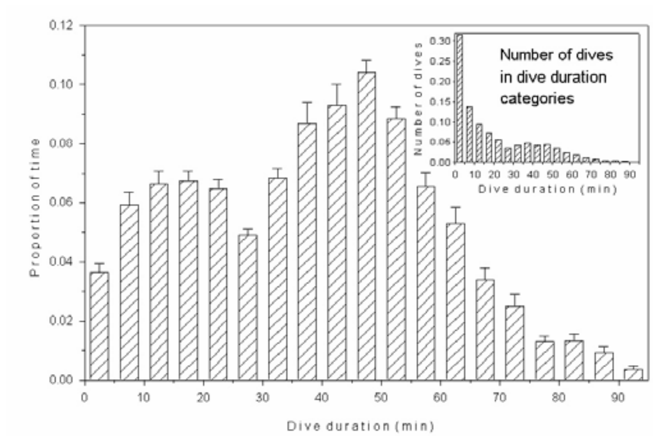

Fig. 3. The proportion of time the turtles spent engaged in dives with different dive duration. In number of dives, however, the turtles made mainly shallower dives, as shown in the inserted graph. The great amount of shallow dives might be partially because the turtles stayed around the baseline (the depth at which the turtles are considered diving) and fluctuations in the depth readings of the TDRs.

Effects of temperature on the timing of emergence of leatherback sea turtle (*Dermochelys coriacea*) hatchlings from the nest

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Hatchling sea turtles primarily emerge from the nest at night. Delaying emergence until nightfall has advantages for the survival of the hatchlings (Mrosovsky 1968, Stancyk 1982). Sand temperature in and around the nest has been demonstrated as one of the major influences on the timing of emergence (Hendrickson 1958, Bustard 1967, Mrosovsky 1968, Witherington 1990, Christens 1990, Moran 1998). There is little information available on the emergence of leatherback hatchlings. The leatherback is in a separate family from other sea turtles and therefore, differs from the other species in many ways. Due to its unique thermal aptitudes (Friar et al. 1972, Paladino et al. 1990, Davenport 1997) the effects of the environment on the hatchlings may differ from the effects on other species. The primary objective of this study was to determine the effects of temperature on the timing of emergence of leatherback hatchlings from the nest. I collected thermal data continuously throughout all stages of emergence within and outside of nests at five depths in the sand. Results indicate that temperature of the sand in the nest influences timing of emergence irrespective of time of day. The seven presently recognized species of sea turtles have a great deal in common but also form minor, species-level phenotype sets or strategies fitted to different ecological niches (Hendrickson 1980). All sea turtles have a common reproductive strategy. They exhibit iteroparous reproduction, stereotyped nesting behavior, lay relatively large numbers of eggs several times during the season, and show relatively strong attachment to a particular location for nesting (Miller 1997). Female sea turtles nest on terrestrial beaches. They emerge from the water onto the beach, use their hind flippers to dig a nest chamber, deposit their eggs, and return to the sea. Sea turtles lay several clutches of eggs during a nesting season. The number of clutches of eggs laid and the interval between successive nesting attempts varies within and between species.

The leatherback (*Dermochelys coriacea*) is in a separate family from other sea turtles and therefore, differs from the other species in many ways. Morphologically, it is the largest turtle. Adults may reach 2.5m in length. Its shell structure consists of a thick layer of fibrous tissue overlaid with a continuous sheet of small bones. Its diet consists solely of jellyfish and tunicates. Leatherbacks are the most widely distributed of all living reptiles (Davenport 1997) and are the most pelagic of sea turtles. They breed in tropical waters and forage in cold waters. Leatherbacks are able to maintain their core body temperature of 25 °C even in cold deep waters, unlike other species (Davenport 1997). Paladino et al. (1990) proposed that leatherbacks can use large body size, peripheral tissues as insulation, and circulatory changes to maintain warm body temperatures in cool waters and to avoid overheating in the tropics. Friar et al. (1972) found that leatherbacks are capable of maintaining a considerable differential between their body temperature and the ambient level in situations where behavioral regulation is not possible. This may be accomplished due to heat production through muscular activity, concurrent flows, subcutaneous blubber, and a high degree of heat retention aided by a large body mass (Friar et al. 1972). Female leatherbacks tend to nest on beaches with large waves and a strong onshore current, producing a steep slope and a rapidly shelving bottom at the water line. Other species prefer calm gradually sloping beaches. The size and shape of the nest chamber are determined by the length of the hind limb and the size of the flipper (Miller 1997). Since leatherbacks are so much larger than the other species of sea turtles, their nests are quite deep (60-80cm). Eggs of marine turtles hatch after six to thirteen weeks of incubation (Miller 1997). The hatchlings don't emerge from the nest chamber immediately. The period of time between hatching and emergence from the nest (emergence lag) varies with species, but has been reported to be from three to seven days (Hendrickson 1958, Carr and Ogren 1960, Kraemer and Richardson 1979, Neville et al. 1989). Sand temperature in and around the nest has been proposed as one of the major influences on the timing of emergence. Hatchling sea turtles usually emerge from the nest chamber at night. It has been proposed that this nocturnal emergence is controlled by temperature. Delaying emergence has advantages for the turtles. Mrosovsky (1968) provided evidence that surface sand temperatures during the day can be fatal to hatchlings that cannot regulate their body temperature and can also decrease their activity level (Mrosovsky 1968), allowing higher numbers of predation events to occur. Stancyk (1982) found that bird predation in some localities is quite heavy on nests that emerge during the day. The hatchlings are most visible to terrestrial predators during the day.

Field work was conducted during the 1999-2000 Leatherback nesting season on Llano Grande beach, in Oaxaca Mexico. The beach was patrolled throughout the night, each night of the season. Eggs were collected from nesting turtles during oviposition or soon after the turtle returned to the water. Eggs were relocated within 5 hours to a hatchery. The hatchery consisted of an area of beach (approximately 50 meters x 15 meters) surrounded by a 2.5 meter high chicken wire fence. The nests were located one meter apart within the hatchery. During egg deposition a capped ½ inch diameter PVC pipe was placed in the side of the nest. The nest was marked with a stake detailing the date, nest number, turtle number, nest depth, and number of eggs deposited. The expected emergence date was calculated from an average of incubation times during the season. Approximately two weeks prior to expected emergence, the original pipe was uncapped and another smaller pipe containing a thermocouple array was inserted inside. The original pipe was removed to place thermocouple electrodes in direct contact with the sand. Each array consisted of 16 gauge thermocouple wire. The thermocouple sensors protruded slightly from holes in the PVC pipe located at five depths, 10 cm apart. Thermocouples were read using a digital thermometer (Omega Engineering, Inc., Stamford, CT). The male end of each thermocouple was stored in a film canister when not in use. Temperatures were recorded within and outside of the nests. Temperatures and times were taken at the surface, 10 cm, 20 cm, 30 cm, 40 cm, and in the air, every 6 hours in the 10 days prior to emergence, and then every 15 minutes after a core collapse was noted. The core collapse indicated a loss of egg turgor and hatchling movement.

Emergence events were divided into distinct stages. Temperatures were taken continuously throughout all stages. Stage 1 was when the first hatchling nose appeared, Stage 2- first whole hatchling body, Stage 3- five hatchlings, Stage 4- ten hatchlings, and Stage 5- a frenzy of hatchling activity. Emergence was defined as 10 or more hatchlings. Emergence events occurred between 18:00 and 04:00 then again between 09:00 and 12:00. The greatest number of emergences occurred between 22:00 and 23:00.

At the time of emergence, the temperature at depths of 20cm, 30cm, and 40cm was significantly higher (ANOVA, $p=0.005$) in the nest array than in the adjacent array. The temperatures at each pair of depths at each stage of emergence was tested to determine relationships between depths. There was no relationship between depth and temperature in the neck (ANOVA, $p=0.850$) at any stage of emergence. However, surface and subsurface temperatures were statistically different (ANOVA, $p=0.005$). The mean temperature at all stages of emergence in the neck was 30.1°C ± 0.23.

There are a number of studies on the mechanism by which hatchlings control emergence times. Hendrickson (1958), Bustard (1967), and Mrosovsky (1968) suggested that thermal cues have a direct effect on the timing of emergence of green turtles (*Chelonia mydas*). Witherington (1990) found that loggerhead (*Caretta caretta*) hatchlings began to emerge as sand temperatures dropped from 34°C to 30°C. Hays et al. (1992) concluded that responding to the rate of change of sand temperature may be a more reliable way of ensuring that emergence occurs at night. Moran (1998) however, demonstrated that for loggerheads, the rate of change was less important than an actual threshold temperature. This study showed that emergences occurred at a mean neck temperature of 30.1°C. The range of temperatures at which turtles emerged was 29.9°C to 32.6°C. This range was relatively limited. There were no emergence events when the neck temperatures were above 32.6°C. Witherington et al. (1990) found that the majority of loggerhead hatchlings emerged when temperatures at a 5cm depth were below a threshold temperature of 33°C. Bustard (1972) found that green turtles did not emerge above 31°C. Mrosovsky (1968) showed that emergence in green turtle hatchlings occurs below a threshold temperature of 28.5°C. Moran (1998) found that loggerhead emergence occurred soon after a threshold temperature of 32.4°C at the surface. Temperatures above a threshold could physiologically inhibit hatchlings (Mrosovsky 1968). All my data were taken from relocated nests. This was due to the threat of poaching and the frequent sampling required. In order to fully understand the nest environment of the hatchlings, data is needed from in situ nests. Moran (1998) found that pre-emergent loggerhead hatchlings heat the sand around them making the nest temperatures significantly higher than adjacent temperatures. My data also showed that temperatures in the neck were significantly higher than adjacent temperatures. As the hatchlings approach the surface, they experience slightly different temperatures, but there was no significant difference between the temperatures at 10cm to 40cm depth at any stage of emergence. Because the temperatures at different depths are so similar, it is possible to that the cues at one depth are representative of the other depths. The temperatures at the surface and 10cm were found to be significantly different from the other neck temperatures due to the activity of the hatchlings and increased environmental effects. Throughout the nesting season, a large number of emergences occurred nocturnally between 18:00 and 04:00, although there were also emergences between 09:00 and 12:00. This thermal data shows that temperature may influence timing of emergence irrespective of time of day. Gyuris (1993) noted that hatchlings emerge on days when it's cool, cloudy, and/or rainy. Christens (1990) provided evidence that emergence occurred earlier in the evening when temperatures were cooler.

The effects of the thermal environment on hatchling emergence may have important implications on the management of the endangered marine turtles. The thermal profiles of hatchery nests could be compared to in situ nests to determine the effects of relocation. The effects of temperature are also important for development of beach areas and renourishment of sand. Investigations of all species must be compared to eliminate discrepancies. The topography of the beaches used for nesting is very different for each species. Further research on the effect of temperature on the physiology of hatchlings of all species is needed also.

Analysis of the stomach and intestinal contents of a hawksbill turtle (*Eretmochelys imbricata*) captured in Porshoure, Zulia State, Venezuela

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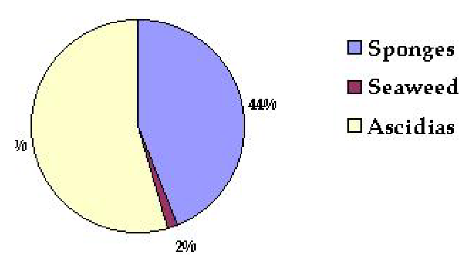
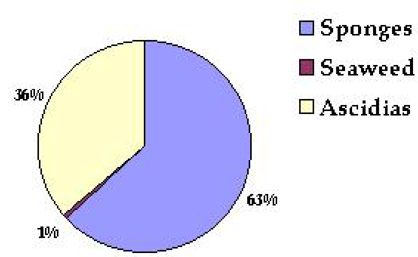
The Venezuelan Gulf represents a vital area of feeding for the marine turtles. The objective is to determine the main components of the diet of a hawksbill turtle (*Eretmochelys imbricata*) captured by artisan fishing activities in the locality of Porshoure (Guajira Venezuelan) and collected by members of the Tortugueros group of the Venezuelan Gulf (TGV). The turtle was a sub-adult male measuring 64.2 cm in carapace length, 56.4 in carapace width, 47.8 cm in plastron length, and 38.6 plastron width. We extracted the stomach and duodenum. Contents were deposited separately in hermetic plastic bags and refrigerated. In the laboratory the total of the samples was weighed in a semi analytical balance, then separated by groups and each item weighed separately. The samples were identified as: Ascidians, sponges (*Chondrilla*) and seaweed (*Udotea*). The sponges constituted 62.9% of the stomach content and 43.4% of the intestines; Ascidians represented 36.1% and 53.8%, respectively, whereas the seaweed measured 0.5% and 1.7%, respectively. The remaining percentage was comprised of shell fragments. Trematode parasites were found in both sections. Reports of the diet of the turtle did not exist for sea turtles in the Venezuelan Gulf and these results indicated that it fed on soft-bodied sessile animals and seaweed.





Orientation of leatherback turtle hatchlings, *Dermochelys coriacea*, at Sandy Point National Wildlife Refuge, US Virgin Islands

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INTRODUCTION

Under natural light conditions hatchlings crawl directly from the nest to the sea, however this sea-finding behavior is usually disrupted if artificial light sources can be seen from the nesting beach (McFarlane 1963, Witherington and Martin 1996). Experiments with loggerheads and green turtles demonstrated that fluctuations in background illumination from the moon could restore normal sea-finding orientation (Irwin et al. 1998, Salmon and Witherington 1995).

Sandy Point National Wildlife Refuge (SPNWR) in St. Croix, US Virgin Islands, supports the largest nesting population of leatherback turtles, *Dermochelys coriacea*, in the United States and northern Caribbean. Although its beaches are protected from public development, the lights from the adjacent town Frederiksted may be affecting hatchlings during their seaward crawl. Our objective was to assess for the first time the leatherback-hatchling orientation at SPNWR considering the presence of the moon.

METHODS

Research was conducted during the 2001 nesting season at SPNWR, located in the southwestern corner of St. Croix, US Virgin Islands (17°41′ N, 064°54′ W). The beach is 2.8 km long and demarcated with numbered stakes every 20 meters. The beach was divided into three sectors. The adjacent town Frederiksted and its suburbs are located northeast of the refuge. Facing seaward, its lights are directly visible to the left at sector I (stake numbers 65 to 139) and to the right at sector III (175 to 205). At sector II (140 to 174) the city lights are only indirectly visible as reflection above the vegetation.

Shortly after the emergence of 236 randomly selected nests, a circular arena (4 m in diameter) was drawn into the sand and the following data collected: (1) Modal direction of hatchling tracks: bearing from the nest to the center of the densest cluster of tracks. The bearing was defined as the clockwise angle (0 to 359º) starting in the direction facing opposite to the shortest path to the sea (Fig. 1a); (2) Crawl spread: angle (1 to 360º) formed by the nest and the most widely separated tracks crossing the arena boundary (Fig. 1b); (3) Date, time, and nest location: triangulation from the nearest two stakes; and (4) Moon condition (moon visible or not visible).

Misorientation was defined as the locomotion on a straight path but in a direction other than toward the sea (Witherington and Martin 1996) and estimated by the deviation of the modal direction from a straight path to the sea. Disorientation was defined as the lack of directed orientation (Witherington and Martin 1996) and estimated by the crawl spread.

Modal-direction and crawl-spread data were grouped into 6 categories (n =236) based combinations of the three sectors and the two moon conditions. We used one-way ANOVA and Tukey-Kramer multiple-comparison procedure to test for significant differences among categories (Sokal and Rohlf 1998). Critical values of Student's t-distribution were used to test for differences between modal direction and the shortest path to the sea. We adjusted the t-values for multiple testing based on Sidak's multiplicative inequality (Rohlf and Sokal 1995, Sokal and Rohlf 1998). All tests were performed with an alpha error set at 0.01. Number of nests, modal direction, and crawl spread of hatchling tracks were averaged within two-stake intervals and then plotted on a map using ArcView GIS 3.2a (Environmental Systems Research Institute, Inc.).

RESULTS

ANOVA showed significant differences among mean modal directions (df=5,231, F=28.9) and mean crawl spreads (df=5, 231, F=10.1). Multiple-comparison procedure detected significant differences in mean modal direction between moon conditions at sectors I and III (Table 1). Mean crawl spread in the category "sector II, moon not visible" was significantly wider than all other categories (Table 2). During "moon not visible" conditions mean modal direction differed significantly from a straight path to the sea at sectors I (t=6.4, n=23) and III (t=9.5, n=52). Nesting activity was highest in sectors II and III (Fig. 2).

DISCUSSION

At SPNWR the artificial lights from Frederiksted and its suburbs significantly disrupted hatchling orientation when the moon was not visible. Where lights were directly visible (sectors I and III), hatchlings significantly deviated from a straight path to the sea toward the lights (misorientation). Where lights were indirectly visible (sector II), crawl spread was significantly wider (disorientation). The presence of the moon lowered the relative brightness of the artificial lights, thus reducing their attractiveness for hatchlings. This is in accordance with results published for loggerhead and green hatchlings, where natural lights restored normal sea finding orientation (Irwin et al. 1998, Salmon and Witherington 1995). Therefore, emergences during "moon not visible" conditions should receive special attention and hatchlings may have to be assisted in their sea finding. The critical times of orientation disruption are given for a lunar month and may aid in developing hatchling management-strategies for SPNWR.

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LITERATURE CITED

Irwin, M.S., B.J. Godley, and A.C. Broderick. 1998. The effect of anthropogenic lighting on marine turtles in northern Cyprus. In: R. Byles and Y. Fernandez, comps. Proceedings of the Sixteenth Annual Symposium on Sea Turtle Biology and Conservation. NOAA Tech. Memo. NMFS- SEFSC-412. p. 71-74.

McFarlane, R.W. 1963. Disorientation of loggerhead hatchlings by artificial road lighting. Copeia 1963:153.

Philibosian, R. 1976. Disorientation of hawksbill turtle hatchlings, *Eretmochelys imbricata*, by stadium lights. Copeia 1976:824.

Rohlf, F.J. and R.R. Sokal. 1995. Statistical tables. Third edition. W. H. Freeman and Company, New York, 199 p.

Salmon, M. and B.E. Witherington. 1995. Artificial lighting and seafinding by loggerhead hatchlings: evidence for lunar modulation. Copeia 1995:931-938.

Sokal, R.R. and F.J. Rohlf. 1998. Biometry: the principles and practice of statistics in biological research. Third edition. W. H. Freeman and Company, New York, 887 p.
Witherington, B.E. and R.E. Martin. 1996. Understanding, assessing, and resolving light-pollution problems on sea turtle nesting beaches. FMRI Technical Report TR-2. Florida Marine Research Institute, St. Petersburg, Florida, 73 p.

Table 1. Mean modal direction considering sector and the moon conditions V (visible) and NV (not visible). Alpha error was 0.01.

Sector	Moon	Misori-entation	Mean	n	SE	T Grouping		
I	NV	19.0	161.0	23	3.0	A	N/A	N/A
I	V	1.3	181.3	21	2.0	Sig.	N/A	N/A
II	NV	11.4	191.4	29	4.3	N/A	B	N/A
II	V	1.2	181.2	26	2.2	N/A	B	N/A
III	NV	26.8	206.8	52	2.8	N/A	N/A	C
III	V	0.0	180.0	85	1.7	N/A	N/A	Sig.

Table 2. Mean crawl spread considering sector and the moon conditions V (visible) and NV (not visible). Alpha error was 0.01.

Sector	Moon	Mean	n	SE	T Grouping	
II	NV	142.2	29	16.9	A	N/A
III	NV	94.7	52	5.8	Sig.	B
I	NV	90.4	23	8.6	Sig.	B
II	V	72.8	26	8.7	Sig.	B
III	V	72.4	85	4.1	Sig.	B
I	V	71.7	21	7.0	Sig.	B

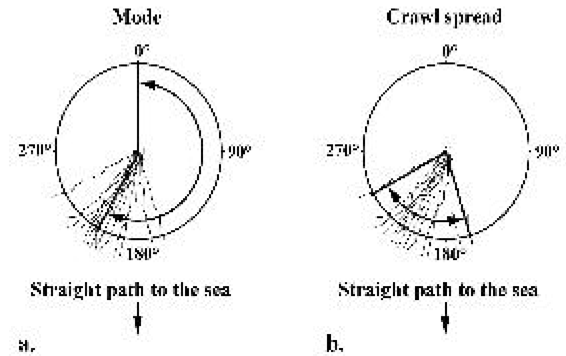

Fig. 1. Modal direction (a) and crawl spread (b) of hatchling tracks.

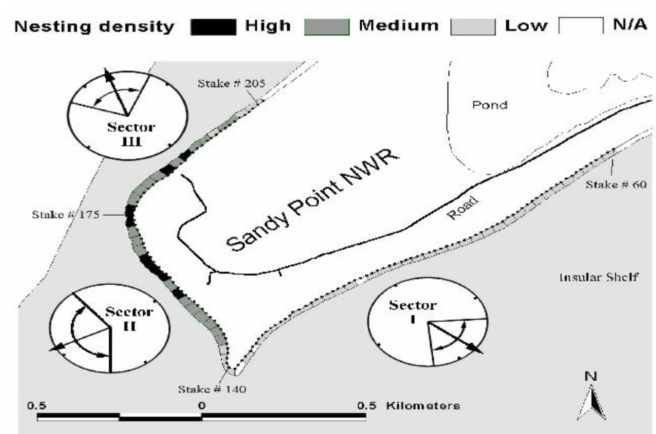

Fig. 2. Mean modal direction and crawl spread at the three sectors and nesting density within two-stake intervals at SPNWR.

Factors affecting cold-stunning of juvenile sea turtles in Massachusetts

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During the fall and early winter, the bayside beaches of Cape Cod Massachusetts are littered with juvenile Kemp's ridley and loggerhead sea turtles from cold-stunning events. These events range in size from 10 to 270+ turtles per year. Regional and local factors such as juvenile dispersal dynamics, offshore water temperature, number and intensity of cold fronts, and near-shore water temperature decline determine sea turtle abundance in New England waters and the date, location, and severity of cold-stunning events in Cape Cod Bay. We will examine these factors to determine their influence on the severity of juvenile sea turtle cold-stunning events. By comparing oceanographic and climatic conditions with stranding data from 1985-2000, we will determine what combination of factors lead to major cold-stunning events. Given the endangered status of Kemp's ridley and loggerhead populations, the number of organizations involved in major stranding events, and the cost associated with long-term rehab and release of cold-stunned animals, this work will provide an early warning system to better facilitate the management of major cold-stunning events in Massachusetts.

Estero Banderitas Marine Protected Area: a critical component to the recovery of the East Pacific green turtle (*Chelonia mydas*)

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INTRODUCTION

The protected coastal lagoons and rich, upwelling waters of the Californias provide critical feeding and developmental habitat for East Pacific green turtles (*Chelonia mydas*), also known commonly as black turtles or tortuga prieta. Green turtles from this region migrate to Michoacán to mate and nest once they reach maturity (Nichols 2000). Though these nesting beaches have been over 90% protected since the 1980's, researchers continued to see a sharp decline in numbers of nesting females throughout the last decade (Alvarado-Diaz and Delgado-Trejo 2001, Cliffton et al. 1982). Direct and indirect take from in-water habitat is primarily responsible for the downward trend in numbers. Mortality is estimated at between 8,000 and 30,000 turtles per year in Baja California – perhaps the most important region for developing and feeding East Pacific green turtles (Nichols 2000, Gardner and Nichols, in press).

Bahia Magdalena, Baja California Sur, is regarded as a critical feeding area for juvenile and adult turtles. Estero Banderitas, the largest branch of the Bahía Magdalena-Almejas complex, is located north of the fishing community of Puerto San Carlos, and encompasses nearly 60 km^2 (approximately 15,000 acres). The estero is characterized by shallow, tidal mud flats surrounding deeper channels, which reach up to 20 m in depth. Fishermen associated with the project reported both a relatively high occurrence of sea turtles and a high level of illegal catch of turtles in this area.

Studies in Estero Banderitas were initiated in the June 2000. They have focused on mark-recapture, home-range analysis, feeding ecology, population demographics and diel movement of sea turtles in the area. In addition, work was begun with eight fishing cooperatives and community members towards establishing a sea turtle protected area in Estero Banderitas (Bird and Nichols, in press). International organizations such as Wildcoast and PRONATURA have joined the efforts. Information from studies conducted in Estero Banderitas will directly inform the establishment of the marine protected area.

METHODS

Mark-recapture. Two 100-m entanglement nets were deployed to catch turtles within Estero Banderitas at four locations. The nets were drifted with the current or anchored across channels, depending on tidal conditions, and were constantly monitored by kayak or panga. Standard morphometric data were recorded for each turtle captured, including straight carapace length (SCL-measured notch to tip), curved carapace length (CCL), and weight. Inconel tags (National Band and Tag Company, Newport, KY, USA) were attached to the rear flippers of each turtle. Turtles were released at the site of capture.

Diel movement. Turtles were tracked with a tethered radio transmitter. Turtles were tracked day and night by kayak. GPS, depth, and environmental data were taken every fifteen minutes for the duration of the tracking period. Behavior, breathing patterns, water temperature and proximity of additional turtles were also noted.

RESULTS

Mark-recapture. A total of 117 captures have been made in Estero Banderitas. These consist of 85 individual turtles: 82 green turtles and three hawksbill (*Eretmochelys imbricata*) turtles. Mean SCL for green turtles was 51.6 cm (n=82, range=41.2 – 79.4 cm., Fig. 1). Mean weight was 42.4 lbs (n=77, range=18.0 – 140.0 lbs). Turtles were captured in both summer and winter months and water temperature varied from 16°C to 29°C. Sixteen individuals were recaptured a total of thirty-two times. The average time at large was 200 days (range=1-456 days). Those that remained at large ten or more months (n=8) averaged 2 cm SCL growth per year. Individuals were captured at both major capture areas.

Diel movement. Data obtained from initial tracking studies are preliminary in nature and are presented qualitatively here. A total of eleven turtles were tracked for from four to forty-eight hours. Data and observations suggest that: (1) turtles move through the entire Estero Banderitas region and travel upwards of twenty-five km per day; (2) turtles are found in depths between 2 - 20 m; (3) turtles move during both day and night; (4) turtles do not leave Estero Banderitas during typical daily movement (5) turtle movement is influenced by the strong tidal currents in the estero; and (6) turtles may be drifting with the currents during the strong ebb and flow stages of the tidal cycle, and feeding and swimming during the slack stages.

DISCUSSION

Captures in Estero Banderitas indicate that the area is not only an important habitat for the endangered green turtle, but one of the last known refuges for the rarely-encountered east Pacific hawksbill. The size distribution of the green turtles captured in Estero Banderitas suggests that this is an important area for juvenile turtles. Of eighty-five captures, only one turtle was of mature size (SCL=79.4 cm). The lack of adult turtles could reflect the regional decline in abundance of large turtles (Koch, this symposium) or an adult tendency to move to deeper waters. Year-round capture data indicate that turtles utilize the area in both summer and winter. Recapture data support this, as individuals were caught in the estero in summer were recaptured in the winter (n=5), and vice versa (n=1). Recapture data also suggest that turtles are moving widely throughout the estero. Turtles captured at one net site were often recaptured at another more than two miles away.

Growth data, while scarce, indicate that turtles are growing at rates comparable to green turtles in similar habitats. Individuals that remained at large for ten or more months (n=8) exhibited a growth rate of approximately 2 cm/year. This can be compared to mean growth rates for Gulf of California green turtles of approximately 2.0 cm/y (Nichols and Seminoff, unpubl. data). Also, Zug et al. (2002) recently calculated growth rates of Hawaiian green turtles in similar age classes (40-70 cm SCL) to be from 2.1 to 2.3 cm/year. Future mark-recapture work will increase sample size to aid in population size estimates (by use of Jolly-Seber model), mortality rates, growth rates and other demographic statistics regarding this population.

Research concerning diel movement of turtles in Estero Banderitas remains in its preliminary stages. Further deployments of radio and GPS transmitters will occur during the 2002 field season in order to provide fine-scale GPS data, which will be analyzed and compared to tidal current information. Preliminary observations (n=10) indicate that turtles are moving great distances throughout the estero on a daily basis, and that these movements are significantly affected by the strong tidal currents in the area.

Conservation and the proposed marine protected area. Mortality data for sea turtles in the Baja California region place it among the deadliest in the world (Nichols 2000). Biologists, community activists, fishers, students and conservationists recognize that sea turtle protection and population recovery will be successful through a "mosaic" of approaches, focusing on mortality reduction in the in-water habitat. Estero Banderitas presents a unique opportunity to protect the sea turtles of this region; the region is biologically, economically and socially appropriate for a reserve.

Biologically, Estero Banderitas is home to a relatively large number of green turtles, most of which are juveniles or subadults. Elasticity analyses indicate that this is the most important age class to protect for sea turtles, and protection of this age-class will result in a faster recovery of the population (Heppell et al. 1999). Sea turtles found in Estero Banderitas appear to remain in the area year-round, indicating that a protected area encompassing the estero would protect their developmental habitat during a critical life stage. Economically, Estero Banderitas has brought both tourist and conservation resources to the community. Estero Banderitas is one of six monitoring sites on the peninsula in a project funded by USFWS and NMFS. Alternative tourism (e.g. eco- and science tourism) has the potential to be a source of economic growth for the community, as both kayak companies and school groups already visit the area.

Socially, the Estero Banderitas Reserve is a community catalyst. It is recognized that successful conservation endeavors must be supported and initiated by the community. Marsh et al. (this symposium) and Garcia-Martinez et al. (this symposium) indicate that there is substantial community support in Puerto San Carlos for the protected area, and for community involvement in the management and monitoring of the area. In addition, local knowledge has guided the research and conservation work (Bird et al., this symposium). This approach provides ownership of the reserve initiative.

Studies in Estero Banderitas are motivated and guided by its potential designation as a sea turtle marine protected area, and by the community-based conservation initiatives that will be central to the area's success. Estero Banderitas is poised to become the first in-water sea turtle protected area in the Californias and a model of successful community based conservation for endangered species.

LITERATURE CITED

Alvarado-Diaz, J. and C. Delgado-Trejo. In press. Evaluation of the black turtle project in Michoacán, Mexico. In: M. Coyne, comp. Proceedings of the Twentieth Annual Symposium on Biology and Conservation. Philadelphia, Pennsylvania.

Bird, K.E., W.J. Nichols and C.R. Tambiah. This symposium. Integrating local knowledge and outside science in sea turtle conservation: a case from Baja California, Mexico.

Bird, K. and W.J. Nichols. In press. The evolution of community-based conservation action: formation of the Comité para Protección de las Tortugas Marinas, Bahía Magdalena, Baja California Sur, México. Proceedings of the 21st Annual Symposium on Sea Turtle Biology and Conservation.

Cliffton, K., D.O. Cornejo, and R.S. Felger. 1982. Sea turtles of the Pacific coast of Mexico. In: K.A. Bjorndal, ed. Biology and Conservation of Sea Turtles. Smithsonian Institution Press, Washington, D.C. p. 199-209.

Garcia-Martinez, S., A.S. Scherr, R. Jason, G. Anderson and T. Saturen. This symposium. Conserving black sea turtles: assessing the willingness to accept a marine protected area in Estero Banderitas, Baja California Sur, Mexico.

Gardner, S.C. and W. J. Nichols. In press. Mortality rates of sea turtle species in the Bahía Magdalena region. Proceedings of the Twentieth Annual Symposium on Sea Turtle Biology and Conservation, Orlando, FL, USA. 29 February 29-March 4, 2000.

Heppell, S.S., L.B. Crowder and T.R. Menzel. 1999. Life table analysis of long-lived marine species with implications for conservation and management. American Fisheries Society Symposium 23:137-148.

Koch, V. This symposium. Black turtle (*Chelonia mydas*) mortality in Bahia Magdalena, Baja California Sur, Mexico.

Marsh, J.C., W.J. Nichols, E. Palacios-Castro, S. Garcia-Martinez and K.E. Bird. This symposium. Community-based coastal resource management: success factors and the sea turtle reserve in Estero Banderitas, BCS, Mexico.

Nichols, W.J. 2000. Biology and conservation of the sea turtles of the Baja California peninsula, Mexico. Ph.D. Dissertation. The University of Arizona, Tucson.

Zug, G.R., G.H. Balazs, J.A. Wetherall, D.M. Parker and S.K.K. Murakawa. 2002. Age and growth of Hawaiian green seaturtles (*Chelonia mydas*): an analysis based on skeletochronology. Fisheries Bulletin 100:117-127.

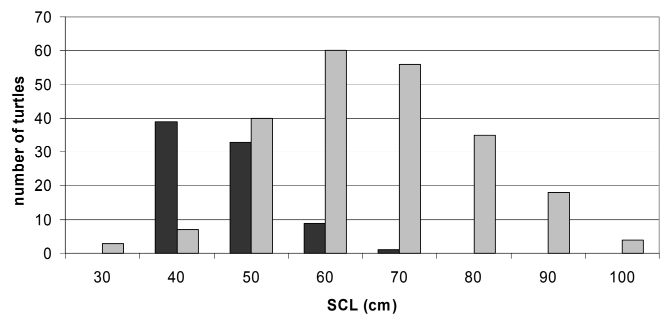

Fig. 1. Length frequency (in cm) of green turtles encountered in Baja California (1994-1999) in light (n=223) vs. green turtles captured in Estero Banderitas (2000-2002) in dark (n=82).

In-water surveys of green sea turtles (*Chelonia mydas*) at Culebra Archipelago, Puerto Rico

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Past in-water surveys on green sea turtles' feeding grounds at Culebra Archipelago have been conducted from 1986 to 1989 in order to obtain information on population dynamics of the juvenile and sub-adult green turtles found in the area. During 1998, U.S. National Marine Fisheries Service reinitiated this study for a one-year survey to evaluate the current status of this aggregation (Rivera, pers. comm.). The 1998 survey results, combined with the data collected by Collazo et al. (1992), demonstrate the importance of these feeding grounds and the need for long-term continued monitoring. Somatic growth rates and prevalence of fibropapillomas in the green turtle aggregation are some of the parameters that are assessed. The following poster will present a summary of the results obtained during in-water surveys conducted by us on June 2000 to June 2001 at the Culebra Archipelago combined with the results of past studies in the area.

Juvenile *Lepidochelys olivacea* in the open sea

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INTRODUCTION

The use of marine turtles as a food resource has caused seven species of marine turtles to be declared in danger of extinction by CITES (Hykle 2000) and listed in the Red List Book of Threatened Animals of the IUCN (Baillie and Groombrige 1996). For a long time, conservation efforts were concentrated on protecting the nesting females and their eggs. At the moment, distribution of marine turtles in areas of resting, feeding, growth, and their migratory routes has become a topic of great interest because fisheries severely impact populations and because this unknown aspect of their lives opens new investigation perspectives. Once the hatchlings emerge from their beachfront nests, they enter the sea to begin a pelagic stage known as "the lost year" that, in fact, can last several years (Musick and Limpus 1997). This stage has been considered "the most substantial obstacle to understand the ecology of the marine turtles" (Carr 1982). The loggerhead (*Caretta caretta*), green (*Chelonia mydas*), and hawksbill (*Eretmochelys imbricata*) have been observed to float in the Sargasso drift accumulations or tide lines formed by the oceanic currents, while the flat back (*Natator depressus*), endemic to Australia, remains in coastal waters. The habitat of the juvenile leatherback (*Dermochelys coriacea*) and olive ridley (*Lepidochelys olivacea*) continue to be ignored (Meylan and Meylan 2000). Olive ridleys (*L. olivacea*) are distributed mainly in neritic and coastal areas, and sometime in pelagic areas. In the Eastern Pacific, adults are restricted to warm tropical waters, limited on the north by the California Current and on the south by the Humboldt Current. There are few reports of findings west of 140° W. Elsewhere, few, if any, findings are known about the habitat of juveniles during development. It is hypothesized that distribution of juveniles would be similar to adults, depending on food sources (Márquez 1990, NMFS and USFWS 1998, Pitman 1990). In one study in open seas of the Eastern Tropical Pacific that included several years of sailing, olive ridley was considered the most abundant and widely distributed. However, no juvenile was reported (Pitman 1990). This abundance can not be explained. The coast of Mexico and Costa Rica are two of the most important nesting areas for the olive ridley. For example, on La Escobilla beach in Oaxaca state, Mexico, thousands of turtles deposit millions of eggs. There are millions of hatchlings, but their destiny is unknown.

METHODS

Four traverse marine surveys were carried out between Socorro Island of the Revillagigedo Archipelago (18°45' N, 111° W), and Bahia de Manzanillo (19°N, 104°38' W) in the Pacific on the following dates: 3-4 November 1999 Manzanillo – Socorro; 8-10 December 1999 Socorro – Manzanillo; 9-10 October 2000 Manzanillo – Socorro; and 5-6 December 2000 Socorro – Manzanillo. Observations were made by at least two observers at the same time, one from a high point in the crow's-nest or the command cabin, and the other from the prow of the main deck during the day. Each sighted turtle was identified by species, the geographical position was determined with the GPS of the ship, and the time of the observation was recorded. An olive ridley juvenile was captured and examined carefully to verify the species, and it was weighed. We took pictures and the curved carapace length (CCL) and curve carapace width (CCW) were measured with a metric tape as recommended by Bolten (2000). The size of observed turtles was estimated from the size of the captured turtle after it was returned to the sea.

RESULTS AND DISCUSSION

On 9 December 1999, an olive ridley juvenile was captured in the middle of the traverse between Socorro and Manzanillo. CCL was 29 cm, passing the metric tape on one side of the keel only present in juveniles, CCW was 32.7 cm, and the specimen weighed 2.025 kg. On 9 October 2000, on the traverse from Manzanillo to Socorro, 14 *L. olivacea* were sighted, 11 juveniles and 3 adults. All the juveniles appeared to be the same size as the measured specimen, about 30 cm CCL.

The olive ridleys observed in this survey were sighted between 106° 40.75' and 108° 05.4' W and 18°51.5' and 18°56.04 ' N (Fig. 1). It is worth mentioning that the 11 juveniles observed on October 9 were sighted within a relatively short distance of each other and almost always seen in pairs. The specimen at the left of the square in Fig. 1, is the one captured in 1999. This is a pelagic environment without any visible land or algae accumulation. Depth ranges from the 2 to 3.5 km. About halfway in the latitudinal transect (107° 30'), an ocean floor elevation patch is only about 1.7 km deep and., other similar elevations are present around this transect (INEGI 1983). Although this is also a great depth, it is curious that the mature turtles were nearer to these positions, (Fig. 1), while all the juveniles were observed in areas of depths greater than 2 km.

Other olive ridley turtles observations have been reported in the vicinity of the Archipelago of Revillagigedo, but none were juveniles, nor in groups such as reported here. Caldwell (1966) reported olive ridleys (without mentioning state of maturity) between Baja California and Socorro Island in the Archipelago, while Argueta (1994) reported 4 individuals of this species in the waters of the Archipelago, three in waters of Clarión Island (60-70 cm length) and another (40 cm), which is similar to the range of sizes for turtles observed in this survey.

Aggregations of immature loggerhead turtles have been reported in relatively shallow areas. The turtles ranged from 21.6 cm upward, but averaged 74 cm CCL. Aggregations of juveniles in the open sea measured between 20 and 30 cm. (Lutcavage and Musick 1985, Pitman 1990). Both olive ridley and loggerhead turtles could be the only turtles with hard shells that remain for a considerable time in their pelagic areas. An advantage of growth in the pelagic area is the low density of potential predators in comparison with a shallow environment (Musick and Limpus 1997). However, food availability and refuge become more difficult.

There are many issues that remain unanswered. What is the role that marine turtles play in the exchange of matter and energy in areas of low primary productivity? What is the survival rate during this developmental stage? Why do the turtles seem to choose this area within the wide ocean?

The observations made in this work were carried out in a linear survey, east-west an not north-south; is possible for that to find more juvenile olive ridleys toward north and south behind the same longitudes registered in this study. Because specimens were captured and observed in two years and mariners' reports have described turtles that match the characteristics of juvenile olive ridleys in this area, it is possible that the turtles are present throughout the year, or possibly only during the fall months. The distribution of juveniles of some species of marine turtle change, depending on the time of year, although this happens mainly in temperate zones (Musick and Limpus 1997).

It is necessary to devote more effort in the study of the pelagic phase of marine turtles; but the main obstacle is the high economic costs of a study to define nurturing zones and the difficulty of spotting and recognizing small organisms in the open sea. However, sightings of aggregations of juvenile turtles in the open sea, like the one described here, will facilitate considerations for fisheries regulations in the open sea, and this is a first step to plan research protocols for further studies of marine turtle biology and migrations in years after hatchling success.

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LITERATURE CITED

Argueta, V.T. 1994. Importancia del Archipiélago Revillagigedo, Colima, como zona de alimentación, crecimiento y anidación de tortugas marinas. Tesis de Licenciatura. UNAM. Facultad de Ciencias, México

Baillie, J. and B. Groombridge. 1996. IUCN Red List of Threatened Animals. World Conservation Union (IUCN), Gland, Switzerland. 368 p.

Bolten, A.B. 2000. Técnicas Para la Medición de Tortugas Marinas. In: K.L. Eckert, K.L. Bjorndal, F.A. Abreu-Grobois, and M. Donnelly, eds. Técnicas de Investigación y Manejo Para la Conservación de las Tortugas Marinas. Grupo de Especialistas en Tortugas Marinas UICN/CSE Publicación No. 4.

Caldwell, D.K. 1966. A nesting report on the American ridley. International Turtle and Tortoise Society Journal 1:10-13.

Carr, A. 1982. Notes on the behavioral ecology of sea turtles. In: K.A. Bjorndal, ed. Biology and Conservation of Sea Turtles. Smithsonian Institution Press, Washington, D.C.

Hykle, D. 2000. Tratados Internacionales de Conservación. In: K.L. Eckert, K.L. Bjorndal, F.A. Abreu-Grobois, and M. Donnelly, eds. Técnicas de Investigación y Manejo Para la Conservación de las Tortugas Marinas. Grupo de Especialistas en Tortugas Marinas UICN/CSE Publicación No. 4.

INEGI. 1983. Islas Revillagigedo. Carta Batimétrica, 1:1000000. Dirección Grl. De Geografía. CB:0065PP

Lutcavage, M. and J.A. Musick. 1985. Aspects of the biology of sea turtles in Virginia. Copeia 1985:449-456

Márquez, R. 1990. FAO species catalogue. Vol.11: Sea Turtles of the world. An annotated and illustrated catalogue of sea turtle species known to date. FAO Fisheries Synopsis. No. 125, Vol. 11. Rome, FAO. 1990. 81 p.

Meylan, A.B. and P.A. Meylan. 2000. Introducción a la evolución, historias de vida y biología de las tortugas marinas. In: K.L. Eckert, K.A. Bjorndal, F.A. Abreu-Grobois, and M. Donnelly, eds. Técnicas de Investigación y Manejo Para la Conservación de las Tortugas Marinas. Grupo de Especialistas en Tortugas Marinas UICN/CSE Publicación No. 4.

Musick, J.A. and C.J. Limpus. 1997. Habitat utilization and migration in juvenile sea turtles. In: P.L. Lutz and J.A. Musick, eds. The Biology of Sea Turtles. CRC Press. Boca Raton, FL. p. 137-163.

NMFS and USFWS. 1998. Recovery plan for U.S. Pacific populations of the olive ridley turtle (*Lepidochelys olivacea*). National Marine Fisheries Service, Silver Spring, MD.

Pitman, R.L. 1990. Pelagic distribution and biology of sea turtles in the Eastern Tropical Pacific. In: T.H. Richardson, J.I. Richardson and M. Donnelly, comps. Proceedings of the Tenth Annual Symposium on Sea Turtle Biology and Conservation. NOAA Tech. Memo. NMFS-SEFC-278, p. 143-148.

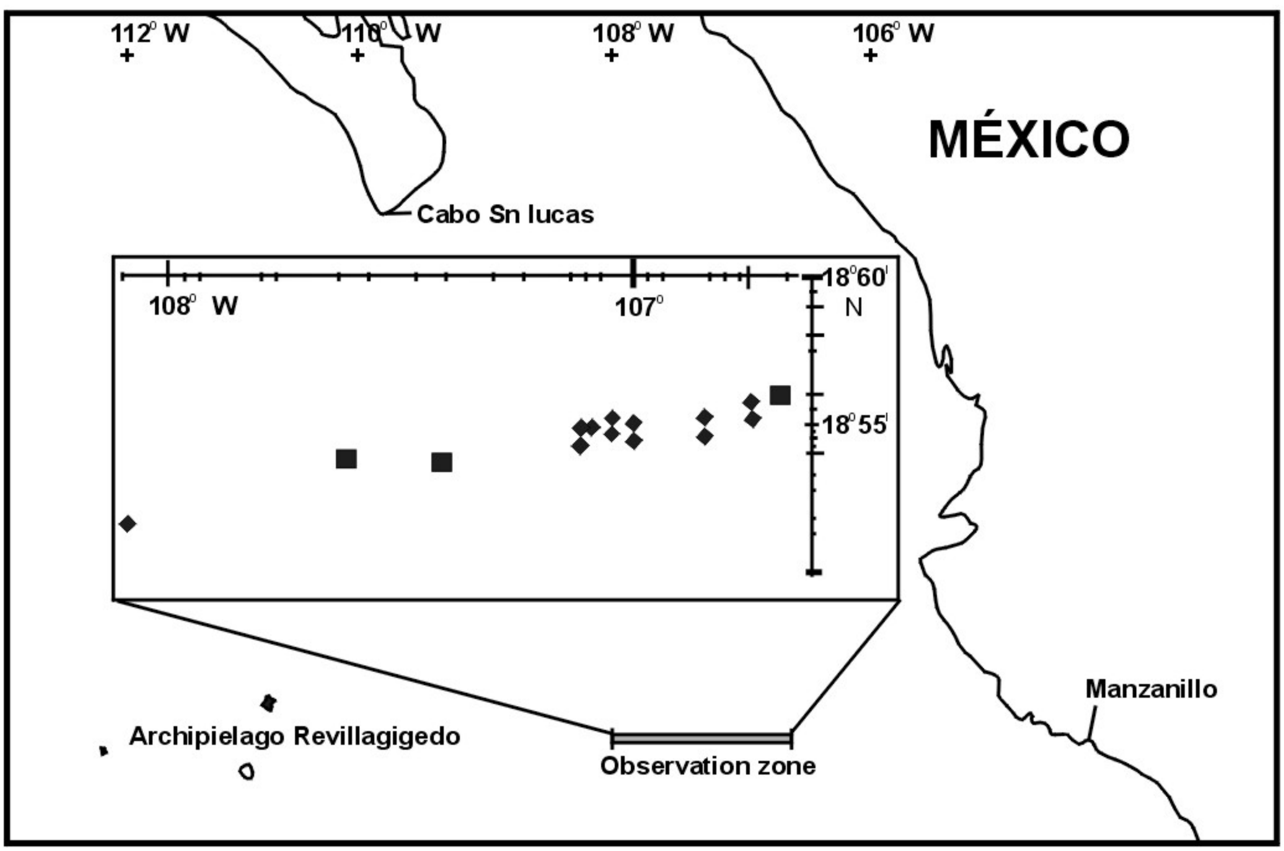

Fig. 1. Olive ridley distribution in open sea trough a census between Revillagigedos Archipelago and Manzanillo Port. Black diamonds are juveniles and black squares are adults.

Juvenile hawksbill sea turtle habitat use depicted by radio and sonic telemetry

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Juvenile hawksbill, *Eretmochelys imbricata*, and green, *Chelonia mydas*, sea turtles are found in the waters of Buck Island Reef National Monument, St. Croix, U.S. Virgin Islands. Line transect snorkel surveys were conducted at Buck Island in the summer of 1998 and winter of 1999. The monument was divided into survey blocks (A-R) and all turtles were noted along with major habitat types. Green turtles were found in the southern area of the monument either adjacent to or near areas of large sea grass beds, which are predominant foraging areas for green sea turtles. Most juvenile hawksbills were sighted along the north side of the monument in areas of high zoanthid cover. Juvenile hawksbills preferentially feed on zoanthids at Buck Island where sponges are very rare. Five juvenile hawksbills were radio tracked between 1998 - 1999. These turtles exhibited strong site philopatry for the north side of Buck Island. Each turtle monitored had a relatively small home range (£ 2 km^2) which it occupied for at least several months. The turtles moved less than 1.09 km over a period of several months. Their ranges appeared to not be limited by the park boundaries but possibly by the distribution of zoanthids in the habitat. Judging from past tag and recapture and recent telemetry studies, these animals may be resident in the habitat for periods of at least several years. Strong site philopatry was maintained by one juvenile hawksbill despite the passage of Hurricane Lenny in November of 1999.

"Shark fishing": a technique for estimating the distribution of juvenile green turtles (*Chelonia mydas*) in shallow water developmental habitats, Palm Beach County, Florida USA

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Juvenile green turtles return to shallow-water "developmental" habitats as "dinner-plate" sized individuals, after 1-2 years in the open ocean. Our objective was to estimate the abundance and distribution of these turtles in the shallow (2-6 m depth) waters of Palm Beach County, Florida (72.63 km of shoreline). This area consists of patches of narrow reef that parallel shore, often for several km. Between the reefs are areas of sandy bottom, devoid of structure. Generally clear waters (10 – 15 m lateral visibility) enabled us to survey by "shark fishing": instantaneous observations by two observers, scanning for turtles located to each side of a slowly (1.5 – 2.5 km/h) moving boat. The boat was driven parallel to shore in transects over every reef, as well as three sandy bottom regions of similar depth. A total of 25 transects were made during 10 days of observations. When a turtle was seen, its position was recorded by GPS and its size (carapace length) was estimated. Turtles showed little tendency to flee from the boat or observers, probably because they are acclimated to high levels of local boating and diving activity. No turtles were seen over sand. Sixty-five turtles, ranging from 15.26 – 40.64 cm in carapace length were seen over the reefs. Results suggest that the technique is an efficient method for instantaneous estimates of habitat use, essential to managers. Many questions remain for future study, for example, season patterns of habitat use in relation to resource abundance and distribution. These topics remain for future study.

A review of foraging habitat along Florida's east coast: are marine turtles at risk?

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Marine turtles utilize a diversity of in-water habitats during their complex life cycles, from oceanic waters and offshore reefs to sea grass beds, nearshore reefs and coastal lagoons. In Florida, loggerhead, green, leatherback, hawksbill, and Kemp's ridley turtles have been reported from all of these habitat types. While many of these natural communities are protected from most human impacts, others, in particular nearshore reefs and coastal lagoons, remain at risk. Recent plans to nourish many beaches along Florida's Atlantic coast from Brevard through Dade County could result in the destruction of up to 100 acres of nearshore reef. While utilization of these communities by juvenile green turtles has been well documented in some depths and regions of the state, use of nearshore hard bottom in other areas by juvenile greens or any marine turtle species is not well known. Proponents for beach restoration projects argue that loss of this particular community type is insignificant given the relative abundance of other hard bottom communities in deeper waters at the site. This perspective assumes that the composition of hard bottom communities and utilization by foraging turtles are static with respect to depth or location along the shoreline. Information on the composition of benthic communities on hard bottom, potential biotic and abiotic factors influencing these communities, and the known foraging requirements for different marine turtle species will be assessed for a number of proposed impact sites.

Abundance and distribution of green turtles within shallow, hard-bottom foraging habitat adjacent to a Florida nesting beach

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The hard-bottom reef environment in the Atlantic Ocean adjacent to sand beaches of Indian River County, Florida, represents a unique foraging habitat type for the green turtle, supporting an abundance of macroalgae in an area where breaking waves and longshore current have a large influence. Green turtles forage in high density in this region. To determine the distribution and abundance of green turtles within this habitat, an in-water survey was conducted during the summer of 2001. The nearshore region of Indian River County, spanning approximately 20 miles from north to south, was sampled using nine transect lines representing the northern, middle and southern county, and three distances from shore: 91 meters, 183 meters, and 366 meters. Turtles were sighted from a 3.85 meter tower on a boat moving at approximately 5.5 knots along each of the transect lines. The position of each sighted turtle was determined by a global positioning system on the vessel, an inclinometer reading to the sighted turtle, and trigonometric calculations of distance from the vessel. On four survey dates, 126 green turtles and 17 loggerhead sea turtles were sighted throughout the study area. The vast majority of individuals were sighted in the northern transects, more turtles being found along the 91 meters-from-shore transect than those transects further from shore. The technique of quantifying the distribution of sea turtles from an observation platform on a slow moving vessel is one that might be used in a number of similar habitats.

Locations and movements of juvenile sea turtles in the bay systems and coastal waters of Alabama

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INTRODUCTION

Estuarine ecosystems may serve as critical habitat for sea turtles in the northern Gulf of Mexico (Carr and Caldwell 1956, Hildebrand 1982, Ogren 1989), especially for the survival of Kemp's ridley and loggerhead sea turtles, since they could serve as developmental habitat for juveniles (Musick and Limpus 1990). In fact, estuaries may be optimal foraging grounds for juvenile turtles, given that the location of turtles may be correlated with certain crabs which are abundant in estuaries (Ogren 1989). Further, since the severely endangered Kemp's ridley is primarily restricted to the Gulf of Mexico, the estuaries may be a critical asset for its survival. Although the coast of Alabama represents one of the major estuarine systems in the northern Gulf of Mexico, the abundance of juvenile sea turtles in this ecosystem has never been adequately examined. It is clear, that numerous juvenile turtles have been captured in trawls in this area (Carr 1980, Ogren 1989), but this is based on anecdotal observations in the past. Additionally, stranding data clearly indicate that sea turtles such as Kemp's ridleys and loggerheads inhabit the near-shore waters and bay systems of Alabama, but such data does not identify specific foraging areas within these waters. During the spring, summer, and fall of 2001, we surveyed a variety of areas in the bay systems of Alabama for juvenile sea turtles. Information of this sort is a prerequisite for designing an optimal management strategy for Alabama estuaries that would protect sea turtles and prevent possible conflicts with fisheries and coastal development.

METHODS AND MATERIALS

We used a tangle net methodology combined with observational surveys in order to examine a variety of areas in the Alabama bay systems during the spring, summer, and fall of 2001. Additionally, we interacted with the stranding network in order to obtain additional turtles for tracking studies. The tangle net methodology was similar to that currently being used on a routine basis by sea turtle projects in Florida and Texas (Ehrhart 1983, Goodman et al. 1996). The tangle net is a relatively long (223 m), shallow depth (3 m), wide mesh (25 cm) net. It is anchored on both ends and supported by floats along the top line of the net. The net is set in potential foraging areas and is continually tended. The net is checked at regular intervals of approximately 30 minutes. All turtles are immediately removed from the net. We also used observational methodology which has proven effective for catching Kemp's ridley at Ten Thousand Islands, FL (Witzell and Schmitt pers. comm.). This technique involved systematic observational surveys of nearshore waters from a boat. Typically, we would anchor the boat for approximately 30 minutes and post observers to watch for turtle heads in the entire 360 degree area surrounding the boat. We would systematically move the boat in order to cover a given survey area. If a turtle was spotted, the net was then deployed in an attempt to capture the turtle. Turtle obtained during our study were subsequently tracked with either sonic or satellite transmitters.

RESULTS AND DISCUSSION

During the spring, summer, and fall of 2001 we conducted 16 days of sampling and/or observations in areas ranging from the far western portion of the Alabama near Bayou La Batre to the far eastern portion of Alabama in Perdido Bay. During that period we tagged and tracked three juvenile turtles, two loggerheads and one Kemp's ridley. We successfully tracked a loggerhead turtle in the Perdido Bay area over an approximate 24 hour period. The turtle moved approximately 2 kilometers down Cotton Bayou to the area near the Perdido Bay channel. It later moved back to the western end of the Bayou near its point of release. We also tracked a juvenile Kemp's ridley down the Fowl

River for several kilometers. It was initially released at the mouth of the Fowl River and then moved several km west down the river and took up residency for approximately 20 hours. We also tracked a juvenile loggerhead for approximately 40 days using a satellite transmitter (Telonics ST-18-A200) (methods described by Balazs and Dutton 2000). During that time period, the turtle was tracked for hundreds of kilometers, including in nearshore, offshore, and bay waters. The turtle initially moved east from Dauphin Island to Perdido Bay. It then traveled in nearshore waters into Florida before heading offshore. Once offshore, the turtle moved west back through Alabama waters to the Mississippi/Alabama border and remained in an area south of Dauphin Island and Petit Bois Island for several weeks. During 2001 we also obtained recapture data on two juvenile turtles captured in previous years of this study. In one case, a loggerhead captured in Perdido Bay was recaptured one year later, several kilometers from the original capture site. In another case, a loggerhead had moved from Perdido Bay into Pensacola Bay over a several month period. Through this study we are generating baseline data on the location, abundance, and movement of juvenile sea turtles in estuarine and coastal waters of Alabama.

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LITERATURE CITED

Balazs, G. and P. Dutton. 2000. Proceedings of the Pacific Region Training Workshop on the Use of Satellite Transmitters and the Argos System to Track Post-Nesting Migrations of Hawksbill Turtles. August 7-11, 2000. NMFS Laboratory, Honolulu, HI

Carr, A. 1980. Some problems of sea turtle ecology. Amer. Zool. 20:489-498.

Carr, A., and D.K. Caldwell. 1956. The ecology and migrations of sea turtles, 1 results of field work in Florida, 1955. American Museum Novitates 1793:1-23.

Ehrhart, L.M. 1983. Marine turtles from the Indian River Lagoon System. Florida Sci. 46:337.

Goodman, L.C., M.S. Coyne, and A.M. Landry. 1996. Fidelity of green sea turtle to jetty habitat in south Texas waters. In: J.A. Keinath, D.E. Barnard, J.A. Musick, and B.A. Bell, comps. Proceedings of the Fifteenth Annual Symposium on Biology and Conservation. NOAA Tech. Memo. NMFS-SEFSC-387. p. 105-106.

Hildebrand, H.H. 1982. A historical review of the status of sea turtles populations in the western Gulf of Mexico. In: K.A. Bjorndal, ed. Biology and Conservation of Sea Turtles. Smithsonian Inst. Press, Washington, D.C. p. 447-453.

Hoskings, W., S. Chang, H.A. Clonts Jr., A.R. St. Clair. 1990. Economic aspects of Mobile Bay. In: Mobile Bay: Issues, Resources, Status, and Management. NOAA Estuarine Programs Office. NOAA Estuary-of-the-Month Seminar Series No. 15.

Magnuson J.J., K.A. Bjorndal, W.D. DuPaul, G.L. Graham, D.W. Owens, P.C.H. Pritchard, G.E. Saul, and C.W. West. 1990. Decline of the Sea Turtles. National Research Council, National Academy Press, Washington, D.C.

Musick, J.A. and C. Limpus. 1996. Habitat utilization and migration of juvenile sea turtles. In: P. Lutz and J. Musick, eds. The Biology of Sea Turtles. CRC Press, Boca Raton. p. 137-164.

Ogren, L. 1989. Distribution of juvenile and subadult Kemp's ridley turtles: preliminary results from the 1984-1987 surveys. In: C. Caillouet and A. Landre, eds. Proceeding of the First International Symposium on Kemp's Ridley Sea Turtle Biology, Conservation and Management. Texas A&M Sea Grant College Publication. p. 116-123.

Schmid, J.R. 1998. Marine turtle populations on the west central coast of Florida: results of tagging studies, 1986-1995. Fish. Bull. 96:589-602.

Is it possible to obtain trends in sea turtle abundance from pelagic longline logbook data?

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Loggerheads (*Caretta caretta*) and leatherbacks (*Dermochelys coriacea*) are the sea turtle species most commonly taken as bycatch in the Northwest Atlantic pelagic longline fishery. We modelled trends in abundance for these species using U.S. logbook data, the largest pelagic longline dataset for the Northwest Atlantic. This data provided information from vessels that fished in the U.S. Atlantic, the Caribbean and the Gulf of Mexico (Fig. 1). Reporting of sea turtle bycatch information has been required by the U.S. pelagic longline fleet since 1992 (Witzell and Cramer 1995); thus we present trends in abundance based on 1992-2000 data.

We developed a new robust approach to analyzing logbook data; we assumed that fishers did not always report turtles but that if turtles were reported then that number was approximately correct. This approach deals with a major problem in analyzing logbook data; bycatch species are often underreported and since zeros are not recorded, missing values cannot be distinguished from real zeros. Therefore, we assumed that non-zero turtle catches follow a zero-truncated negative binomial distribution. We used generalized linear models to standardize the catch per unit effort time series data. To test the robustness of our results we also modelled the trends with a negative binomial distribution and included the zero catches in this analysis.

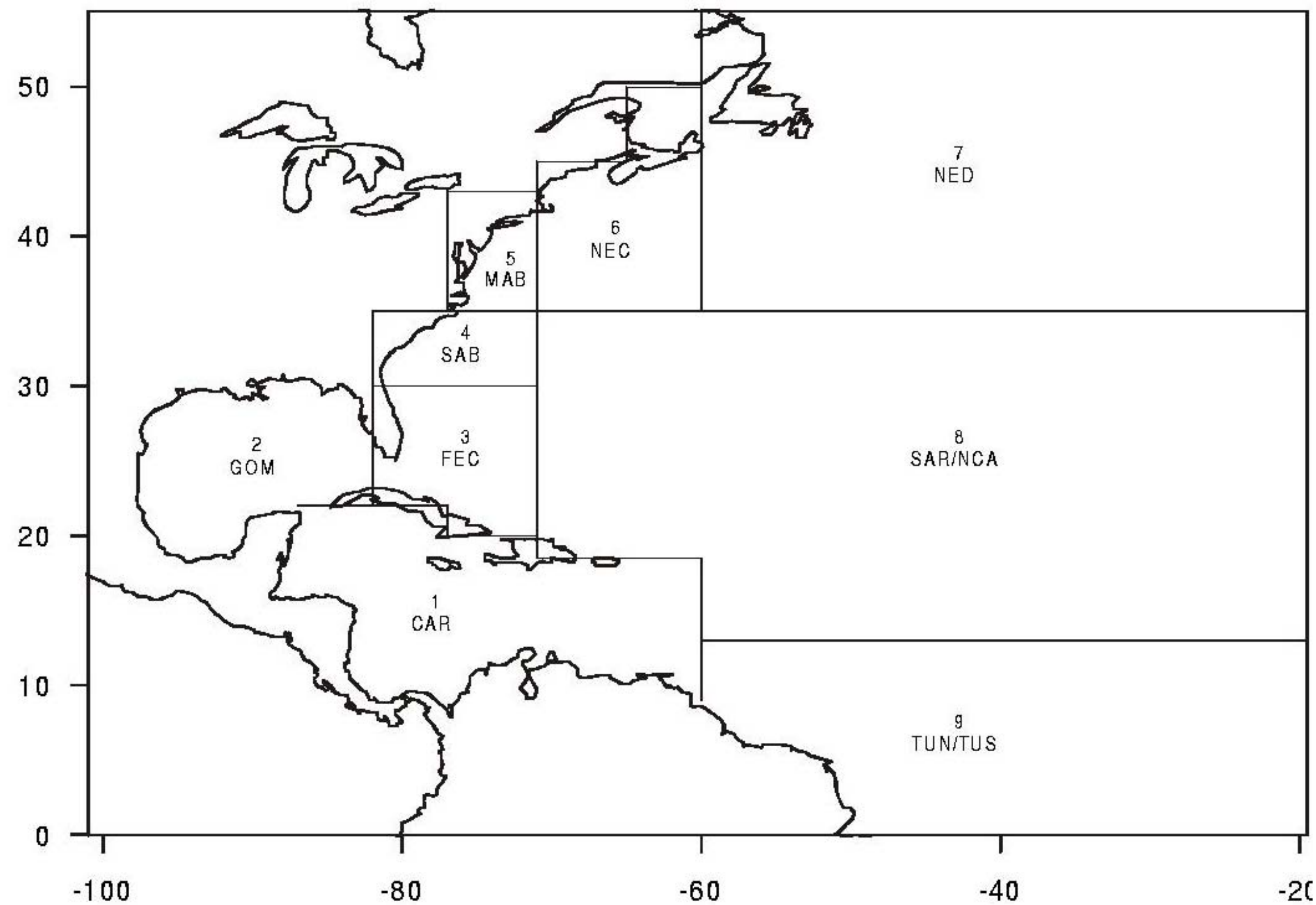
Both analyses show an overall increase in loggerhead abundance in the western North Atlantic, however this increase is not uniform in all areas (Fig. 2). An increase of approximately 16% per year (95% CI is 11.1% to 21.8% for the truncated model) resulted in both cases. However, the population trends vary among regions ($P<0.01$), e.g. loggerheads appear to be increasing significantly in the Northeast Distant and Northeast Coastal areas but declining non-significantly in the Gulf of Mexico. Thus, regardless of whether the zero catches are used in the analysis, there is an overall increasing trend in loggerhead abundance.

The two leatherback analyses indicate conflicting trends. With the zero-truncated negative binomial analysis, leatherback turtle populations show no detectable rate of change (0.83% per year, 95% CI = -4.9 to +6.8%; Fig. 3). However, the negative binomial model indicates an overall decline of 10.1% per year (95% CI is -12.3 to -8.0%). Thus, if the reporting rate has not changed over time, there is strong evidence that leatherback abundance in the western North Atlantic is declining. Unfortunately the zero-truncated negative binomial model was not powerful for modelling leatherback trends because there is little contrast in the positive catch rates, e.g. 81% of all sets that caught leatherbacks caught only 1 compared to 40% for loggerheads. The decline of leatherbacks caught at sea is consistent with nesting trends observed in French Guiana and Suriname (Myers et al. 2001). Further work is needed to resolve the controversy of leatherback population status. The confidence intervals are underestimated because of unexplained interannual heterogeneity in catches of turtles that was not accounted for in our models; this might be due to interannual variation in numbers of turtles that migrate into northern regions.

LITERATURE CITED

Myers, R.A., K.G. Bowen and L. Gerber. 2001. Meta-analysis of population trends of loggerhead and leatherback turtles. In: National Marine Fisheries Service Southeast Fisheries Center, Stock assessments of loggerhead and leatherback sea turtles and an assessment of the impact of the pelagic longline fishery on the loggerhead and leatherback sea turtles of the Western North Atlantic. NOAA Tech. Memo. NMFS-SEFSC-455. p. 227-244.

Witzell, W.N. and J. Cramer. 1995. Estimates of Sea Turtle By-catch by the U.S. Pelagic Longline Fleet in the Western North Atlantic Ocean. NOAA Tech. Memo. NMFS-SEFSC-359. 14 p.



Legend

CAR	Caribbean
GOM	Gulf of Mexico
FEC	Florida East Coast
SAB	South Atlantic Bight
MAB	Mid Atlantic Bight
NEC	Northeast Coastal
NED	Northeast Distant
SAR/NCA	Sargasso/North Central Atlantic
TUN/TUS	Tuna North & South

Fig. 1. Geographic zones used to define U.S. Atlantic fishing effort.

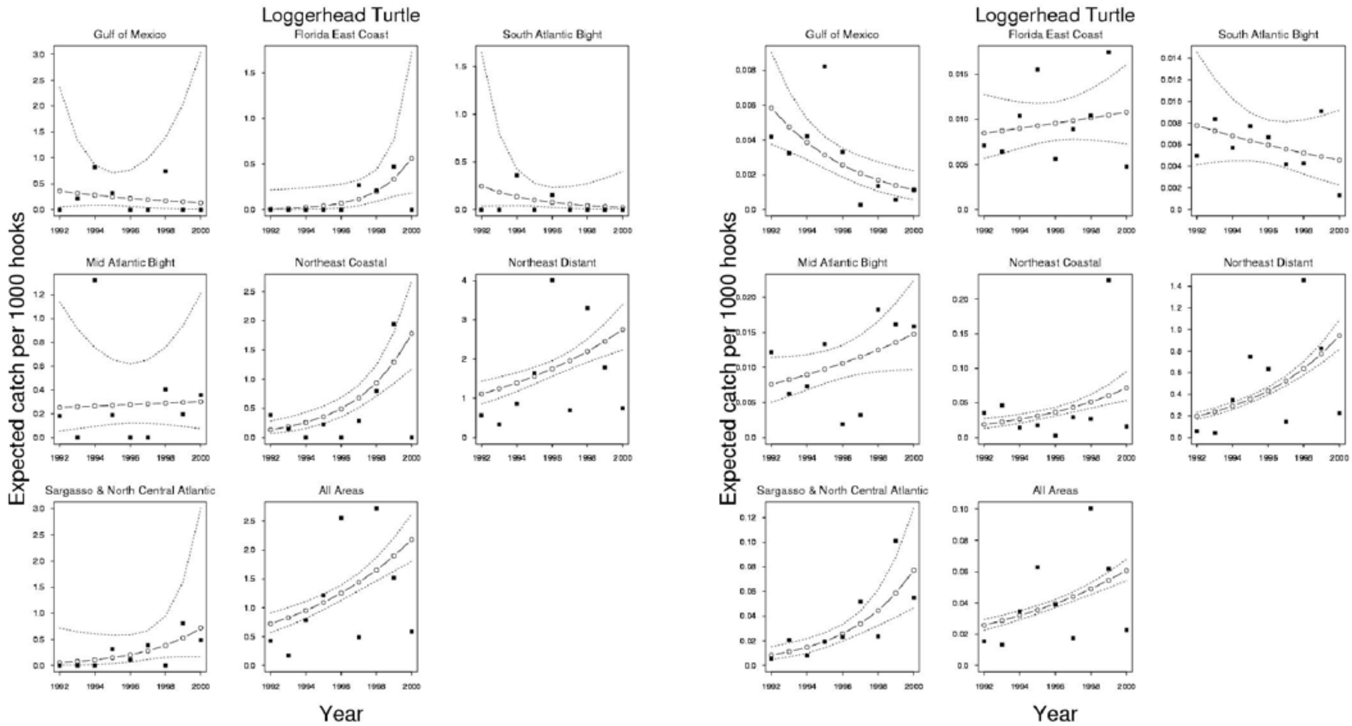


Fig. 2. The trend (solid line with open circles and 95% confidence region) and year effect estimates (black points) for the zero-truncated negative binomial model (left figure) and negative binomial model (right figure) in catch rates (relative abundance) for loggerhead turtles for each area and all areas combined.

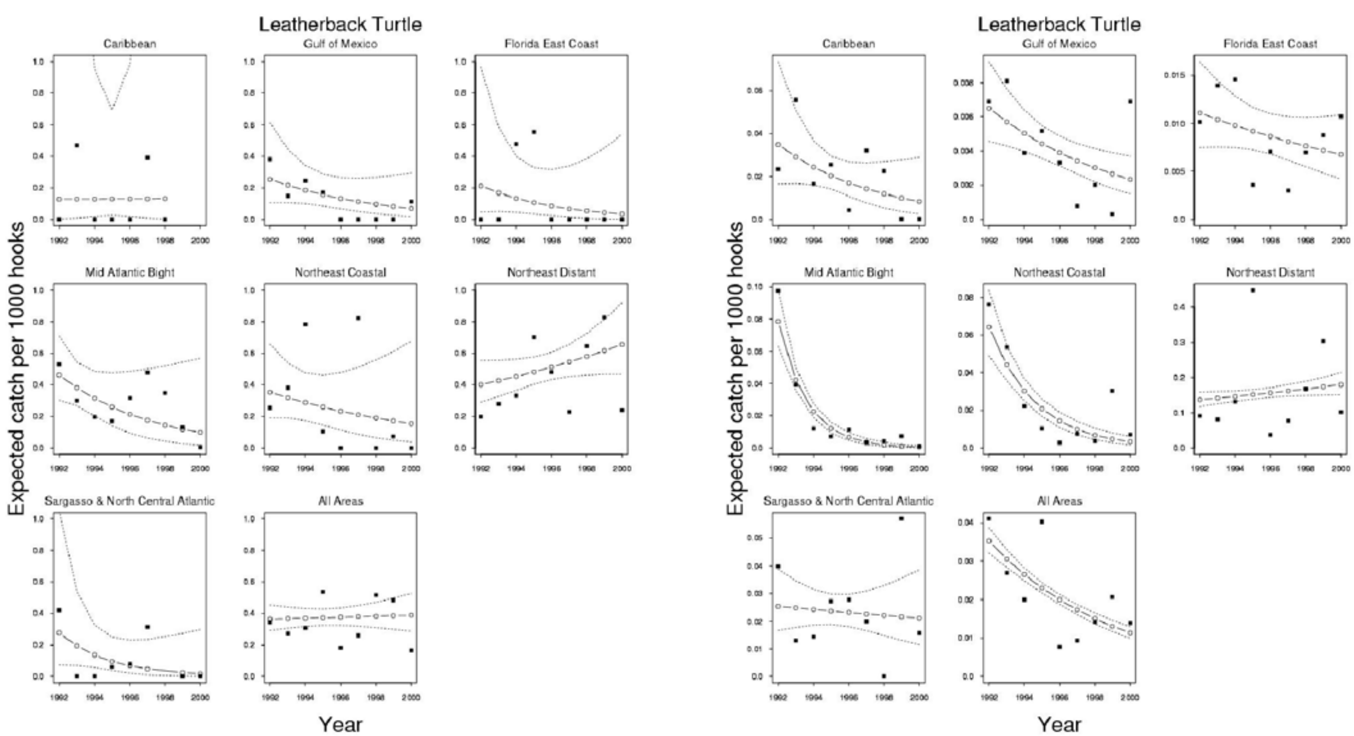


Fig. 3. The trend (solid line with open circles and 95% confidence region) and year effect estimates (black points) for the zero-truncated negative binomial model (left figure) and negative binomial model (right figure) in catch rates for leatherback turtles for each area and all areas combined.

Estimating hatching success on a high density nesting beach

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An important parameter in demographic studies of sea turtles is the hatching success of nests laid by females on nesting beaches. Theoretically, hatching success is a straightforward measurement, being the proportion of live hatchlings produced from the total number of fertilized eggs laid in a single clutch. Less straightforward is the method of sampling employed to ensure that the nests used to estimate mean hatching success consititute an unbiased sample of the overall population. On low density nesting beaches (less than 10 nests per night), this problem can be avoided by sampling all nests laid. On high density nesting beaches (with over 100 nests a night), it is not possible to investigate hatching success for every nest. The beach of Awala-Yalimapo, French Guiana, is a high-density leatherback nesting beach. In the 2000 and 2001 nesting seasons, we used different sampling protocols to estimate hatching success. The merits and limitations of the different protocols are discussed.

Sea turtle pound net tagging and health assessment study in Maryland's Chesapeake Bay in 2001

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The incidental capture of sea turtles in pound nets offers a unique opportunity to study wild, live specimens, which might otherwise be inaccessible in open waters. Many researchers along the Atlantic coast of the United States have taken advantage of these opportunities to gather information on sea turtle biology and ecology in their region. There have been anecdotal reports of sea turtles incidentally captured in pound nets in Maryland waters, but few have been documented. A pound net tagging and health assessment study was initiated in the summer of 2001 to assess the health and status of the sea turtle population in Maryland's Chesapeake Bay. Through a cooperative agreement between Department of Natural Resources' biologists and pound net fishermen, one Kemp's ridley and six loggerhead sea turtles were examined between July and October 2001. The turtles were removed from pound nets and measured, weighed, photographed and scanned for internal tags. They were also tagged with flipper and PIT tags, sampled for tissue and blood, and then released unharmed back into the water. Blood samples were analyzed for baseline biochemical values and sex determination and tissue samples were archived for future genetic analysis. Over time, the collection of this data will provide essential details on migratory behavior, baseline health and blood parameters, growth rates, sex ratios, capture rates, mortality and geographical origin of sea turtles in the Chesapeake Bay. This information has important implications for the development of regional management and conservation strategies to protect these endangered and threatened species.

An analysis of apparent growth in nesting hawksbills: Jumby Bay, Antigua, West Indies

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Curved carapace lengths (CCLs) have been recorded for nesting hawksbill turtles (*Eretmochelys imbricata*) at Jumby Bay, Antigua, West Indies for fifteen consecutive seasons. Measurements were taken according to project protocol: median carapace length from most anterior point of the nuchal to the most posterior point of the supracaudal. In excess of a thousand CCL measurements have been recorded from 150 individuals. Large sample size and realistic estimates of sampling error allow us to evaluate the confidence of using CCL measurements to assess growth. For instance, collective CCL measurements for an individual display a range of lengths both within and between nesting seasons. We attribute CCL growth within seasons to human error, while growth between seasons is considered a combination of error, actual growth, and wear of the supracaudal scutes. Some individuals exhibit "negative" growth between seasons, suggesting that supracaudal wear exceeds growth in carapace length. However, this observation is equally explainable as the result of measurement error (variance) within season. Whereas CCLs provide an estimate of relative size for a population of nesting hawksbills, variance precludes any findings of real growth in terms of CCL between seasons. Therefore, CCL should be questioned, if not rejected, as an indication of annual growth in adult female hawksbills at Jumby Bay.

Growth rates of immature hawksbills (*Eretmochelys imbricata*) at Aldabra Atoll, Seychelles (Western Indian Ocean)

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INTRODUCTION

A mark-recapture study of immature foraging sea turtles has been ongoing at Aldabra atoll since 1986. This abstract presents preliminary data from that study which describe the growth of hawksbill turtles.

METHODS

Fig. 1 shows the location of the study site. Turtle captures were made using two methods: a) the 'rodeo' technique (in which people leap out of moving boats onto turtles); and b) by walking in shallow water at low tide and picking up turtles trapped in tidal pools. Each captured turtle was double-tagged (one tag on each front flipper), weighed, and a series of carapace measurements were taken. The present analysis describes average annual growth rates recorded for hawksbills based on one of those measurements -- over the curve maximum carapace length (OCCL-max).

RESULTS

A total of 375 hawksbill turtles were captured between 1986 and 2001. Of these, 115 animals were captured on two or more occasions: 76, twice; 19, three times; 12, four times; 5, five times; 2, seven times; and 1, eight times. Fig. 2 presents the average annual growth rate during the interval between the first and the last time a turtle was captured. To minimise seasonal bias, data are presented only for intervals greater than eight months (n=58). These intervals ranged from eight months to ten years. Table 1 presents the same data in a tabular format.

CONCLUSIONS

We conclude that the immature hawksbills foraging in the warm waters of Aldabra atoll, grow slowly, at rates that are: similar to those recorded for hawksbills in the cool waters of Heron Island, Australia (Chaloupka and Limpus 1997); faster than those recorded for hawksbills in the warm waters of Diego Garcia atoll, British Indian Ocean Territory (Mortimer et al. 2002); and slower than those recorded for hawksbills at Mona Island, Puerto Rico (Diez and van Dam, in press).

At Aldabra, the highest growth rates for hawksbills were recorded in the 50-60 cm size class of turtle. At other sites, the highest growth rates recorded for hawksbills were in the following size classes: 50-60 cm at Heron Island, Australia (Chaloupka and Limpus 1997); 40-50 cm at Diego Garcia, BIOT (Mortimer et al. 2001); and 30-40 cm size class at Mona Island, Puerto Rico (Diez and van Dam, in press) and in the Virgin Islands (Boulon 1994).

Acknowledgements. We are grateful for the continuous support of the Seychelles Islands Foundation (SIF) and the Government of Seychelles. We thank all the SIF personnel who participated in the fieldwork (including the island wardens, conservation and research officers, rangers, boatmen, and fieldworkers) as well as visiting scientists and volunteers. SIF provided logistical support and accommodation. The Islands Development Company (IDC) provided transportation to and from Aldabra on several occasions. Prior to 1995, financial support came from World Wildlife Fund (Projects No. 1809 and MY0034/SC0009), the Seychelles Government, and the Smithsonian Expeditions to Aldabra in 1987 and 1992. Since 1995, significant funding came from two projects financed jointly by the Global Environment Facility (GEF) (administered by the World Bank) and by the Government of Seychelles: a) the EMPS Project J1: Turtle and Tortoise Conservation; and b) the GEF Marine Ecosystems Management Project: Turtle Component. Assistance and support from the Seychelles Ministry of Environment has been invaluable. JAM is grateful to the organisers of the 22nd Annual Symposium on Sea Turtle Biology and Conservation and to the Packard Foundation for assistance with transportation to attend this symposium.

LITERATURE CITED

Boulon, R.H. 1994. Growth rates of wild juvenile hawksbill turtles, *Eretmochelys imbricata*, in St. Thomas, United States Virgin Islands. Copeia 1994:811-814.

Chaloupka, M.Y. and C.J. Limpus. 1997. Robust statistical modelling of hawksbill sea turtle growth rates (southern Great Barrier Reef). Mar. Ecol. Prog. Ser. 146:1-8.

Diez, C.E. and R.P. van Dam. In press. Habitat effect on hawksbill growth rates on feeding grounds at Mona and Monito Islands, Puerto Rico. Mar. Ecol. Prog. Ser.

Mortimer, J.A., M. Day, and D. Broderick. 2002. Sea turtle populations of the Chagos Archipelago, British Indian Ocean Territory. In: A. Mosier, A. Foley, and B. Brost, comps. Proceedings of the Twentieth Annual Symposium on Biology and Conservation. NOAA Tech. Memo. NMFS-SEFSC-477.

Table 1. Mean growth rates by 10 cm over-curve carapace length (OCCL-max) size classes of 58 hawksbills turtles at Aldabra atoll. Turtles were assigned to size classes according to individual mean OCCL-max of first and last capture.

	Size of Turtles		Growth Rate		
OCCL-max size class (cm)	Mean OCCL-max of sample (cm)	Range (cm/yr)	Mean growth rate ± S.D. (cm/year)	Range (cm/yr)	n
30-40	36.1	32.6 - 39.4	1.5 ± 0.6	0.5 - 2.5	13
40-50	44.9	40.3 - 49.4	2.7 ± 0.7	1.9 - 4.6	23
50-60	54.4	50.2 - 59.3	3.2 ± 1.3	1.4 - 5.5	17
60-70	69.9		3.7		1
70-80	73.8	71.2 - 78.0	1.6 ± 1.2	0.1 - 2.8	4

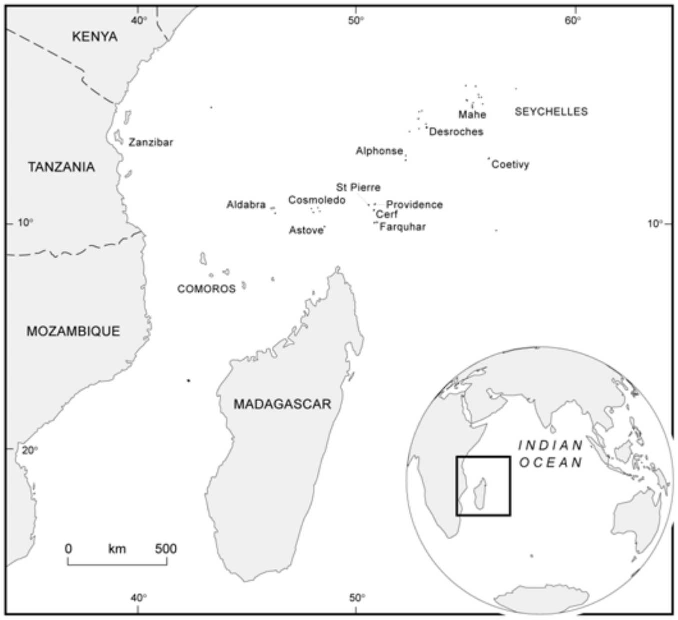

Fig. 1. Location of the study site, Aldabra Atoll, in the western Indian Ocean.

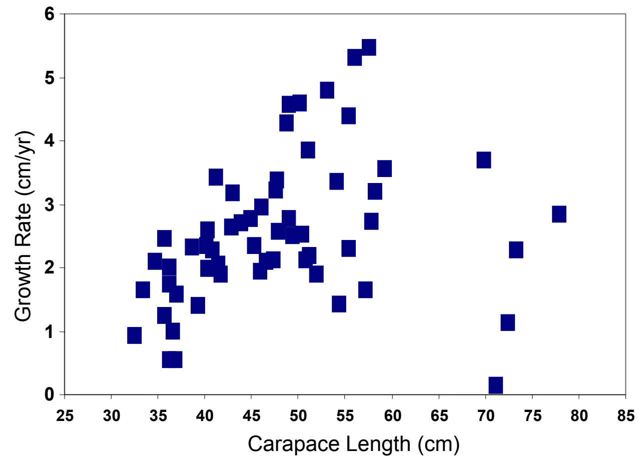

Fig. 2. The average annual growth rate during the interval between the first and the last time a hawksbill turtle was captured at Aldabra (n=58).

Growth and reproductive output of female leatherbacks over time

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INTRODUCTION AND METHODS

Leatherback sea turtles (*Dermochelys coriacea*) are the largest living reptiles, reaching 916 kg in mass and 170 cm in carapace length. Hatchlings must grow to about 30 times their emergence length before reaching adulthood, at which point growth slows. Even after reaching adult size, reptiles grow indeterminately, and adult growth rate is contingent upon environmental conditions and other factors. Zug and Parham (1996) modeled growth curves for leatherbacks and showed rapidly decreasing growth after the age of about 9 years. However, aside from this growth model, little is known about the adult growth rate of leatherbacks, although variations in size exist within and among the world's nesting populations. We measured females (standard curved carapace length and curved carapace width) across seasons to determine their growth rate during this remigration interval in order to elucidate the relationship between this interval and growth rate. Multiple measurements within a season were averaged to determine the turtle's size. Growth was determined by comparing an individual's mean size during a given nesting season with its mean size during its previous nesting season. Growth rate was determined by dividing the growth of a turtle by the number of years passed since it previously nested (remigration interval).

Instead of allocating resources to growth, nesting female leatherback turtles could also invest energy in reproduction. It is unknown what effect different remigration intervals have on reproductive output of nesting leatherbacks. We examined the relationship between remigration interval and seasonal fecundity, measured by mean clutch size and estimated clutch frequency (ECF), an estimate of the number of nests a female lays in one season.

RESULTS AND DISCUSSION

As modeled previously for leatherbacks (Zug and Parham 1996), adult females in this population continued to grow after reaching reproductive age. Furthermore, the growth rate of adults decreases in larger turtles. These results imply that turtles are reaching reproductive age and continuing to grow, but that growth slows down as they age further. Reina et al. (2002) report that there are no significant relationships between carapace size and either ECF or number of eggs laid for this population. Therefore, this slowing in growth is not due to a shift in resource allocation to reproduction.

Nesting leatherbacks at Playa Grande are up to 20 cm smaller on average than those nesting in other populations around the world (Zug and Parham 1996). Given the slow adult growth rate that these females experience, it seems unlikely that the age of the population alone explains this size difference. It is more likely that different populations of leatherback females are reaching maturity at different sizes, as was found in slider turtles (*Trachemys scripta*; Gibbons and Greene 1990), or that adult female growth rates vary between populations.

Our data do not support the hypothesis that remigration interval has a consistent effect on either growth rate or fecundity. This begs the question: If turtles with a large remigration interval are not more fecund when they migrate to the nesting beach, and are not investing in growth, why do they not nest more often and achieve greater lifetime reproductive output? Hays (2000) proposed a model for marine turtles suggesting that good conditions encountered at the feeding grounds will shorten the interval between consecutive nesting seasons and vice versa. Previous work on slider turtles has shown that growth rates at virtually every age are highly variable, probably reflecting individual variation in acquisition of resources, resource allocation, as well as other environmental factors such as temperature (Dunham and Gibbons 1990). Thus, different individual leatherbacks may be encountering varying resource availability in the ocean, accounting for different growth rates and remigration intervals. Future analyses will be focused on relating physical conditions with resource encounter rate and resource allocation in leatherbacks.

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LITERATURE CITED

Dunham, A.E. and J.W. Gibbons. 1990. Growth of the slider turtle. In: J.W. Gibbons, ed. Life History and Ecology of the Slider Turtle. Smithsonian Institution Press.

Gibbons, J.W. and J.L. Greene. 1990. Reproduction in the slider and other species of turtles. In: J.W. Gibbons, ed. Life History and Ecology of the Slider Turtle. Smithsonian Institution Press.

Hays, G.C. 2000. The implications of variable remigration intervals for the assessment of population size in marine turtles. J. Theor. Biol. 206:221-227.

Reina, R.D., P.A. Mayor, J.R. Spotila, R. Piedra, and F.V. Paladino. 2002. Nesting ecology of the leatherback turtle, *Dermochelys coriacea*, at Parque Nacional Marino Las Baulas, Costa Rica: 1988-89 to 1999-2000. Copeia 2002:653-664.

Zug, G.R. and J.F. Parham. 1996. Age and growth in leatherback turtles, *Dermochelys coriacea* (Testudines: Dermochelyidae): a skeletochronological analysis. Chel. Conserv. Biol. 2:244-249.

Fecundity-age relationship of nesting Kemp's ridley sea turtles (*Lepidochelys kempii*) at Rancho Nuevo, Tamaulipas, Mexico

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INTRODUCTION

Sea turtles tend to nest more than one time during nesting seasons. The number of nesting occurrences varies among the species, but more than one nesting can occur in a season with varied time intervals between each nesting (Chávez 1968, Márquez 1994, Miller 1997). Early results show the *Lepidochelys kempii* nesting population, on the northern coast of Tamaulipas, Mexico, at Rancho Nuevo, has varied nesting occurrences. It is estimated that 67% of the nesting females had only one nesting occurrence, 27% had two nesting occurrences, and 3% had nested three times during the nesting season for one year, estimating a total fecundity of 140.8 eggs (Márquez et al. 1981). Regular patrols and monitoring efforts in this area during the nesting seasons 1978 to 1994 show that 55% of the nesting females returned to nest a second time, 16.4 nested three times, and only 0.7% nested a fourth time during the same nesting season. This information shows the egg range is between 16.7 and 192.4 eggs (Márquez 1994).

The adult sea turtles have very little morphometric variation for which the size of the turtle is not an accurate indicator to determine the age or maturity of the species (Miller 1997), however, the fecundity of the younger nesters is different from those individuals that have occurred nesting many times during previous nesting seasons (Wood 1986, Márquez et al. 1989). The information collected establishes a relationship between age and fecundity for nesting females nesting at Rancho Nuevo, Tamaulipas, Mexico. Results show that the older or "mature" females nested more often and produced a larger clutch of eggs than younger or "neophyte" females.

METHODS

Data collection in the field consisting of marking the nesting *L. kempii* with various tags and collecting the eggs for protected incubation at the nesting beach of Rancho Nuevo, Tamaulipas, Mexico, has allowed the use of tagging data to determine the number of turtles that have nested and to determine how many nests in a season an individual has laid. This information is used to determine the occurrence of nesters that have not been documented nesting (first-time nesters) in previous seasons and do not have any evidence of being tagged by a metal tag, electronic tag (PIT tag), and lack tag scars on the flippers. These individuals that have not been documented in previous years are called "neophytes". Another category for nesting *L. kempii* called "mature" is a name given to those individuals that have been marked or are marked with a combination of the following during previous seasons: metal tag; PIT tag; tag scar on the flippers; and, mating scars. Information was utilized from those individuals that had complete tag and egg number information from two nesting occurrences in the same season.

The data shows the regression among the average number of eggs per nest and the time of the increase in patrol coverage of the nesting beach area (1978-200) to observe the trend of the average number of eggs per nest. Also considered is data taken from the same nesting zone (30.0 km) and the effort to protect the nesting area did not vary.

The results were determined by using the One-Way Variable Analysis (ANOVA) to show that a statistically significant difference exists between both groups of turtles ("neophyte" and "mature"), showing that there was a difference in the number of eggs laid in a one-time nesting occurrence and a two-time nesting occurrence and there were also differences in the total fecundity between both groups utilizing information from the 2000 nesting season.

RESULTS

This trend leads us to the hypothesis that the current number of "neophyte" turtles has increased, due to evidence that the proportion of "mature" individuals in the population is decreased and the average number of eggs laid per season tends to diminish until it reaches an equilibrium. For "neophyte" turtles, the average number of eggs laid in a nesting was 94.1 for a first-time nesting occurrence and 98.8 for a second-time nesting occurrence. The one-way ANOVA shows a F(1,474, 0.5%)=10.723, for which it can be said that there is a difference in the number of eggs laid between nesting occurrences during the same season. In the "mature" turtles, the average number of eggs laid in a nesting was 96.0 for a first-time nesting occurrence and 102.7 for a second-time nesting occurrence. The one-way ANOVA shows F (1,324, 0.5%) = 13.22, showing that a difference also exists, as did in the "neophytes", showing that a higher number of eggs are laid in the second-time nesting occurrence. In both groups of turtles ("neophyte" and "mature") the fecundity was calculated, by the sum of the first- and second-time nesting occurrences was resulted in an average of 192.9 eggs for "neophyte" turtles and 198.7 eggs for "mature" turtles during a nesting season. The one-way ANOVA shows F (1,324, 0.5%) = 13.22, showing that a difference exists in the fecundity of "neophyte" and "mature" turtles, showing that the total fecundity is higher for the later.

CONCLUSIONS

It can be inferred that the *L. kempii* population at the Rancho Nuevo nesting beach in Tamaulipas, Mexico, is being integrated each time with a larger group of "neophytes" as of the 1990 nesting season. Considering total fecundity for two nestings in *L. kempii*, the older "mature" turtles will show a higher average in the number of eggs laid during the first-and second-time nesting occurrence as compared to the "neophyte" turtles. The average number of eggs per nesting is lower in a first-time nesting occurrence and higher in a second-time nesting occurrence, regardless of whether or not the individual is a "mature" or "neophyte" nester.

LITERATURE CITED

Chavéz, H. 1968. Marcado y recaptura de individuos de tortuga lora *Lepidochelys kempi* (Garman 1880). Pub. Inst. Nal. Inv. Biol. Pesq. 19:28.

Márquez, M.R. 1994. Sinopsis de datos biológicos sobre la tortuga lora (Garman 1880). Instituto Nacional de la Pesca, México/FAO Sinopsis. SAST-Tortuga Lora 5.31(07) 016.02.

Márquez, M.R., A. Villanueva and M. Sánchez. 1982. The population of Kemp's ridley sea turtles in the Gulf of México, *Lepidochelys kempi*. In: K.A. Bjorndal, ed. Biology and Conservation of Sea Turtles. Smithsonian Institution Press, Washington, D.C. p. 159-164.

Márquez, M.R., A. Villanueva, J. Diaz and M. Carrasco. 1989. Notes on the reproduction of the Kemp's ridley at Rancho Nuevo. In: S.A. Eckert, K.L. Eckert and T.H. Richardson, comps. Proceeding of the Ninth Annual Workshop on Sea Turtle Conservation and Biology. NOAA Tech. Memo. VMFS-SEFC-232. p.107-110.

Miller, D.J. 1997. Reproduction in sea turtles. In: P.L. Lutz and J.A. Musick, eds. The Biology of Sea Turtles. CRC Press, Inc. Boca Raton, Florida. p. 51-81.

Wood, V.E. 1986. Breading success of hawksbill turtles *Eretmochelys imbricata* at Cousin Island, Seychelles and the implication for their conservation. Biol. Conserv. 37:321-332.

Global status of the green turtle (*Chelonia mydas*): the 2002 MTSG green turtle assessment for the IUCN Red List Programme

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This paper presents the final results of the Marine Turtle Specialist Group global assessment of the green turtle (*Chelonia mydas*) that was performed for the 2002 IUCN Red List Programme. Evaluations of green turtle subpopulations focus on annual nesting activity and egg production at 29 Index Sites distributed globally. Analysis of historic and recent published accounts indicate extensive population declines in all major ocean basins as a result of overexploitation of eggs and turtles and, to a lesser extent, incidental mortality relating to marine fisheries and degradation of marine and nesting habitats. Although a few large populations remain, they are increasingly vulnerable to intentional and incidental impacts. Based on a variety of indices, the global green turtle population has declined by 35% - 66% over the last 135 years (3 generations). These estimates are, however, based on a conservative approach; actual declines may be closer to 80%. This rate of decline, coupled with impending threats, justify Endangered status for green turtles under the 2001 Red List Criteria.

Preliminary information on the effective population size of the Kemp's ridley (*Lepidochelys kempii*) sea turtle

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Almost the entire adult female population of the endangered Kemp's ridley (*Lepidochelys kempii*) nests on one beach near Rancho Nuevo, Tamaulipas, Mexico. Historically, 40,000 nesting females arrived between the months of May and June. Today, the population is estimated to consist of 2,000 nesting females. A population crash of this magnitude is a major concern in species conservation due to loss of genetic diversity. However, when considering a specific population, one must look at the effective population size instead of the absolute number of individuals. The effective population is an idealized population where every individual has an equal chance of contributing genetically. In order to maximize the effective population size there must be an equal sex ratio as well as an equal contribution from all members. The goal of this research is to measure the effective population size derived from genetic data for Kemps ridley. The hypothesis is that the estimates of effective population size from genetic data would be considerably smaller than the current estimate of sexually mature individuals in the population. In order to obtain genetic information about this species, different single copy nuclear DNA loci (ScnDNA) are currently being amplified as well as mitochondrial DNA loci. Polymorphic alleles will be characterized with several molecular genetic techniques. Allele frequencies will be used in order to estimate effective population size from nuclear DNA as well as for mtDNA data.

Genetic stock composition of foraging green turtles off the southern coast of Molokai, Hawaii

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INTRODUCTION

The Hawaiian Archipelago contains some of the principal nesting and foraging sites for the green turtle (*Chelonia mydas*) in the central Pacific. This population of threatened green turtles has been monitored for many years and is one of the few populations within the Pacific that is increasing in numbers (Balazs 1998, Wetherall et al. 1997). Our study focuses on one of the largest resident foraging populations in the Hawaiian Archipelago, Palaau. The Palaau foraging site is located off the south-central coast of Molokai at approximately 21°06′N, 157°07′W (Balazs et al. 1987). We have used molecular genetics to examine the stock composition of the Palaau forage population by analyzing mtDNA sequences obtained from the large number of samples provided by ongoing tag-recapture studies. MtDNA haplotype frequencies were compared with those found at the nesting beaches at French Frigate Shoals (FFS) and other key nesting beaches throughout the Pacific basin in order to determine whether this is a mixed or genetically isolated stock. Previous studies have indicated that green turtles from genetically distinct nesting populations share common foraging grounds (Fitzsimmons et al. 1997, Lahanas et al. 1998). However, it is thought that the Hawaiian foraging population is derived from a single nesting stock located at FFS (Balazs et al. 1987).

MATERIALS AND METHODS

Samples for genetic analysis were routinely collected throughout the Hawaiian Archipelago. MtDNA control region sequences were obtained from blood or skin samples collected at FFS and Palaau during 1995, 1996 and 1997. Juvenile, subadult, and adult green turtles foraging off the coast of Southern Molokai were caught using the bullpen capture method as described in Balazs et al. (1998). Skin samples from females nesting at FFS were collected during the nesting season which takes place May through August (Balazs et al. 1987). Standard laboratory techniques were used in order to isolate and analyze DNA samples (Sambrook et al. 1989). Statistical analyses of haplotype frequencies found in Palaau and FFS were carried out using a permutation Chi-Square test (Roff and Bentzen 1989).

RESULTS AND DISCUSSION

Three main haplotypes that differ by four variable sites were found within the 428 sequences analyzed. These haplotypes distinguish the FFS nesting stock, which is considered a distinct management unit (P. Dutton unpubl. data). Haplotype B was found to be the most common haplotype showing up in 69% of the samples from FFS (n=229) and 72% of the samples from Palaau (n=205). Although less common, haplotypes C and D appeared in both sample sets with an average frequency of 15% each (Table 1). Of the 205 samples collected at Palaau, only 2 exhibited haplotypes that were different than the three main haplotypes. Haplotype FijA is primarily found in the western Pacific, while haplotype G is commonly found in eastern Pacific stocks, indicating that animals from other nesting stocks rarely recruit into the Hawaiian forage grounds.

Between-year comparisons of haplotype frequencies for turtles sampled at Palaau and FFS during 1995, 1996, and 1997 found no significant differences indicating each site is in genetic equilibrium. Samples were then pooled across years and frequencies at the nesting grounds and foraging area were compared (Table 2). Analysis revealed no significant difference between the haplotype frequencies found at Palaau versus those found in FFS, indicating that the Palaau foraging population is derived from the FFS nesting stock. This suggests that the forage areas throughout the Hawaiian Archipelago are from this central Pacific nesting stock and can be considered a discreet management unit. Since there are substantial differences between FFS and other Pacific nesting stocks in terms of mtDNA haplotypes and frequencies (P. Dutton unpubl. data), no further analysis using mixed stock techniques was necessary.

FURTHER RESEARCH

Further research includes expanding this genetic survey to include other foraging areas throughout the Hawaiian Islands. A Pacific-wide analysis of genetic stock structure among nesting populations, including rookeries at other Pacific nesting sites, is also underway. Finally, microsatellites will be used in conjunction with these mtDNA data to gain a more complete understanding of the molecular ecology of green turtles in the Pacific.

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LITERATURE CITED

Balazs, G.H., R.G. Forsyth, and A.K.H. Kam. 1987. Preliminary assessment of habitat utilization by Hawaiian green turtles in their resident foraging pastures. NOAA Tech. Memo. NOAA-TM-NMFS-SWFC-71, p. 107.

Balazs, G.H., W. Puleloa, E. Medeiros, S.K.K. Murakawa and D.M. Ellis. 1998. Growth rates and incidence of fibropapillomatosis in Hawaiian green turtles utilizing coastal foraging pastures at Palaau, Molokai. In: S.P. Epperly and J. Braun, comps. Proceedings of the Seventeenth Annual Sea Turtle Symposium. NOAA Tech. Memo.NMFS-SEFSC-415. p. 130-132.

Balazs, G.H. 1998 Sea turtles. In: S.P. Juvik and J.O. Juvik, eds. Atlas of Hawaii, Third Edition. University of Hawaii Press, Honolulu, Hawaii, p. 115.

Fitzsimmons, N.N., C. Mortiz, C.J. Limpus, L. Pope, and R. Prince. 1997. Geographic structure of mitochondrial and nuclear gene polymorphisms in Australian green turtle populations and male-biased gene flow. Genetics 147: 1843-1854

Lahanas, P.N., K.A. Bjorndal, A.B. Bolten, S.E. Encalada, M.M. Miyamoto, R.A. Valverde, and B.W. Bowen. 1998. Genetic composition of a green turtle (*Chelonia mydas*) feeding ground population: evidence for multiple origins. Marine Biology 130:345-352.

Roff, D.A. and P. Bentzen. 1989. The statistical analysis of mitochondrial DNA polymorphisms: X^2 and the problem of small samples. Mol. Biol. Evol. 6:539-545

Sambrook, J., E.F. Fritsch, and T. Maniatis. 1989. Molecular Cloning: A Laboratory Manual, 2nd edn. Cold Spring Harbor Laboratory Press, New York.

Wetherall, J.A., G.H. Balazs, and M.Y. Yong. 1997. Statistical methods for green turtle nesting surveys in the Hawaiian Islands In: S.P. Epperly and J. Braun, comps. Proceedings of the Seventeenth Annual Sea Turtle Symposium. NOAA Tech. Memo. NMFS-SEFSC-415. p. 278-280.

Table 1. Haplotype frequencies from turtle samples obtained at the Palaau foraging grounds and French Frigate Shoals nesting site during 1995, 1996 and 1997.

Haplotype	B	C	D	G	Fiji A	(n)
French Frigate Shoals	0.69	0.14	0.17	0	0	223
Palaau	0.72	0.14	0.14	< 0.01	< 0.01	205

Table 2. Between-year chi-square comparisons of haplotype frequencies found at Palaau in 1995, 1996, and 1997, along with French Frigate Shoals. Samples from each year were then pooled and compared. Each comparison reveals no significant differences between haplotype frequencies (P>0.5, DF=1).

	Chi-Square	P-Value
Palaau Between Years	6.150	0.659
FFS Between Years	0.662	0.959
Palaau vs. FFS Pooled	2.920	0.633

Accounting for sampling error of rare genotypes in sea turtle stock estimation

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The contributions of different sea turtle rookeries to mixed-stock populations on foraging grounds can only be estimated by statistical methods using mitochondrial DNA samples from the mixed stocks and rookery populations. We evaluate methods for genetic stock estimation using simulations and data from previous studies on green and loggerhead turtles. We introduce Markov Chain Monte Carlo (MCMC) estimation, a general method of estimation which s relatively new in conservation biology and completely new to turtle studies. MCMC differs from older approaches using maximum-likelihood (ML) with non-parametric bootstrapping in (1) using a Bayesian prior to quantify previous knowledge; (2) taking account of multiple modes in the probability distribution of contributions; and (3) incorporating sampling error more flexibly, allowing for the possibility that rare haplotypes actually present in a particular rookery were not detected in a small sample. The differences in point estimates of rookery contributions between ML and MCMC methods are relatively small, but MCMC gives more conservative and more accurate confidence limits than ML with bootstrapping, which tends to underestimate small contributions as zero.

The cultural context of the hawksbill sea turtle (*Eretmochelys imbricata*) in Calusa society

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INTRODUCTION

The Calusa use and symbolic representations of hawksbill turtles is revealed by archeofauna and artifacts, as well as a review of Calusa ethnohistoric and archeological documents. These findings are significant in the context of the probable ethnozoological, ceremonial, spiritual and economic meaning that the hawksbill held for them. Turtles, in general, were important to Native Americans for subsistence and their discarded remains are regularly found at archaeological sites such as middens and mortuary contexts. From a spiritual/mythological context, turtles are seen as figureheads, masks, rattles, and grave goods. Hawksbill material and representations of a ceremonial nature, are found in association with Calusa sites and artifacts.

The Calusa inhabitated southwest Florida, maintaining an estuarine economy focused on the rich aquatic bounty of the surrounding waters enveloping the area (Widmer 1988). They frequently exploited deep-water fauna and were expert seafarers. The semitropical to tropical forests of the mainland and coastal islands were also exploited for upland plant and animal resources. They were hunter-gathers with a long history of a marine-based economy extending back several millennia (Milanich 1994). The dominant tribe of southern Florida at historic contact, Spanish documents chronicle their warlike nature and an extensive trade and tribute system. Their unique and complex society exhibited an intricate hierarchical social organization and rich ceremonial life with large village and ceremonial mounds constructed of shell. Owing to the lack of workable local stone sources, Calusa material culture was comprised predominately of shell, wood, bone and textile artifacts. The recovery of which from the anaerobic muck at Key Marco and other locations have provided a rare glimpse into their material culture.

The hawksbill sea turtle is a marine Chelonian, often found in rocky areas or coral reefs as well as the shallow waters of mangrove bays, and estuarine waters with muddy bottoms and little vegetation. Less commonly, it may be found in pelagic waters and areas of Sargassum weed (Ernst and Barbour 1989). It has a yellow and black radiating pattern on the translucent amber scutes of the carapace with overlapping scutes and four costals on each side with the first not touching the nuchal. The hawksbill nests at low densities with aggregations numbering up to several dozen. Regular observations are made in southeast Florida, predominately from Palm Beach, Martin, Monroe and the Keys (Witzell 1983). In the last century, the Keys were considered good fishing grounds for hawksbills, which are also found in Caribbean. Texas is the only other state with significant observations, but primarily of post-hatchling and juvenile individuals. Their diet consists primarily of sponges and they are generally not considered a good food source. The fatality rate from eating hawksbill flesh is high and there are no known antidotes (Pritchard 1979). Most importantly, hawksbills are the source for tortoiseshell, a thin veneer of outer shell (scute), which has been used worldwide since antiquity for decorative and other purposes.

MATERIALS AND METHODS

This study involved an extensive literature search in conjunction with an examination of curated faunal material and artifacts. The latter material included collections at the Florida Museum of Natural History at Gainesville (FLMNH), the University of Pennsylvania in Philadelphia (UM), and the Chelonian Research Institute at Oviedo (CRI). Photographs were taken of material at all of these locations as part of the research. Additionally, interviews and other communications were undertaken to clarify information previously noted. Faunal material was verified by species utilizing comparative collections and reference material (Rainey 1981, Wolke and George 1981, Witzell 1983, Wyneken 2000).

RESULTS

Hawksbill archeofauna and artifacts, enumerated here include those constructed of and representing this Chelonian. Data is supplemented by related ethnohistoric and archeological documents, in particular, that of Cushing's Key Marco expeditions. Archeofauna examined consisted of eight hawksbill ecofacts (FLMNH) from three southwest FL Calusa sites without buthering/burning evidence.

Sea turtle artifacts included divining pieces (Fig. 1):"Small set of sea tortoise shell plates. One with etched figures of wheeling affrontee dolphins" (UM; Cushing 1896)." Artifacts constructed of hawksbill material include the pupils of the eyes of various animal carvings from Key Marco, woodpecker and simple hairpins, ritual regalia, bird effigy wings, and other fragments and unidentified objects. The "exaggerated effigies of bird wings" were engraved with lines that replicated the feather delineations of the bird wings found embossed on copper plates from Etowah and other sites in the Southeast (Larson, personal communication). Hawksbill effigies were represented by a large figurehead and two masks representing Hawksbill Spirit (FLMNH) and Hawksbill Man (UP). The figurehead's deterioration is evident in the original watercolor by expedition artist/cartographer, Wells Sawyer (Fig. 2), the later photograph by the Smithsonian Institution and the artifact itself (UM; Fig. 3).

There were a number of ethnohistoric documents related to the Calusa. Zubillaga (1946) reported in 1566-1572 that the Calusa believed that a person had three souls and they resided in their eyes (the part of the soul that remained with the body after death – some of their deities ate human eyes) their reflection in water, and their shadow. Fontaneda (1945), a Spanish captive of the Calusa in the early historic period describes a diet rich in turtles and noted "mortuary areas guarded by turtle effigies."

DISCUSSION AND CONCLUSIONS

North American Indians also placed great importance on Chelonians. From a subsistence viewpoint, turtles were very important, often comprising a significant percentage of midden finds. While not necessarily universally true of subsistence remains, many items of ornamental and utilitarian uses may also have had a ceremonial aspect. Representation of Chelonians from a spiritual or ceremonial context may be significant for both the use of the material and the image of the turtle. Figureheads, effigies, masks and rattles as grave goods are also significant. Material culture representations are often associated with myths, particularly that of the spirit messenger.

The Calusa followed this trend and their sites include a variety of turtle remains and representations. In subsistence practices, sea turtles are very important. Many south Florida groups hunted marine and estuarine turtles. Of particular interest to this study, are those items made of or related to the hawksbill sea turtle. Although they were apparently not an important food source, they were hunted and hawksbill bone or shell ecofacts are represented in middens. Objects of an ornamental nature such as hairpins are made of hawksbill and other material in Calusa motifs (Wheeler 1997). *Eretmochelys* artifacts and representations in Calusa sites are significant, attributing it a strong ceremonial, spiritual or mythological relevance.

Hawksbill material itself was important, as it is not believed that this species was collected for food, with consumption often proving fatal. Therefore, hawksbills were a resource primarily targeted for the shell alone rather than a byproduct of subsistence activities. Tortoiseshell ritual regalia in Calusa design was apparently made in south Florida and traded North to Etowah (Larson 1993). Other tortoiseshell objects found there in mortuary context were 'exaggerated effigies of bird wings' engraved with lines that replicated the feather delineations of the bird wings found embossed on copper plates from Etowah and other sites in the Southeast (Larson pers. comm.).

Calusa burial mounds and charnel houses (containing the bodies of the dead), located on islands in lakes (calm reflective water) within their man-made shell mounds, were guarded with the figures of turtles (with the hawksbill figurehead having very prominent and exaggerated pupils of the eye) and other animals functioning to appease the dead (Widmer 1988). The bodies of the dead, reflections in clear water, and pupils of the eyes, were linked to the soul in Calusa mythology. The Miami Circle site included a complete sea turtle carapace aligned east to west in a practice associated with human burials (Miami-Dade Parks 1999). This practice is not unique relative to Chelonians in general, as the Hopi believed that the turtle, one of their totems, was their link with the spirit world and sacrificed them to communicate with their ancestors. All of these may be significant relative to funerary context turtle effigies found elsewhere in Florida such as Fort Center and Hontoon Island.

Marine turtles are unique as part of the South Florida Ceremonial Complex, and not as universal as other turtles in Native American mythology and symbology being part of the Southeastern Ceremonial Complex (Widmer 1989). Ceremonial Complexes are cultural episodes comprises the art, symbolism and ideology of a period (Widmer 1989, Muller 2000). Cushing noted that the masks found at Key Marco were found in twos with the bear masks were associated with those of the turtle. The Cherokee, thought that bears lived in two worlds (Hudson 1985) as they walked on two legs and four. Perhaps turtles also lived in two worlds – that of air or land and that of water and so were similar symbolically. Cushing speculated that turtles may have been thought of as bears of the sea and that in many ways turtles and bears were related at symbolic levels.

With regard to the hunting of hawksbill by the Calusa and trade in tortoiseshell, it appears that there was both a planned Calusa sea turtle fishery and an extensive long-distance trade network. South Florida midden contents are consistent with an active pursuit of sea turtles, particularly in the Calusa areas of southwest Florida. Midden material is unbiased toward nesting females meaning that males were sought offshore (Wing 1977b, Larson 1980). Additional midden evidence of offshore fish corresponds to links in other cultures between sea turtle harvesting and offshore fisheries (Mosseri-Marlio 1998, Mosseri-Marlio 1999). The most probable sources for *Eretmochelys* scute are south Florida and the Caribbean, which would be consistent with current nesting demographics. It appears that worked *Eretmochelys* shell in Calusa design was actively traded into northern Georgia (Larson 1993). Tortoiseshell artifacts, ostensively originating in south Florida, have been found throughout Mississippi River valley sites in mortuary context (Foster 1878, Fagin 2000).

Verification of hawksbill hunting and the tortoiseshell trade, however, is not universal in south Florida. The Calusa sea turtle and hawksbill industry in southwest Florida is substantiated in regard to tortoiseshell (Fairbanks 1959, Wing 1977a) and there is some midden evidence at the Florida Museum of Natural History, *Eretmochelys* is seldom found at archaeological sites. The absence of sea turtles from faunal assemblages may be due to site butchering, requiring only transport of the meat (Wing and Reitz 1982). With hawksbills the hunt was probably for scute, rather than meat, as the hawksbill archeofauna examined showed no evidence of burning or butchering. Scute is usually removed from the animal's shell by placing the previously removed shell in a fire until the outer layer loosens. The scute is then pried off. Records exist of scute removal by placing the entire living animal in a fire until the scute is loosened (Roberts 1827). In this method, the turtle is then freed further decreasing midden material.

Hawksbills were commonly found, hunted, and utilized with sufficient regularity to imbed them in Calusa ethnozoology in an area where today, they do not regularly nest and are not currently abundant. This raises another important question. Could they have been over collected to the extent that entire nesting colonies were extirpated? Past subsistence practices can have great effect on sea turtles and other marine organisms long past the time of the original exploitation (Jackson et al. 2001, Mayell 2001). It would be naive to imagine that primitive people decimated sea turtle populations to the exclusion of all other factors; but clearly some significant impact was made. Clearly, the Calusa did actively hunt hawksbill sea turtles, possibly to the detriment of current populations, for the express purpose of utilizing their scutes for ornamentation, often related to ceremonial aspects of their lives and regularly with spiritual relevance. Many tortoiseshell artifacts are found in mortuary contexts and there is a strong funerary symbology connected with the hawksbill and other Chelonians. Hawksbills found their way into the Calusa symbology, which ultimately spread over half of North America.

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LITERATURE CITED

Clark, M.R. In press. A mechanical waterbird mask from Pineland and the Calusa masking tradition. University of Florida, Gainesville.
Cushing, F.H. 1896. Exploration of the ancient key. Amer. Phil. Soc. 35:153: 329-448.
Ernst, C.H. and R.W. Barbour. 1972. Turtles of the United States. University of Kentucky Press, Lexington.
Fagin, B.F. 2000. Ancient North America. Thames and Hudson, London.
Fairbanks, C.H. 1959. Additional Elliot's Point Complex sites. Florida Anthropologist 12:95-99.
Fontaneda, Do. D'Escalante. 1945. Memoirs of Do. D'Escalante Fontaneda respecting Florida. In: B. Smith, ed. D.O. True. Glade House, Coral Gables.
Foster, J.W. 1878. Prehistoric races of the United States of America. S.C. Griggs and Co., Chicago.
Gilland, M.S. 1975. The Material Culture of Key Marco, Florida. University Presses of Florida, Gainesville.
Gilland, M.S. 1989. Key Marco's Buried Treasure. University Press of Florida, Gainesville.
Hann, J. ed. and trans. 1991. Missions to the Calusa. University of Florida Press, Gainesville.
Jackson, J.B.C., M.X. Kirby, K.A. Bjorndal, et al. 2001. Historical overfishing and the recent collapse of coastal ecosystems. Science 293:629-637.
Larson, L.H. 1980. Aboriginal Subsistence Technology on the Southeastern Coastal Plain during the Late Prehistoric Period. University of Florida Press, Gainesville.
Larson, L. 1993. An examination of the significance of a tortoiseshell pin. Archaeological Report, No. 25, 1993.
Luer, G. 1992. Popeyed bird-head effigies in West-Central and Southwest Florida. Florida Anthropologist 45: 52-62.
Mayell, H. 2001. Overfishing long ago tied to modern ecosystem collapse. National Geographic News,08/07/01.
Milanich, J.T., A.S. Cordell, V.J. Knight, Jr., S. Hale, and R.A. Marrinan. 1984. Prehistoric development of Calusa Society. In: D.D. Davis, ed. Perspectives on Gulf Coast Prehistory, University Presses of Florida, Gainesville. p. 258-314.
Muller, J. 2000. Contradictions in the interpretation of the Southeastern Ceremonial Complex. Society for American Archaeology 2000 Annual Meeting.
Mosseri-Marlio, C. 1998. Marine turtle exploitation in Bronze Age of Oman. Marine Turtle Newsletter 81: 7-9.
Mosseri-Marlio, C.E. 1999. The Fat of the Land? Aspects of Sea Turtle and Dolphin Exploitation in Bronze Age Oman. MSc Dissertation, Univ. London.
Pritchard, P.C.H. 1979. Encyclopedia of Turtles. T.F.H. Publications, Inc. Ltd., Neptune, New Jersey.
Rainey, W.E. 1981. Guide to sea turtle viceral anatomy. US Department of Commerce, Miami.
Roberts, O. 1827. Narratives of the voyages of Central America. Constable and Co., Edinburgh.
van der Schalie, H. and P.W. Parmalee. 1960. Animal remains from the Etowah Site, Georgia. FL Anthropologist 13:37-54.
Wheeler, R.J. 1997. Metal crested woodpeckers: Artifacts of the Terminal Glades Complex. FL Anthropologist 50:67-82.
Wheeler, R.J. 2000. Treasure of the Calusa. Rose Printing, Tallahassee.
Widmer, R.J. 1988. The Evolution of the Calusa. University of Alabama Press, Tuscaloosa.
Widmer, R.J. 1989. The relationship of ceremonial artifacts from South Florida with the Southeastern Ceremonial Complex In: P. Galloway, ed. The Southeastern Ceremonial Complex, Univ. Nebraska Press, Lincoln, NE. p. 166-180.
Wing, E.S. 1977a. Subsistence at the McLarty Site. Florida Anthropologist 31:3-7.
Wing, E.S. 1977b. Subsistence systems in the southeast. Florida Anthropologist 30:81-87.
Wing, E.S. and E.J. Reitz. 1982. Prehistoric fishing economies of the Caribbean. J. New World Archaeology 5: 13-32.
Witzell, W. 1983. Synopsis of biological data on the hawksbill turtle *Eretmochelys imbricata*. FAO, Rome.
Wolke, R.E. and A. George. 1981. Sea turtle necropsy manual. U.S. Department of Commerce, Miami.
Wyneken, J. 2000. Sea Turtle Anatomy Workshop. Symposium on Sea Turtle Biology and Conservation, Orlando, FL.
Zubillaga, F. 1946. Monumenta Antiquae Floridae (1566-1572). Monumenta Missionum Societatis Jesu, Rome.

Fig. 1. "sea tortoise" shell plates with "wheeling afrontee dolphins." (UM).

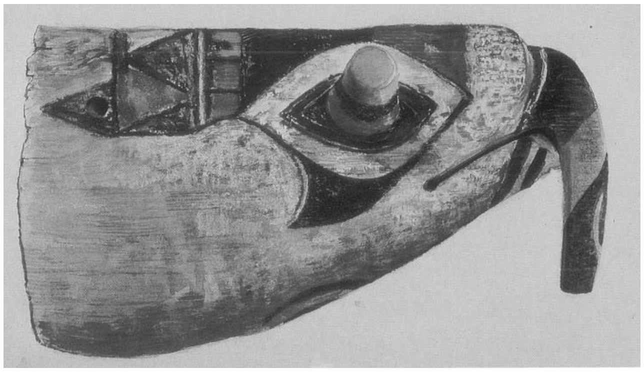

Fig. 2. Wells Sawyer watercolor (SI).

Fig 3. Hawksbill figurehead (UM).

Collection of sea turtles of the section of herpetology of the Museu Oceanografico Do Vale Do Itajai (Movi), Brazil

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The collection of the Section of Herpetology of the Museu Oceanografico do Vale do Itajai (MOVI) began in January of 1987, through the creation of the Centro de Estudos Bio-Ecologicos Costeiros, Limnologicos e Marinhos (CEBECLIM). In 1993, CEBECLIM joined to the Universidade do Vale do Itajai (UNIVALI), creating MOVI, which had a great influence in the implementation of the collection. The collection has since turned into one of the best in the world for sea turtles. The collection is composed primarily of sea turtles: whole specimens (fixed or taxidermied), craniums, skeletons, carapaces, neonates, embryos, eggs, organs, tissues, pictures and VHS tapes, parasites and epibionts. All are placed in the reference collections and identified to phylum. The pieces were mainly acquired through periodic expeditions in the coast of State of Rio Grande do Sul. In addition, the collection includes donations of specimens accidentally captured in the north coast of State of Santa Catarina, contributions of fishing boats of the fleet of Itajai and of specimens originating from the southeast and northeast of Brazil, besides the Brazilian oceanic islands (Island of Trindade and Archipelago of Fernando de Noronha). The collection is organized in 328 lots, formed mainly by skeletons and whole specimens. The five species of sea turtles that occur in the Brazilian coast are represented in the collection and include (with the respective amount of lots): *Caretta caretta* (135), *Chelonia mydas* (128), *Lepidochelys olivacea* (09), *Eretmochelys imbricata* (09) and *Dermochelys coriacea* (37).

Decreasing turtle mortality by fisheries in central Peru

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The Peruvian Marine Ecosystem supports one the world's largest fisheries. Extensive fishing activities, both at offshore and inshore waters, have led to the incidental or directed capture of non-target marine vertebrates such as pinnipeds, cetaceans, seabirds and turtles, which are recovered for food or bait. Significant captures of marine turtles in fishing nets were recorded in 1987 in Peru (about 22,000 turtles in only one port), but in spite of local laws and international protective status, illegal capture is still occurring. The main marine turtle species affected by incidental capture along the Peruvian coast are the green turtle (*Chelonia mydas agassizii*), olive ridley (*Lepidochelys olivacea*), leatherback (*Dermochelys coriacea*) and hawksbill (*Eretmochelys imbricata*). Since 1999, we monitored the rate of turtle captures in artisanal fishing boats at Chimbote port and found that the number of turtles landed per day were 1.39, 0.46 and 0.37 in 1999, 2000 and 2001, respectively. The interannual decrease of landings was also observed by the Peruvian Marine Research Institute (IMARPE), with annual landings of 4.4, 3.04 and 0.58 metric tons in 1997, 1998 and 1999, respectively. This negative trend may reflect a gradual decline of the turtle populations, but other factors such as fishing effort, type of gear, fleet size, and oceanographic conditions may also affect turtle capture rates at sea. Further studies of sea turtle-fisheries interactions at sea and educational campaining in fishing communities would provide valuable information for a management plan and conservation of sea turtles in coastal areas.

Descriptive analysis of the fishing arts that affect the marine turtles in the Gulf of Venezuela

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INTRODUCTION

Marine turtles are reptiles that have experienced an evolutionary success, adapting to all the changes raised from prehistoric times until present (IUCN 1996). Nevertheless, a combination of factors like commercial fishing, incidental capture, destruction of essential feeding, nesting and rest habitats are negatively affecting the current condition of marine turtles (UICN 1996). The Gulf of Venezuela has witnessed a decrease in marine turtle by virtue that they represent an important feeding resource for the residents (Barrios-Garrido et al. 2001). Equally, they have diminished due to fishing efforts in the area that use a variety of instruments to capture these marine species. There are two types of this art: the fixed art and the mobile art. In the fixed art, fishing equipment is operated and anchored to the bottom or the bank, staying in the same position until it is picked up; the mobile art includes equipment that can be dragged by crafts or left to drift, although it doesn't exclude the assurance of the craft to avoid excessive lodging or loss (Encyclopedia Encarta 2001).

Found Habitat Conditions. The marine turtles developed in a highly marine atmosphere where the presence of aquatic plants, as well as corals, sponges, gastropods and jellyfish prevails. In the Gulf of Venezuela, the presence of these reptiles is more prevalent in the northwestern area where the waters and beaches have a smaller level of human intervention, since they are in the small towns of the indigenous Wayuú.

CONCLUSIONS

In the fishing area of the Gulf of Venezuela, the favorable time to capture marine turtles is during the months of May, June and July; this time is called the time of peacefulness by the fisherman. The reason that the number of marine turtles in the area increases considerably, is because the migration of the nesting turtles in the beach of Tortuguero, in Costa Rica, towards feeding areas to recover energy used during its reproductive stage. The marine turtles are frequently captured in fishing equipment, using the same as for the consumption of meats in the near restaurants; they take advantage the shells (*Eretmochelys imbricata*), oil, blood of the different species (Barrios-Garrido 2000).

LITERATURE CITED

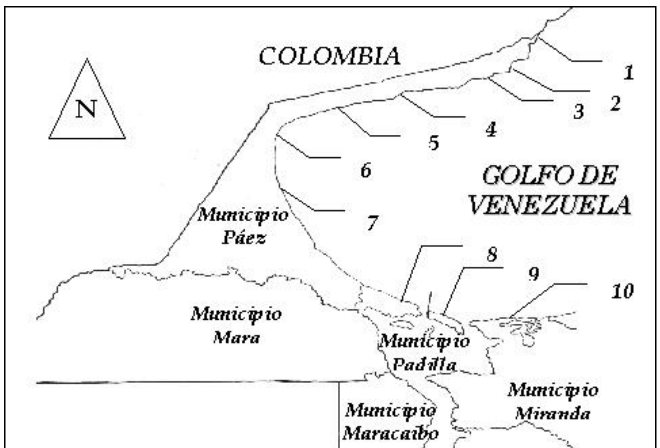
Barrios-Garrido, H. 2000. Aspectos generales sobre la biología de las tortugas marinas. I Taller sobre Nociones Básicas para el estudio de la Biología y Conservación de Tortugas Marinas. Maracaibo-Venezuela, 2000.

Barrios-Garrido, H., M.G. Montiel-Villalobos, T. León, and J. Hernández. 2001. Distribución de especies y tamaños de las tortugas marinas capturadas en el Golfo de Venezuela. II Congreso de Biodiversidad, Fragilidad, Impacto y Estrategias de uso de áreas protegidas. Maracay-Estado Aragua, 2001.

Enciclopedia Interactiva Encarta 2001. Las tortugas marinas.

IUCN. 1996. A Marine Turtle Conservation Strategy and Action Plan for the Western Indian Ocean. Prepared by IUCN East Africa Regional Office and IUCN/SSC Marine Turtle Specialist Group. World Conservation Union (IUCN). 24 p.

Pritchard. P., P. Bacon, F. Berry, A. Carr, J. Fletmeyer, R. Gallagher, S. Hopkins, R. Landford, R. Márquez, L. Ogren, W. Pringle, H. Reichart, and R. Witham. 1983. Manual sobre Técnicas de Investigación y Conservación de Tortugas Marinas. 2da Edición. K. Bjorndal and G.H. Balazs, eds. Center for Environmental Education. Washington D.C.



Field Zone: 1.- Castilletes; 2.- Parashiou; 3.- Porshoure; 4.- Cojoro; 5.- Cazuzai; 6.- Neima; 7.- Paraguaipoa; 8.- Isla de San Carlos; 9.- Isla de Zapara; 10.- Ciénaga de "Los Olivitos".

Fig. 1. Map of the Gulf of Venezuela study area.

Present status of the green turtle (*Chelonia mydas*) in the Gulf of Venezuela

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INTRODUCTION

The marine turtles are reptiles that have had the most evolutionary success through the times, adapting to all the changes raised from the dinosaurs until our days. In the world there exists a total of 8 species of marine turtles; of which 5 are in Venezuela. All are reported in the study zone: loggerhead (tortuga caguama, *Caretta caretta*), green turtle (tortuga verde, *Chelonia mydas*), hawksbill turtle (tortuga carey, *Eretmochelys imbricata*), olive ridley (*Lepidochelys olivacea*) and leatherback turtle (tortuga cardón, *Dermochelys coriacea*). In the Gulf of Venezuela the green turtle is the most abundant turtle, therefore it is the one that receives the most impact to their survival to be an important component inside the coastal populations as a food, economic, and magic-religious resource. The extensive prairies of seagrasses present in the study area constitute a suitable habitat so that a great number of green turtles from different nesting colonies of the Caribbean using it as a feeding area and migratory corridor during the nesting seasons. The present work gathers the more important data characteristic of the area of the Gulf of Venezuela that has been observed by investigators during 5 years of uninterrupted investigations whose objectives are to know and to deepen in relation to biological data, the conservation and ecology of the green turtle in the Gulf of Venezuela.

METHODS

Since 1997, a group of biology students from the University of the Zulia (LUZ), in collaboration with different government and non-government entities of the state, have periodically visited to the main towns of the Gulf of Venezuela, as well as to the beaches where the presence of the marine turtles is an important factor. In a same way of interviewing work, surveys and understanding in the communities have been fundamental factors in obtaining information about the marine turtles in the area, as well as anecdotes, legends and myths about these animals.

RESULTS AND DISCUSSION

Presence. The green turtle is the most present marine turtle in the territorial waters of the Gulf of Venezuela, this is important because this area is used as a feeding and migration area for the most important population of *C. mydas* in the Caribbean, in the nesting colony of Tortuguero (Costa Rica). This is confirmed by the recovery of flipper tags from the referred area, just as there have been a reported number of tags from Aves Island (the second most important nesting beach). The field has clearly differed, through the shell measurements, that a small contingent of turtles of a bigger size than those from Tortuguero and with differences in their deeply ingrained coloration (dark coloration), characteristics that are similar to the errant turtles of Suriname and Guyana (Prichard 1984).

Uses. A series of qualities and virtues are attributed to the marine turtle in many Latin American locations, however the Gulf of Venezuela is highly populated by the indigenous Wayuú whose beliefs are rooted into their culture, and for that, have exploited the marine turtles, specifically the green turtle, for being "a gift sent from heaven from Maleiwä (God) ". Specifically the consumption of meat and of the offering of blood is for longevity, as well as an almost divine "sexual power", the use of the green turtle shells to avoid water contamination and to preserve dressing garments is habitual among the natives. The shells are also used as containers to keep water, later to be used as baths for the women and to provide stronger and more delicate skin to the recently developed women. It is also very common to observe in plants and corral entrances of domestic animals skulls of green turtles to offer acceleration in the fructification and gestation processes, for the belief of being an extremely prosperous and productive species (Barrios-Garrido 2000). From the economic point of view the green turtle is the more famous for the flavor and value of the meat. A great demand of its products exists in local, national and international markets; as well as the fishermen's search to provide bigger economic dividends at a relatively low capture cost.

Stages. A marked difference in the different stages of development of the present green turtle in the Gulf of Venezuela, allows the corroboration that this habitat is used mainly by individual sub-adults that are feeding before they arrive to the reproductive age, then mature individuals (mainly female) that come from the nesting beaches and in that period of Internesting they arrive to the Gulf of Venezuela to restore spent energy from the nesting and migration. Finally a small group of juvenile individuals, found in the area, maybe come from the beaches where they were born, pulled by the oceanic currents and stopped to find a suitable place with sufficient food to stay permanently.

Protection. Due to the presence of the great variety in habitat that favors the development of the green turtle inside the Gulf of Venezuela, the creation of minimal control guard and protection for the animal in this zone becomes necessary. Now then, the place in course of control and handling plans should be accompanied with big educational campaigns to take the information about the imminent danger of extinction in which this reptile is at the moment. There is a great disposition and receptivity by the residents to listen to the information offered to them, but equally this presents the necessity to create viable, effective plans, taking into account the economic, social and cultural reality of the natives where the green turtle is a factor. The resource of the turtle as food in the area is exploded, and no type of control exists on the part of the entities in charge of veiling the defense of the wild fauna. The Gulf of Venezuela, and especially the study area (Caimare Chico - Paraguaipoa), presents a great variety of habitats that favor the development of all the species of marine turtles that are reported by Venezuela. The study beach areas present are very ample, and are very good for nesting the marine turtle nesting. The human activity developed in the study area that most affects the marine turtle is tourism, mainly in the Caimare Chico area that is the main spa of the state Zulia, where in high seasons, the marine level, just as the terrestrial level, are observed to be altered. Then there is the hydrocarbon waste that affects the area more and more because the oil spills that happened in the adjacent lands. The marine turtles are very important inside the Wayuú indigenous culture and it becomes necessary to use an environmental education plan in the area, to create consciousness inside the population that their resource is drainable, but can be sustainable.

LITERATURE CITED

Barrios-Garrido, H. 2000. Aspectos generales sobre la biología de las tortugas marinas. I Taller sobre Nociones Básicas para el estudio de la Biología y Conservación de Tortugas Marinas. Maracaibo-Venezuela, 2000.

Barrios-Garrido, H., M.G. Montiel-Villalobos, T. León, and J. Hernández. 2001. Distribución de especies y tamaños de las tortugas marinas capturadas en el Golfo de Venezuela. II Congreso de Biodiversidad, Fragilidad, Impacto y Estrategias de uso de áreas protegidas. Maracay-Estado Aragua.

Pritchard, P. and P. Trebbau. 1984. The Turtles of Venezuela. Society for the Study of Amphibians and Reptiles. p. 253–399.

Sea turtle bycatch in a demersal gillnet fishery in Pamlico Sound, North Carolina

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INTRODUCTION

The southern flounder (*Paralichthys lethostigma*) fishery is one of the most valuable finfish fisheries along the coast of North Carolina; landings of this fishery were valued at over $7 million in 1995 (NCDMF 1997). A large portion of this fishery is conducted in Pamlico Sound, North Carolina during the annual flounder fall migrations (September 15 to December 15). The increase in gillnet abundance utilized in this fishery over the past 10 years has begun to raise concerns among conservationists and fisheries managers. Not only has the concentration of gillnets increased, so has the number of sea turtle strandings in the southeastern portion of Pamlico Sound (NCDMF 2000, Gearhart 2001, NCDMF 2001a). The increase in sea turtle strandings prompted the North Carolina Division of Marine Fisheries (NCDMF) and the National Marine Fisheries Service (NMFS) to conduct observer trips on two gillnet fisheries, the spotted trout (*Cynoscion nebulosus*) and southern flounder fisheries, operating in the area in the fall of 1999 (NCDMF 2000, Gearhart 2001, NCDMF 2001). Observes implicated the southern flounder gillnets as a possible cause to the increase in strandings when two Kemp's ridley (*Lepidochelys kempii*) sea turtles were observed taken on flounder trips and no sea turtle interactions were recorded during spotted trout trips (NCDMF 2000, Gearhart 2001, NCDMF 2001). The goal of this study was to determine the impact that southern flounder gillnets could be having on sea turtles in Pamlico Sound, NC. Examination of the catch-per-unit-effort of sea turtles were compared among the deep and shallow areas of Pamlico Sound, the first and second halves of the season, gear parameters, soak time, and gear configurations. The objectives of this study are: 1). To characterize the sea turtle bycatch composition and distribution, 2). To suggest reasonable and prudent regulations for the fishery and 3). To test experimental gillnet configurations in an effort to reduce sea turtle bycatch.

METHODS

Study site. Pamlico Sound covers an area of approximately 5,335 km^2 with an average depth of 4.9 m (Stanley 1989, Stanley 1992). The southern flounder gillnet fishery of Pamlico Sound, North Carolina is operated in two primary areas of the sound, which are separated by a sandbar. The shallow area is on the barrier island side of the sandbar while the deep area is located on the mainland side of the sandbar. Water depth in the shallow area rarely exceeds 3 m while the deep area ranges from 3-7 m.

Observations. Observers collected data from randomly assigned commercial fishing trips during the 2000 fall season, conducted from September 15 to December 15. Data recorded included gear characterization data (location by latitude and longitude, length, mesh, etc.) and biological data (number of sea turtles caught, pounds of flounder in each net, etc.). In the fall 2001 season, fishermen were contracted to test 3 gillnet configurations; a double lead line, low profile and a control gillnet. The double lead line net was composed of two lead lines and no float line while the low profile net was approximately half as tall as the control. Observers recorded the location of each net (latitude and longitude) and number and weight of each species landed. Statistical analysis was broken up into fishing practices (area fished, half of season fished, and total effort per net (length * soak)) and gear parameters (length, soak, mesh, twine, etc.). Fishing practices and gear parameter analysis were run utilizing a backward model selection (Steel et al. 1997) technique to determine which factors and interactions were the most significant. Analysis was run in SAS® with Proc Genmod and due to the rare occurrence of a single net catching more than one turtle a logistical regression was utilized where 0 represented a net without an interaction and 1 represent a net with a sea turtle take (SAS 1985, D. Boos, pers. comm.). The most significant factors from the fishing practices and gear parameter analysis were then placed in another backward model selection to determine the most significant variable contributing to sea turtle bycatch.

RESULTS

There were a total of 22 sea turtle interactions observed during the 2000 southern flounder gillnet fishery of Pamlico Sound, NC. Fourteen sea turtles were released alive while the remaining 8 were found dead. There were 10 (4 dead) greens (*Chelonia mydas*), 8 (2 dead) loggerheads (*Caretta caretta*), and 4 (2 dead) Kemp's ridleys observed caught in southern flounder gillnets. A paired t-test analysis determined that there was no significance between finding a sea turtle dead or alive, however it was suggestive ($t=1.92$, $p=0.0562$). Between species, a paired t-test analysis only detected a significant difference between the CPUE of greens and Kemp's ridleys; no other combination of species was significant.

A total of 15 sea turtle interactions occurred in the deep area of Pamlico Sound. There were also more sea turtle interactions in the first half of the season (19) than the second half of the season (3). Area was the only significant variable in the fishing practices analysis ($p=0.0335$). Season ($p=0.2892$) and effort ($p=0.9612$) were both insignificant variables. No significant interactions were detected between the variables in the fishing practices analysis. The length (meters) of net fished was the only significant factor affecting the proportion of sea turtle interactions in the gear parameter analysis ($p=0.002$). However, this significance was probably due to three data values (411, 480, and 1097 meters) in which a sea turtle interaction had occurred in only one observation, thus no variation with those levels can be determined. Height was not a significant factor in the elimination model selection; however, when analyzed separately it was significant ($p=0.0368$). However, again there was only one observation of a net with a vertical mesh count of 17, which could have resulted in this variable being significant. Twine ($p=0.8446$), mesh size (p-value = 0.1589), and soak time ($p=0.1255$) were found to be insignificant factors affecting the proportion of sea turtle interactions with southern flounder gillnets. No significant interactions were detected between these variables.

The significant factors contributing to the proportion of sea turtle interactions were meters of net employed and area. Analysis of a logistical regression model utilizing these parameters determined that meters of net fished was a more significant factor ($p=0.0048$). The interaction of meters*area ($p=0.4244$) was not significant. During the 2000 southern flounder gillnet fishery, tie-down length was analyzed within the deep area of Pamlico Sound because this was the only area in which a tie-down length was utilized. When analyzed by itself, tie-down length was not a significant factor affecting sea turtle interactions ($p=0.9328$). There were also no significant interactions between tie-down length and the other gear parameters. During the experimental gear testing during the 2001 southern flounder gillnet fishery, four sea turtle interactions were recorded. All four sea turtle's were Kemp's ridleys. Three sea turtle interactions occurred in the control gillnet configuration while one occurred in a double lead line configured gillnet.

DISCUSSION

The data gathered from this study seem to suggest that moving the starting date for the fishery or decreasing the amount of effort employed during the first half of the season will decrease the number of sea turtle takes. Even though the halves of the fishing season was not a significant factor, there were more than six times as many sea turtle interactions recorded in the first half than the second half. Sea turtles are still common in the area during the first two weeks of the season because water temperatures are still warm. During the 2000 season, water temperatures were unseasonably warm during both halves of the fishing season, which could have contributed to season being an insignificant factor because sea turtles were still present in the sound even in November (pers. obs.). Moving the start date for the fishery back to October 1 (about 2 weeks) or reducing fishing effort by allowing fishermen to fish only 2 or 3 days a week during the first 2 weeks to reduce total fishery effort is suggested. Regulations are needed for the deep-water portion of the southern flounder fishery. Implementation of the low profile net did not result in a single sea turtle take. Also, these nets were approximately half as long (273 m) and half as tall (12 mesh vertical count) as the gillnets typically fished in the deep-water fishery. All sea turtle interactions occurred in gillnets with a vertical mesh count of 17 or more and the majority of sea turtle interactions occurred in nets with a length over 273 m. Also, these nets do not utilize a tie-down configuration, which is believed to increase sea turtle entanglement (J. Gearhart, pers. comm..), however this analysis did not detect such an affect. Therefore, it is suggested that the deep-water fishery employ the low profile nets to help reduce the number of sea turtle takes.

The intent of this study is to start to analyze the problem of sea turtle bycatch in gillnet fisheries and to begin to develop regulations that will keep the fisheries open and reduce sea turtle takes. These regulations are not a solution to the problem but are good suggestions to begin to solve the problem. Much more work needs to be done; specifically a better method of determining the number of incidental takes, determining the mechanisms in which sea turtles get entangled and the attractiveness of gillnet to sea turtles are poorly understood developed. By using these regulations it is believed that southern flounder gillnet fishery will still be able to operate at a reduction in the number of incidental takes.

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LITERATURE CITED

Gearhart, J. 2001. Sea turtle bycatch monitoring of the 2000 Fall flounder gillnet fishery of southeastern Pamlico Sound, North Carolina. NCDMF Completion Report for Incidental Take Permit 1259. NCDMF, Morehead City, North Carolina. 26 p.

North Carolina Division of Marine Fisheries. 1997. Assessment of North Carolina commercial finfish fisheries, 1994-1996. North Carolina Department of Environment and Natural Resources, Division of Marine Fisheries, Morehead City, NC.

North Carolina Division of Marine Fisheries. 2001. Application for an individual incidental take permit under the Endangered Species Act of 1973. North Carolina Division of Marine Fisheries, Morehead City, NC. 29 p.

North Carolina Division of Marine Fisheries. 2000. Application for and individual incidental take permit under the Endangered Species Act of 1973. North Carolina Division of Marine Fisheries, Morehead City, NC. 25 p.

SAS Institute Inc. 1985. SAS®User's Guide: Basics, Version 5 Edition. Cary, NC: SAS Institute Inc. 1290 p.

Stanley, D.W. 1989. Historical trends in land use, nutrient production, water quality and fisheries in the Albermarle-Pamlico estuarine system. Report to the National Ocean Pollution Program Office, NOAA, Washington, DC.

Stanley, D.W. 1992. Historical trends: water quality and fisheries, Albemarle-Pamlico Sounds, with emphasis on the Pamlico River Estuary. University of North Carolina Sea Grant College Program Publication UNC-SG-92-04. Institute for Coastal and Marine Resources, East Carolina University, Greenville, NC. 215 p.

Steel, R.G.D., J.H. Torrie, and D.A. Dickey. 1997. Principles and Procedures of Statistics: A Biometrical Approach. 3rd Edition. WCB McGraw-Hill, Boston, Massachusetts.

Turtle mortality caused by boat collisions in North Carolina

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There are multiple causes of anthropogenic sea turtle death and injury including: entanglement in commercial and recreational fishing equipment, collisions with boats, ingestion of non-degradable debris, etc. The majority of these causes are difficult to diagnose once the turtles have floated for a long period of time and then wash onshore. This study focuses on dead and injured turtles found with propeller wounds or fresh impact injuries in North Carolina waters. The number of sea turtles affected by vessel collisions from 1995 to 2001 totaled 337 individuals and increased annually from May to August. Loggerheads (*Caretta caretta*) and leatherbacks (*Dermochelys coriacea*) were the principal victims. From 1999 to 2001, 62.9% (±2.1) of sea turtles affected by boat collisions were stranded on the ocean side of the Outer Banks as opposed to the sound side. Almost all leatherbacks (96.6%) killed by boat impacts in the past 7 years were found on the ocean side. The geographic distribution for turtles (all species, n=162) affected by boat collisions from 1999 to 2001 showed 3 clusters of stranded turtles: (1) Ocracoke and Hatteras Island, (2) Cape Lookout and Shackleford island and (3) the stretch from Bald Head Island to Sunset beach. The geographic distribution of stranded leatherbacks killed by boat collisions (n=31) from 1997 to 2001 followed the same cluster pattern as for the distribution for all the species. However, the cluster (2) was more concentrated at the Cape Lookout Bight, where leatherbacks have been reported swimming frequently (K. Rittmaster, pers. comm.). The period of highest boat collision events occurred during the summer months. Fishing boats might collide with sea turtles, but recreational boats (private boats, fishing tournament boats and shuttle boats) might also contribute. The majority of leatherbacks found stranded in NC showed some sign of boat collision. An area of concern is the Cape Lookout Bight where boat traffic increases during the summer. There should be "low speed/no wake" markers in areas of high traffic, especially in narrow inlets such as the Cape Lookout Bight.

Anthropogenic mortality of leatherback turtles in Massachusetts waters

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Sub-adult and adult leatherback turtles (*Dermochelys coriacea*) migrate northward in spring to occupy nearshore habitats, where they feed primarily on jellyfish. In Massachusetts waters, anthropogenic mortality of leatherbacks is highest during summer and fall, coinciding with a peak in human activities. A review of leatherback mortality documented by the Sea Turtle Stranding and Salvage Network (STSSN) in Massachusetts, suggests that vessel strikes and entanglement in fixed gear (primarily lobster and whelk pots) are the principal sources of this mortality. In 2001, more than 30 stranded leatherbacks were reported to the Massachusetts STSSN; the majority of these animals were entangled in pot gear, although four of the turtles exhibited propeller gashes on their carapaces. From 1990-2000, 92 entangled leatherbacks were reported from New York through Maine. Additional leatherbacks stranded with line wraps or evidence of prior entanglement. The proliferation of pot gear in Massachusetts shelf waters, where leatherbacks are known to forage, suggests that the potential for interaction is high. The NMFS Northeast Region Stranding program is working to reduce leatherback mortality associated with fixed gear interactions. The objectives of the program are: (1) to conduct an outreach campaign to increase reporting of entangled turtles; (2) to develop disentanglement gear specific to leatherbacks; (3) to establish a trained and equipped network to respond to reported entanglement incidents in New England waters; and (4) to develop disentanglement guidelines for vessels permitted for fishing with pot gear.

Local exploitation of marine turtles in Equatorial Guinea: market studies

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The marine turtle populations along the coasts of the Gulf of Guinea are suffering from human exploitation that is difficult to halt and is proceeding at such high rate it will lead to serious species depletions or extinctions. Previous studies have indicated that these animals are subject to great threats. We have alarming data on the capture of leatherbacks (*Dermochelys coriacea*) and poaching of nests in the area of Banio (Gabon). Something similar is occurring to the green turtle (*Chelonia mydas*) in Equatorial Guinea, a species which has become one of the most important sources of protein. In fact, its meat is one of the most appreciated by the inhabitants of Bata and therefore, the number of bars and restaurants which use this meat as a primary food continues to increase. The preparation style has considerable social importance: the spicy sauce accompanying the meat (pepe sup) is considered a remedy against hangovers. However, this does not compromise the conservation potential of marine turtles in Equatorial Guinea. We identified 10 bars and restaurants in Bata and surroundings. We established that the green turtle is the most threatened by consumption. 90% of the citizens of Bata eat turtle meat. We estimate that >25 turtles are eaten monthly, approximately 5 leatherbacks and the rest green turtles.

Sea turtles: a myth for Uruguayan long-line fleet fishermen?

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The long-line fishery in Uruguay. The Uruguayan long-line fleet operates in the Economic Exclusive Zone (EEZ) and adjacent international waters, targeting mainly swordfish. The tuna fishery began in 1968, with a single vessel bought by the SOYP (Servicio Oceanográfico y de Pesca – Oceanographic and Fishing Service) from Spain. This ship operated from 1969 to 1974 (Nion 1999). From 1975 to 1980 there was a gap in tuna fishing. The fishery recommenced in the early '80's with a long-line fleet consisting mainly of Japanese vessels. A considerable number of the skippers and crew were also Japanese. In 1992 Japanese vessels were gradually replaced by Spanish and American longliners (Mora 1994, Domingo et al. 1996). Most of the vessels currently operating use monofilament drift longlines of American origin.

Incidental catch of sea turtles. Loggerhead (*Caretta caretta*), leatherback (*Dermochelys coriacea*) and green (*Chelonia mydas*) sea turtles have been reported as incidental capture by the Uruguayan tuna fleet (Domingo et al., this symposium). Only the smaller specimens, less than one meter in length, were brought aboard while the larger ones were released by cutting the fishing lines. The crew showed diverse attitudes towards these animals however, in general, they were respectful. Sometimes, the fishermen took out the hooks, employed resuscitation techniques and cleaned the carapaces of barnacles and algae. Most Uruguayan longline fishermen believe that to kill a sea turtle will result in a poor catch.

Theoretical frame. Culture may be considered as "a unique organization of symbolic meanings that emerge from the interaction of people attempting to adapt to ecological and social pressures in a cultural historical context" (Parker 1984). We agree with Seymour Parker that the essential idea remains that "emergent possibilities at each organizational level are differentially rewarded or punished by endogenous reinforces" (id.). However, there are individual variations on an underlying common theme. Such variations can arise in small communities, also depending on cross-cultural influences.

The Uruguayan case. Japanese in whose culture turtles play a significant mythological role trained the first Uruguayan longline fishermen. The same occurred in many Amerindian (i.e. the Guarani culture) and West African cultures. Though Guarani Indians were exterminated in Uruguay and the surviving traces of their culture are mainly linguistic and archaeological, their culture is still alive in the South of Brazil and their legacy cannot be totally ignored. African cultures continue to have a strong presence in Uruguay, in spite of the fact that only 1.5% of today's population is black. Their religions (i.e. macumba), beliefs and music have contributed a significant degree to the national identity. Sea turtles also have mythological relevance for African peoples.

CONCLUSION

The above described attitude towards sea turtles has been observed almost exclusively in the longline tuna fishery and only occasionally in small scale coastal fishery. In other fisheries sea turtles are killed to sell their carapaces, nails and used frequently for food. The behavior of longline fishermen is not directly related to myths and beliefs or importance in the Uruguayan culture. In our opinion, it is the result of a cultural loan, mainly from the Japanese- among whom sea turtles are important mythological beings- also supported by beliefs from African –and eventually Guarani- cultures. The strength of this "imported" belief is evidenced by the time and care fishermen take to save sea turtles which, due to their high market value, it would be more profitable to kill. Thus, a mere belief in the negative effects of killing sea turtles on the result of the fishery helps to protect sea turtles at a very low cost. This shows that, when studying any animal population it is essential to take into consideration the human community that interacts therewith. In this connection, it should be also taken into account that the scientist/researcher/biologist that is making the study is not detached from the community under analysis: his mere presence influences the behavior of those around him. The human factor cannot be left aside. Most biological studies are made from an anthropocentric and ethnocentric perspective and generally do not deal with the related human communities in spite of the fact that man is often the major agent of pressure which is particularly true in the case of species subject to fishing. A more comprehensive approach could contribute to invert said pressure.

LITERATURE CITED

Becker, U. 1996. Enciclopedia de los Símbolos. Robin Hook. Barcelona Eliade, Mircea

Domingo, A., A. Fallabrino, R. Forselledo and V. Quirici. This symposium. Incidental capture of loggerhead (*Caretta caretta*) and leatherback (*Dermochelys coriacea*) sea turtles in the Uruguayan long-line fishery in southwest Atlantic.

Domingo, A., O. Mora and A. Milessi. 1996. Capturas de Tiburones Pelágicos desembarcadas por la flota atunera de Uruguay. Col. Doc. Cient. Vol. XLVI ICCAT. p. 420-424.

Mora, O. 1994. Informe Nacional de Uruguay, Informe del Período Bienal 1992-93, ICCAT, Madrid, España (II), SCRS/94/28 .

Nion, H. 1999. La pesquería de tiburones en el Uruguay, con especial referencia al cazón (*Galeorhinus galeus*, Linnaeus 1758). In: R. Shotton, ed. Case studies of the management of elasmobranch fisheries. FAO Fisheries Paper F-512.

Parker, S. 1984. Cultural rules, rituals and behavior regulation. American Anthropologist 86:584-600.

Accidental captures of loggerhead sea turtles by the Azores longline fishery in relation to target species and gear retrieving time

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INTRODUCTION

During the last decade the impact of longline fisheries on sea turtles has been much debated and is considered a problem in all oceans where sea turtles and this fishery occur. In the Azorean waters, where juvenile loggerheads from nesting beaches in south-eastern United States spend a part of their oceanic life stage (Bolten et al. 1998) the problem also exists. (Bolten et al. 1994, Ferreira et al. 2001) The longline fishery in Azores targets swordfish (*Xiphias gladius*) and blue shark (*Prionace glauca*). From July to December of 2000 a longline experiment was conducted (Bolten et al. 2000). This experiment tested the effect of three different hooks on sea turtle bycatch rates and target species. Preliminary results were presented at the last symposium (Bolten et al., in press). Here we analyze the capture of loggerheads sea turtles in relation to the species being targeted and to the time of day the turtles were hauled onboard.

Data from 232 turtles, captured in 93 sets from July to December of 2000, were analyzed. Only sets that caught turtles (62) were used. For each set deploy time/depth and the retrieving time for 1168 radar reflector buoys were recorded.

METHODS AND RESULTS

Capture by target species/depth classes. The buoys were split in two depth classes, one for buoys that fished in bottom depths less than 400 fth (28.9%) and another, deeper than 400 fth 71.1%). This division was made because, according to the Captain, the sets with an average bottom depth of less than 400 fth are mainly targeting swordfish while in sets made deeper, the principal target species is the blue shark. (Captain M. Codinha, pers. comm.). CPUE (n turtles/n buoys) was calculated by month for the 2 depth classes. Buoys targeting blue shark (>400ft) captured significantly more loggerheads than buoys targeting swordfish (<400ft) (X^2=40.76; $p < 0.001$) (Fig. 1).

Capture by time of day. The gear (approximately 35 nm) was deployed at dusk and the retrieval began at dawn. Duration of hauling average 8 hours and is normally finished by midafternoon. The loggerheads captured, were aggregated in time classes according to the time of day they were hauled onboard and CPUE (n turtles/n buoys) was calculated for each class, respectively. The result shows that less turtles were caught in the early hours of the day (X^2=37.26; $p < 0.001$; Fig. 2). No differentiation between soaking time and time of day could be found in relation to the loggerhead capture rates (Spearman R=0.94; p=0.0).

DISCUSSION

During the last years the swordfish stock as decreased and to be able to cover a larger area the fishermen started to use less hooks when targeting swordfish, and at the same time increase the distance between the hooks and employ light-sticks. This practice reduce the hauling time and therefore, might also reduce the loggerhead captures without having any major effect on the capture of the target species since swordfish is a night feeder.

The shark fishery (camouflaged in the swordfish fishery) is not restricted in the Azores. Blue sharks are captured in amazing numbers (Silva and Pereira 1998) and the population start to shown signs of overexploitation (Ferreira 1999). Therefore a future management of the blue shark population will probably lead to decrease in fishing effort for this species and consequently a decrease in accidental captures of loggerhead will follow.

For a correct evaluation of the problem we think that spatial and temporal analyses, including area of capture and bathymetry, temperature and weather conditions, should be incorporated in a future study.

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LITERATURE CITED

Bolten, A.B., H.R. Martins, K.A. Bjorndal and J. Gordon. 1993. Size distribution of pelagic-stage loggerhead sea turtles (*Caretta caretta*) in the waters around the Azores and Madeira. Arquipélago 11A:49-54.

Bolten, A.B., K.A. Bjorndal and H.R. Martins. 1994. Life history model for the loggerhead sea turtle (*Caretta Caretta*) population in the Atlantic: Potential impacts of a longline fishery. In: G.H. Balazs and S.G. Pooley, eds. Research Plan to Assess Marine Turtle Hooking Mortality: Results of an Expert Workshop Held in Honolulu, Hawaii, November 16-18, 1993. NOAA Tech. Memo. NMFS-SWFSC-201. p. 48-54

Bolten, A.B., K.A. Bjorndal, H.R. Martins, T. Dellinger, M.J. Biscoito, S.E. Encalada and B.W. Bowen. 1998. Transatlantic developmental migrations of loggerhead sea turtles demonstrated by mtDNA sequence analysis. Ecological Applications 8:1-7.

Bolten, A.B., H.R. Martins, and K.A. Bjorndal, eds. 2000. Proceedings of a workshop to design an experiment to determine the effects of longline gear modification on sea turtle bycatch rates NOAA Tech. Memo. NMFS-OPR-19. 50 p.

Bolten, A.B., H.R. Martins, E. Isidro, R.L Ferreira, M. Santos, A. Giga, B. Riewald, and K.A. Bjorndal. In press. Results of an experiment to evaluate effects of hook type on sea turtle bycatch in the swordfish longline fishery in the Azores.

Ferreira, R.L. 1999. Caracterização das Capturas Acessórias da Pesca Dirigida ao Espadarte (*Xiphias gladius*) nos Açores. B.Sc. thesis in Marine and Fisheries Biology, University of Algarve, Portugal. 58.

Ferreira, L.R., H.R. Martins, A.B. Bolten and A.A. Silva. 2001. Impact of longline fishing on sea turtle bycatch in Azores. Arquipélago, Life and Marine Sci. 18:75-79.

Silva, A.A. and J.G. Pereira. 1998. Catch rates for pelagic sharks taken by the Portuguese swordfish fishery in the waters around Azores, 1993-1997. ICCAT Working Document SCRS/98/168:12p.

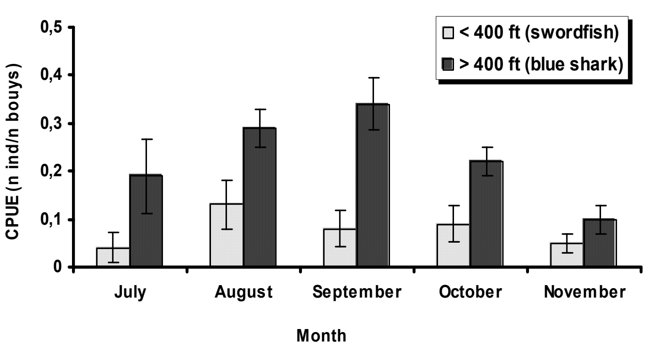

Fig. 1. Loggerhead CPUE for the two depth classes (less and more than 400ft) for each month of the study. Only sets that caught turtles were used. Bars represent Standard Error.

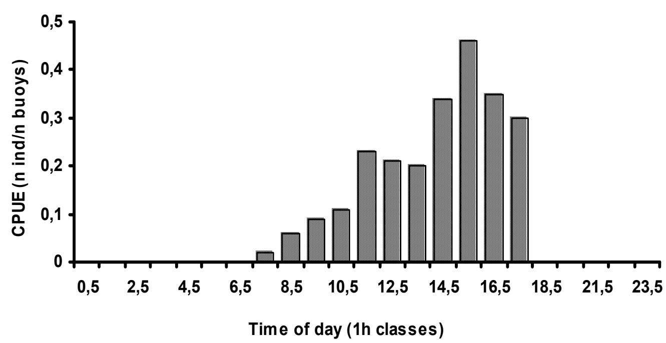

Fig. 2. Loggerhead CPUE by time of day. Hour interval. Only sets that caught turtles were used.

Sea turtles in Lampedusa, South Mediterranean Sea: rescue and fishermen education between 2000 and 2001

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INTRODUCTION

The Island ranges in the Mediterranean Sea between 35° and 32°N and 12° to 13°E. The most of its 30 km of coasts are rocky, but some of its creeks and inlets give small protected beaches not affected by night lighting, so there is still one of them, Isola dei Conigli, where sometimes sea turtles nest. More than 400 boats work in the harbour: almost 100 come from around (Mazara del Vallo, but also from Adriatic, France, Tunisia) and use trawl net; more than 300 local boats (often little boats) using fishing line (55%), trawl net (20%), permanent or circling net (20%) and wicker-work fish traps. Actually trawl is in strong growth. We have spent the last ten years educating the maritime world in Lampedusa and the data here collected on rescued sea turtles have truly convinced us to begin a Rescue Centre. It is outside the town, on a private structure that we pay with difficulties, on 1400 mq of green spaces; next to a recovering zone, we arrange a scientific space with aquariums, biological pannels, anatomic champions, show room and documentary projection hall; underneath a wide roof 20 basins waiting for turtles; a little veterinary ambulatorium contains surgical instruments where is possible to operate damaged animals with the precious collaboration of General Surgery Local Staff. Although lacking financial help, the Centre is now one of the most important reality of the island, involving the most of mass media and summer visitors attention, with about 10 thousand visitors each summer. Thanks to the education of marina and local people, we collected data on about 300 turtles each year that help to better understand sea turtle life. Marking specimen and taking care of wounded animals not only can increase their number, but it's a way to have more biometrical data and general information. Teaching basic elements of ecological respect, the Centre is now a big aggregation point for Lampedusa young people and this pushes them moving towards nature. In the wave of the interest local schools collaborate in releasing rehabilitated animals and the majority of the students help us. At the end of every year we support a thanksgiving meeting with local and Mazara fishermen, one of the best occasion to gather fresh information and new friends. We are witnessing that collaboration in ecological activity radically improves attitude of crews. Many of them now collect rubbish found in their nets, and takes personally care of captured turtles until they consign to us. Some boats, in order to keep animals in good conditions, have also basins on board, meanwhile the captains interested in biological data, ask information about the elaboration on data they give us. The group of young people collaborating with the Centre is involving directly in caring rescued specimen, in making contacts with fishermen, in the education of tourists and organization of association members. It's in such a way that a passionate team of collaboration and work was born, best reward to our engagement and adversities.

METHODS

The most common species of turtles around Lampedusa is certainly *Caretta caretta*, two other species were rarely spotted: *Dermochelys coriacea* and *Chelonia mydas*. The most used fishing method is trawling (90% coming from Mazara), boulter is used on about 100 small boats, and 10 of them use it during summer for swordfish, at the rest of time with fixed net. Our strategy went on two main directions: educating local and visiting fishermen and collecting data from professional sea workers. A better knowledge of turtle world and its problems has pushed fishermen to their defense: fishing activity and pollution are the main cause of turtles' mortality. We involve more than 50 Mazara trawl boats: their captains join us to report data and animals in every moment and find us ready at their coming. We have relations with their crew, more than 200 people. They work around Lampedusa, mainly in South direction, from January to April and from September to December. They collaborate strongly with us, in fact they have basins for turtles where animals can wait for care. They are involved in the first aid and collecting data. Lampedusa fishermen, almost 30, work mainly to swordfish from June to August, and the number of their catches is big. Also pleasure boats and military force (Carabinieri, Capitaneria di Porto, Guardia di Finanza, and Corpo Forestale) are aware of the problem. The most common accident that happens to a turtle is to be caught by fishing activity. If its a trawl normally turtles don't suffer too much, however, swallowing a hook from a longline can be a big problem. In this case if the animal is rescued quite soon and the hook is still in the first part of esophagus, it can be extracted with gag and pincers. If an X-ray exam shows a hook deep into the digestive apparatus, a bolus of an extra alimentation can still inglobate the hook, letting pass metal protecting paries from perforation. In all the other cases we apply a surgical intervention, the most quickly possible. We use our ambulatory, sleeping animals with chetamin or fluoretan anestetic. A little cut permit to join metal and to put it out. We hope to add endoscopic exams to find hooks. With the help of Poliambulatorio staff we can echograph big female animals to determine if they have eggs. We analyzed stomach contents and have found crustaceans. Meanwhile we feed rescued animals mainly with fish, but we hope to increase our equipment with more exams like blood analysis to determinate adequate nutrition. We apply growing diet for small and very young individuals and we checked them weekly.

RESULTS

Among fishing methods, two are of main impact on turtles: trawling net and hook of boulter. Swordfish is caught only from the end of June to August, and the number of boats is a lot less, but the incidence with turtles is very high. Trawling net works about ten months, boats are numerous and big, so we concentrated our attention on Mazara boats. We are available for them at any time all the year round. In this way our recovering and rescuing activity insures a continuous assistance. During 2000 we increased a collaborative link with trawling boats and we communicated with 30 boats: their presence during winter and autumn give interesting data. In the first months of the year, boats report more than 60 turtles, April and May are months with less work. In June starts swordfish job (4-8 boats) and the number of rescued sea turtles depends of the relation with that kind of boats. During winter turtles are constantly captured in trawling net (more than 150), but they rarely are damaged. Total turtles released in 2000 were 291. We operated 50 turtles and in almost 80% of the case pincers have been enough, if turtles are quickly recovered. We used surgery intervention with chetamin anestesy only when hook were too far from mouth. We had 5% of mortality and autopsy confirmed a vasus or mediastinum had been perforated. During 2001, also if we couldn't always guarantee April and May, we increased relations with boats (more than 40) and interventions (we had 498 animals). This year we increased longfishing link and they report 142 turtles in less than 50 days. We operated 120 turtles, mainly to put out hooks and we registered 20 deaths. We used chetamin, but also fluoretan anestesy. We'll rebuilt a humerus in a little turtles, so to release it in good conditions. Ecographies on big females of more than 50 kg, were very interesting. A turtle captured in August with eggs in abdomen, was recaptured 16 days after and in ecography no eggs! Does it nest? Where?

Acknowledgements. All the work told in these pages, describing a constant and passionate engagement, carried on in Lampedusa together with precious collaborators, wouldn't have been possible without the support of fishermen, doctors (Lampedusa Poliambulatorio staff, ASL 6), Police Force (Carabinieri, Capitaneria di Porto, Corpo Forestale, Guardia di Finanza), and especially the young team involved. May this work make precious the Island, so far from many things, and motivate its youth for future activities. To fishermen and students at my side, a great thank and the wish that they never surrender. We also thank WWF Italy and TRAFFIC-Europe Italian Office, the David and Lucile Packard Foundation, and the Sea Turtle Symposium for travel and lodging support. A' toi, maman, tout l'amour que des fois je n'ai pas pu te temoigner, mon petit douce ange: tu seras pour toujours en moi.

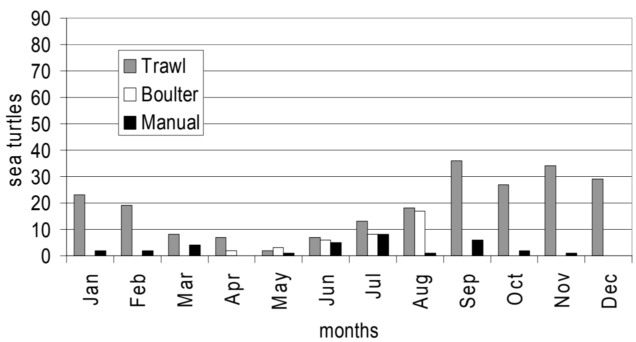

Fig. 1. Rescues 2000 (n=291).

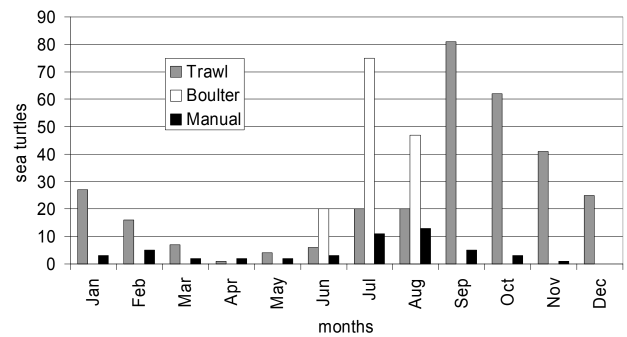

Fig. 2. Rescues 2001 (n=502).

Marine turtle strandings at the Clearwater Marine Aquarium

Glenn Harman and Kelly Rowles

Clearwater Marine Aquarium

The Clearwater Marine Aquarium since 1979 has strived to rescue and rehabilitate injured and sick sea turtles. Over the last five years CMA has responded to an increasing number of both live and dead strandings. Unfortunately CMA has seen a dramatic increase in the number of strandings due to boat collisions, entanglement and disease in fishing gear. Strandings have included five species of marine turtles with various injuries. Injured turtles reside at CMA until they are fully recuperated others are given a permanent home.

Current status of sea turtles along the northern coast of Peru: preliminary results

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INTRODUCTION

In the marine environments of Peru, four species of sea turtles occur: black turtle (*Chelonia mydas agassizii*), leatherback turtle (*Dermochelys coriacea*), hawksbill turtle (*Eretmochelys imbricata*) and olive ridley turtle (*Lepidochelys olivacea*) (Frazier 1979, Hays-Brown and Brown 1982). The Peruvian Sea is used by sea turtles in their migratory movements as well as a feeding ground and possibly as a developmental habitat of juvenile sea turtles. (Hays-Brown and Brown 1982)

The northern Peruvian ocean presents two different kinds of ecological regions: the tropical sea from California to the 5° of south latitude with warm temperature (19°C winter, 22°C summer); and the cold sea of the Peruvian Current from the 5° of south latitude to Chile central with cold temperature (13-1°C winter, 15-17°C summer).

On the Peruvian coast exists traditional sea turtle fishing. The fishermen and their families use sea turtle products, such as meat, blood, fat, heart and kidneys. In 1995, the Peruvian Government passed a law banning the capture and commerce of sea turtles and their products. Since then, the commerce of meat has been reduced, but still the capture of sea turtle continues because of the lack of law enforcement.

METHODS

Seven beaches, eleven fishermen villages and thirteen fishery ports from the departments of Tumbes, Piura, Lambayeque, La Libertad and Ancash were survey during this research. The survey covered 915 kilometers of the coastline, between Punta Capones (3°3'S, 80°0'W) and Casma Port (9°8'S, 78°4'W). The survey methodology had been based on personal interviews with fishermen and marine authorities and also on direct observations of sea turtles presence (stranding, handicrafts, carapaces, bones)

CONCLUSIONS

(1) In the northern department (Tumbes), 13 stranded turtles were observed: 12 *L. olivacea*, 1 *C. mydas agassizii*. This phenomenon seems to be very common in the area, according to the local fishermen; (2) *L. olivacea* has a greater presence in the North, whereas *C. m. agassizii* appears more commonly from Piura towards the south. *E. imbricata* and *D. coriacea* proved to be rare; (3) In Tumbes, sea turtles appear regularly throughout the year whereas a seasonal behaviour is observed towards the south, with higher presence in the summer (December to February); (4) The sexual state of the registered individuals apparently was: 73% immature *C. mydas* (n=22, mean=59.7 cm CCL), 100% *L. olivacea* adults (n=16, mean=66.6 cm CCL) and one *E. imbricata* immature (38.1 cm CCL) (Table 1); (5) The artisanal fishermen commonly capture sea turtles incidentally. The turtles get entangled in gillnets and hooks-and-lines; (6) In general, in the little fishermen villages, if the turtle captured is alive fishermen sometimes liberated them but if the turtle is dying or almost death they kill it but in the biggest towns the fishermen almost always kill all the turtles that are incidentally captured because a sea turtle meat demand exist; (7) The main sea turtle products that the fishermen consume are first the meat, second the blood which is drunk immediately after the turtle had been killed and they believe is good for health, and third the fat or oil which is drunk when they have cough; (8) The commerce of carapaces exists in the department of Tumbes and in the northern part of the department of Piura, because of the tourism. The carapaces are varnished and some times painted and the prices depend on the size of the carapace. One painted carapace of 50 cm cost around US$ 15.

According to the preliminary data obtained, we concluded that the northern Peruvian coast is a feeding and developmental habitat for sea turtles. However the presence of these species has diminished in the last 20 years. Following studies are recommended to identify and protect the critic zones that will help for the conservation of the sea turtles in the Southeast Pacific.

LITERATURE CITED

Frazier, J. 1979. Marine Turtles in Peru and the East Pacific. Office of Zoological Research, National Zoological Park, Smithsonian Institution. Unpublished manuscript. 236 p.

Hays-Brown and Brown 1982. The status of sea turtles in Peru. In: K.A. Bjorndal, ed. Biology and Conservation of Sea Turtles. Smithsonian Institution Press. Washington, D.C.

Table 1. Size means of the turtles and carapaces found during the survey.

	Chelonia mydas agassizii	*Lepidochelys olivacea*	*Eretmochelys imbricata*
mean (cm)	59.7	66.6	38.1
N	22	16	1

Side scan sonar: a tool for assessing sub-surface bycatch mortalities of sea turtles in Virginia (USA) fisheries

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INTRODUCTION

Two to four hundred sea turtle stranding deaths are recorded within Virginia's waters each year. The majority of these strandings are juvenile loggerhead (*Caretta caretta*) and Kemp's ridley (*Lepidochelys kempii*) sea turtles. Historical stranding data show that up to 55.0% of the yearly turtle deaths occur in May and June when the turtles first enter the Bay (Lutcavage 1981, Lutcavage and Musick 1985, Keinath et al. 1987, Coles 1999). Virginia's turtles have been observed to interact with a variety of commercial fishing gears including whelk and crab pots, poundnet leaders (>12 inch stretch), large mesh (>12 inch stretch) gillnets, longline and trawling gear, and dredges (Musick et al. 1984, Bellmund et al. 1987). Nets that have long soak times, particularly poundnet leaders, may entangle sea turtles sub-surface. These mortalities are at risk of not being observed or included in mortality estimates. Poundnet fishing effort has not remained constant over time within Virginia. In the early 1980's, between 3% and 33% of sea turtle mortalities were attributed to large mesh poundnet leaders (> 12 inches stretch) (Musick et al. 1984, Bellmund et al. 1987). The poundnet fishery in Virginia has declined significantly since the 1980's. At that time, 300 nets were active in the main-stem Chesapeake Bay, with over 170 large mesh nets present (Musick et al. 1984, Bellmund et al. 1987). There are currently less than 100 active nets in the Bay, with less than 20 active large mesh nets (Mansfield et al. 2001). Despite this, the number of sea turtle strandings in spring has been rising in recent years.

In the 1980's, the Virginia Institute of Marine Science conducted SCUBA surveys for sub-surface sea turtle entanglements in poundnet leaders. These surveys were conducted during the earlier portion of the stranding season and did not evaluate sub-surface mortalities throughout sea turtle residency (Musick et al. 1984). One alternative method of assessing sub-surface bycatch is by using side scan sonar. Kasul and Dickerson (1993) explored the feasibility of using acoustic methods to detect sea turtles sub-surface. They cited unpublished data supporting the ability of side scan sonar (500 KHz) to detect turtle carcasses and carapaces placed on the seabed. No work has been published evaluating the use of side scan sonar in detecting sea turtle carcasses entangled in netting and/or suspended within the water column. The primary objective of this study was to evaluate the use of side scan sonar as a tool for determining the presence of sub-surface sea turtle entanglements.

METHODS

A Marine Sonics Technology side scan sonar system (900 KHz) was used to scan poundnet leaders for sub-surface sea turtle entanglements. Data were processed in an on-board computer, providing real time data management and storage. A side scan review program (Sea Scan PC Review 2.0) allowed for post-processing and viewing of all survey sites. Frozen sea turtle carcasses of varying sizes and species were placed within the leader of a sample net. These specimens, representing some of the smallest sizes common to Virginia (35.0 to 50.0 cm CCL), were scanned and compared to baseline scans of the net in order to determine whether the turtles have an acoustic signature within the water column. Other objects commonly found ensnared in poundnet leaders were also tested, including garbage bags (Heftytm 50 gallon bags), seagrass, dead fish, etc.

All poundnets in the main-stem Chesapeake Bay were scanned early in the sea turtle residency season to establish a base-line image of each net. The sonar was towed at a depth of one meter, a speed of 2.0-3.5 knots and a distance of 10 to 20 meters from the net. Leader poles were counted during scans, and the location, indicated by pole number, of any acoustic signature similar to that of a sea turtle was recorded. Once the scan was complete, potential sea turtle signatures were verified by returning to the target's location along the net and recording any objects visible at surface or at depth. Subsequent scans were compared to archived base-line images of each net to determine the presence of potential acoustic turtle targets-particularly at depth, below the level of visibility.

RESULTS

Ten loggerheads were found entangled in poundnet leaders during routine fisheries surveys in 2001. All turtles were observed within the top two meters of the water column. Nine of these turtles were found in June, one in August. Only one of the ten turtles was alive at time of observation. Three turtles were severely decomposed and appeared to have floated into the leaders post-mortem (Mansfield et al. 2002). Thus, 1.8% of Virginia's known strandings (n=395) could be directly attributed to poundnet leaders via surface surveys of Bay nets.

Prior to the sonar surveys, we tested the ability of the sonar to pick up acoustic images of sea turtle carcasses anchored along a poundnet leader in the York River. Ground truthed images indicate that sea turtles as small as 35.0 cm CCL (Kemp’s ridley juvenile) have an acoustic signature within the water column. These images, depending upon orientation of the specimen in the water column, could be measured via imaging software within a couple centimeters of the known carapace length. Turtle images could also be differentiated from solid objects, such as poundnet poles or tree branches. The acoustic images of the turtles appeared mottled due to variations in density (bone vs. muscle tissue and air pockets) within the carcass in comparison to objects of uniform density. The garbage bags scanned did not result in a very distinct acoustic signature and could easily be differentiated from the turtle carcasses. The images of other objects scanned (fish, seagrass), were cataloged for visual comparison and reference during subsequent surveys.

Between the dates of June 1 and October 31, 2001, all poundnets with active leaders (n=55) in Virginia's main stem Chesapeake Bay, and approximately five miles up river of the major tributaries, were scanned by sonar. Survey efficiency was very high: each net took approximately four minutes per side to scan at a tow speed of 2.0 to 3.5 knots. A total of 825 images were archived of the 55 active poundnet leaders surveyed. For each net, between ten and fifteen images were recorded per scan, dependent upon length of net. Relative mesh sizes, poundnet structure and the presence of string leaders could be determined sub-surface through the use of sonar. These surveys indicate that various species of algae, seagrass and other detritus may imitate the signature of sub-surface sea turtle entanglements. The sonar also detected the presence of fish within a pound or schooling along a leader. In one southern Eastern Shore net, seven juvenile sandbar sharks (*Charcharhinus plumbeus*) were observed entangled within the surface of a leader. No verified sea turtle acoustic signatures were observed during baseline or follow-up surveys. This indicates that late season sub-surface entanglements are not probable.

DISCUSSION

Side scan sonar has strong potential for assessing subsurface entanglements of sea turtles within fixed gear fisheries. Though these surveys provide an efficient way to observe subsurface entanglements, they are limited by weather and sea conditions and on the ability to verify object signatures within the nets. Successful surveys occurred when the sea state was relatively calm since suspended sediments (due to turbulence) are reflected acoustically by the sonar. Surveys also targeted sea turtles that are entangled in a net somewhere within the water column-above the seabed. As such, a quantifiable acoustic signature may be difficult to obtain since target strength changes based on the orientation of a turtle within a net. The strongest acoustic returns/reflections are received from objects containing air/gas pockets (Kasul and Dickerson 1993) and dense structures such as bone. Thus, decomposition and bloat of the entangled animal may also define the type of signature returned. Future side scan sonar studies will include cataloging signatures of turtles based on size, species, orientation and decomposition stage. The use of sub-surface video surveillance as a means of target identification will also be employed for potential targets found below the first few meters of water.

LITERATURE CITED

Bellmund, S.A, J.A. Musick, R.E. Klinger, R.A. Byles, J.A. Keinath, and D.E. Barnard. 1987. Ecology of sea turtles in Virginia. VIMS Special Scientific Report No. 119. Virginia Institute of Marine Science, Gloucester Point, VA 48 p.

Byles, R.A. 1988. The behavior and ecology of sea turtles in Virginia. Ph.D. Dissertation, Virginia Institute of Marine Science, College of William and Mary, Gloucester Point, VA, 112 p.

Coles, W. 1999. Aspects of the biology of sea turtles in the Mid-Atlantic Bight. Unpubl. Ph.D. Dissertation, Virginia Institute of Marine Science, College of William and Mary, Gloucester Point, VA. 153 p.

Kasul, R.L. and D.D. Dickerson. 1993. Feasibility of sea turtle detection in coastal waterways using acoustic methods. Draft Report. Army Corps of Engineers, South Atlantic Region. Atlanta, GA. 43 p.

Keinath, J.A., J.A. Musick and R.A. Byles. 1987. Aspects of the biology of Virginia's sea turtles: 1979-1986. VA Jour. Sci. 38:329-336.

Keinath, J.A. 1993. Movements and behavior of wild and head-started sea turtles. Ph.D. Dissertation. Virginia Institute of Marine Science, College of William and Mary, Gloucester Point, VA, 206 p.

Lutcavage, M. 1981. The status of marine turtles in the Chesapeake Bay and Virginia coastal waters. M.A. Thesis, Virginia Institute of Marine Science, College of William and Mary, Gloucester Point, VA.

Lutcavage, M. and J.A. Musick. 1985. Aspects of the biology of sea turtles in Virginia. Copeia 1985:449-456.

Mansfield, K., J.A. Musick, and R.A. Pemberton. 2001. Characterization of the Chesapeake Bay poundnet and whelk pot fisheries and their potential interactions with marine sea turtle Species. Final Report, NMFS, Woods Hole, MA. Contract #: 43EANFO30131. 66 p.

Mansfield K.L., E. Seney and J.A. Musick. 2002. An evaluation of sea turtle abundances, mortalities and fisheries interactions in the Chesapeake Bay, Virginia, 2001. Final Report, NMFS, Woods Hole, MA. Contract # 43-EA-NF-110773. In prep.

Musick, J.A., R. Byles, R. Klinger, and S. Bellmund. 1984. Mortality and behavior of sea turtles in the Chesapeake Bay. Summery Report for 1979 through 1983. National Marine Fisheries Service, NEFSC. Woods Hole, MA. Contract #: NA80FA00004. 52 p.

Illegal commerce of marine turtles in the Gulf of Venezuela

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INTRODUCTION

The coastal areas of the Gulf of Venezuela represent an essential ecosystem for the feeding and forage of the marine turtles that follow their migratory routes in the Caribbean (Barrios-Garrido 2000). The marine turtles are affected by natural and anthropogenic factors during every the stage of their life cycle (Marconaldi and Thomé 1999). Hunting for the commercial use of their meat and shells (for production of crafts and decorations) is one of the most critical anthropogenic factors, which affects these animals in their juvenile, sub-adult, and adult stages. The Gulf of Venezuela has towns that function as capture and commercial centers of the marine turtle. Principally, marketing and consumption, as in the trade of the by-products like oil, shells (used as house and restaurant decorations), are common activities that are deeply ingrained in the Wayuú culture, which prevails in the region. The scarce data existent about capture with trading ends of marine turtles in the Gulf of Venezuela is reflected in the absence of official statistics that allow evaluation of the impact that these activities exercised on the populations of marine turtles, principally the green turtle (*Chelonia mydas*) that is found in this feeding area feeding and preparing to enter the reproductive stage (the next sub-adult individuals to reach reproductive maturity; male and female "primerizos") or in interposed periods in the case of the adults (sexually mature individuals) coming from different reproduction areas in the Caribbean (Barrios-Garrido et al. 2001b). This shortage of data motivated the realization of this investigation that has these objectives: - To identify the markets and the areas which market marine turtles or their by-products, - to Determine the most consumed species and most demanded for by-products and - to Establish the local, national and international commercialization routes continued by this activity in the Gulf of Venezuela.

METHODS

From 1997 to 2001, surveys and interviews (open discussion) were carried out with the fishermen in coastal communities of the Gulf of Venezuela (Fig. 1). Other establishments were also visited: markets and restaurants that sell turtle meat and other by-products, establishing regional, national and international routes that continue to appear (Fig. 2). Morphometric measurements were made (according to Hirth 1971) from the specimens that were captured and sacrificed, as much for consumption as for trade.

DISCUSSION

The current levels of direct capture of marine turtles in feeding areas should be evaluated. Since 1977, Venezuela has figured among the country members of CITES (International Convention in the Trade of Threatened Species), which prohibits the import or export of marine turtles and its products. However, the use of the marine turtles constitutes together with fishing, extraction of salt, and cattle raising (caprine and ovine) which are the main resources indigenous communities of the Venezuelan Guajira.

The levels of commercialization of marine turtles and their products in the Gulf of Venezuela are local (to sustain the family), national (sold in markets and restaurants of nearby areas) and international (transported and marketed in markets of Colombia). The turtle meat and their products are sold secretly at homes, as well as openly in markets and restaurants (the meat already prepared). The articles on sale in markets include from the complete turtle, with a price that oscillates between 80 and 100 $, according to the species; meat that is sold in secret and public markets ($2/kilogram) and prepared in restaurants and by traveling vendors; the refined shell is sold as craft with prices that oscillate between $10 and $25 if it is of *Chelonia mydas*, and $80 if it is that of *Eretmochelys imbricata*. Turtle oil is also marketed, mainly of *Dermochelys coriacea* species with an average price of $1 /liter; the penis is very sought-after for its magical-religious meaning, mainly that of *Eretmochelys imbricata* which is priced around $15 and that of *Chelonia mydas* priced at $2. There is a very ingrained connection that exists between the marine turtle resource and the area´s dominate culture, Wayuú which considers these reptiles as "a gift of God", to compensate the lack of other activities like agriculture, the marine turtles are even considered "prayers of the sea". Joined to this, the cost-benefit level of the capture and trade of marine turtles produces bigger dividends (more gain) with less effort, through incidental fishing. This type of fishing is represented by the arts of "Palangre" and "Arrastre", while the intentional fishing is represented by the tortugueros nets, both types which are used in the whole Gulf of Venezuela. Barrios-Garrido et al. (2001b) determined that capture for commercial exploitation is centered around the population's segments that represent individual sub-adults and adults (with 70 cm for maximum shell length) principally of *C. mydas* that are found in this feeding area and are preparing to enter the reproductive stage (the next individuals to reach reproductive maturity; male and female "primerizos") or in periods interposed in the case of the adults (sexually mature individuals) coming from different reproduction areas in the Caribbean. The main market publishes at the local level represented by "The Filúos", the nationally located in Maracaibo, Barquisimeto, San Cristóbal and Mérida and the internationally located in Maicao and Rio Hacha (Colombia).

LITERATURE CITED

Barrios-Garrido, H. 2000. Aspectos generales sobre la biología de las Tortugas Marinas. I Taller sobre Nociones Básicas para el estudio de la Biología y Conservación de Tortugas Marinas. Maracaibo-Venezuela,

Barrios-Garrido, H., M.G. Montiel-Villalobos, T. León, and J. Hernández. 2000b Distribución de especies y tamaños de las tortugas marinas capturadas en el Golfo de Venezuela. II Congreso de Biodiversidad, Fragilidad, Impacto y Estrategias de uso de áreas protegidas. Maracay-Estado Aragua, 2001 (b).

Hirth, H. 1971. Synopsis of the biological data on the green turtle, *Chelonia mydas* (Linnaeus 1758). Food and Agriculture Organization of the United Nations. 85 p.

Marcovaldi, M. and J. Thomé. 1999. Reducción de las amenazas a las tortugas marinas. In: K.L. Eckert, K.A. Bjorndal, F.A. Abreu-Grobois, and M. Donnelly, eds. Técnicas de Investigación y Manejo para la conservación de las tortugas marinas. UICN/SSC. Grupo de Especialistas de tortugas marinas. 189 p.

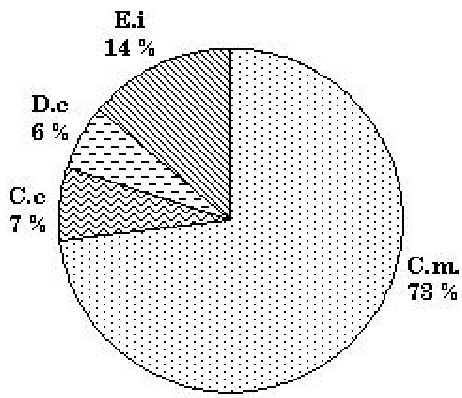

Fig. 1. Distribution of species of marine turtles captured and marketed in the Gulf of Venezuela.

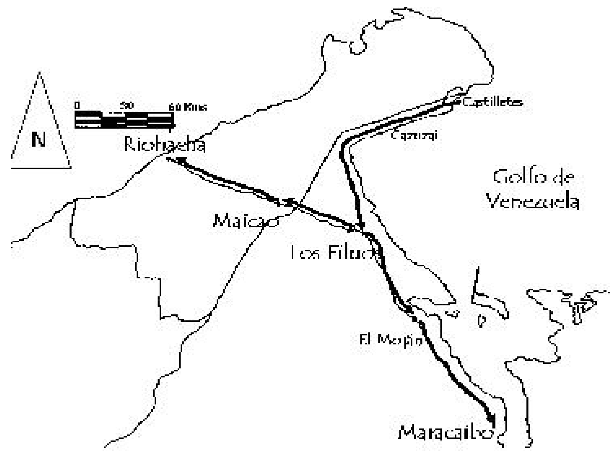

Fig. 2. Map of the Gulf of Venezuela study area.

Reducing sea turtle damage to crab pots using a low-profile pot design in Core Sound, North Carolina

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The blue crab (*Callinectes sapidus*) supports North Carolina's most valuable commercial fishery; the value of hard blue crabs landed in 2000 was over $30 million dollars. This lucrative fishery may be adversely affected by loggerhead sea turtles (*Caretta caretta*), which are listed as threatened under the Endangered Species Act of 1973. Crabbers in Core Sound, North Carolina, report that sea turtle damage to crab pots has become an increasingly serious issue. Turtles damage crab pots by overturning them while trying to get the bait, tearing up the bottoms and sides of the pots; this damage results in higher gear replacement costs and losses in crab catch. Experimental fishing was conducted to test for differences in crab catch and pot damage using three types of crab pots: low-profile, square mesh, and hexagonal mesh. The hexagonal mesh pot is the most common pot type used by crabbers in Core Sound, and the low-profile pot was designed to reduce the sea turtles' ability to overturn the pots. The number and size of all crabs caught in the experimental pots were recorded. An analysis of variance (ANOVA) was used to analyze the relationship between number of crabs caught per pot and the effect of pot type, location, date, the interaction of date and location, and the interaction of pot type and location. Tukey-Kramer multiple comparison tests were used to determine significant differences among treatments. There was no significant difference in crab catch between the low-profile and the square mesh pots at any of the three experimental fishing locations. There was a significant difference in catch between the low-profile and hexagonal mesh pots at one location. The low-profile pots sustained considerably less damage than both the square mesh and hexagonal mesh pot types. In interviews with 19 Core and Pamlico Sound crabbers, crabbers estimated that 62% of all crab pot damage, and 37% of lost crab catch, is due to sea turtle damage. The low-profile crab pot has the potential to improve this situation by allowing crabbers to maintain crab catch with a reduction in gear replacement costs.

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Sea turtle strandings in Chile (VII Region)

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The appearance of sea turtles on the Chilean coast is still regarded as an unusual event, despite more than 100 specimens being recovered since the 19th century (between 18°S to 52°S). Although forage areas of *Chelonia mydas* have been identified near the coast of northern Chile (23°05' S, 78°28' W), most records from south-central Chile (VIII Region) are from unhealthy or injured turtles, many of them eventually dying. Between June and July 2001, three strandings of *Lepidochelys olivacea* were recorded from three different localities of south-central Chile (36°). Only one of these specimens survived. Given that most strandings of *L. olivacea* specimens in south-central Chile coincide with storm periods, it is possible that their poor state of health is due mainly to hypothermia caused by a drop in sea temperature associated with the Chile-Peru Current.

Preliminary study of the tortoiseshell trade in the Dominican Republic

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INTRODUCTION

Four sea turtle species have been reported for the DR's coastal areas: hawksbills (*Eretmochelys imbricata*), green turtles (*Chelonia mydas*), loggerheads (*Caretta caretta*) and leatherbacks (*Dermochelys coriacea*) (Ottenwalder 1981). Of these, hawksbills are the most popular given the economic benefits obtained from their meat, eggs, and especially their shell (tortoiseshell).

Widespread sale of tortoiseshell items in Santo Domingo and a number of coastal localities has been well documented in shops catering to tourists (Stam and Stam 1992, Domínguez and Villalba 1994, TRAFFIC 2001). This activity greatly undermines regional conservation efforts. Tortoiseshell sales are in violation of domestic legislation and, if sold to international tourists, also of the Convention for the International Trade in Endangered Species of Flora and Fauna (CITES), ratified by the DR. However, compliance with and enforcement of the regulations remains low (TRAFFIC 2001). Given the magnitude of this trade, the Coastal and Marine Resource Sub-secretariat started in 2001 a market study of tortoiseshell crafts to help in the design of an effective strategy for its regulation in the country.

METHODS

We visited gift shops in different tourist localities of the Dominican coast between January of 2001 and January of 2002. Some interviews were structured, while others were semi-structured, given the reserves some of the store owners and employees had on discussing this illegal trade. Some key informants were more extensively interviewed, and the information obtained is presented in a qualitative fashion. Interview questions centered around most popular tortoiseshell items, customer profiles, and other aspects of shell commercialization.

To get an idea of the size of the turtles utilized for hand craft manufacture, 46 right coastal scutes (anteriormost) from tortoiseshell sacks stored in a shop in Santo Domingo were diagonally measured (curved length) with a flexible vinyl tape in cm.

RESULTS

A total of 305 gift shops were visited. Of these, 29% featured tortoiseshell items. However, shell availability varied greatly according to locality (Fig. 1). The most demanded tortoiseshell items included personal use items, such as necklaces, hand bags, bracelets and rings. Price fluctuated between US$ 18-70, 30-95, 10-60 and 15-50, respectively. When 20 gift shop employees were asked what was the major nationality group that demanded these products, they responded (in that order): Spain, Italy and Puerto Rico. According to the same respondents, most customers were between the ages of 20-30 years, representing 74% of the visitors to the country. Costal scute measurements ranged from 22 - 32 cm curved length. Using allometric growth equations obtained by van Dam and Diez (1998) for a wild aggregation of hawksbills in Mona and Monito islands, Puerto Rico, we estimated that the shell came from individuals ranging in 69.9-97.7 cm of straight carapace length (Fig. 2)

DISCUSSION

With the exception of gift shops in Puerto Plata-Sosúa, the majority of shops surveyed offered tortoiseshell merchandise. The large amounts of the merchandise openly on display, despite the fact that a number of shop owners and clerks declared that they knew it was an illegal activity. The significant quantities of finished tortoiseshell items, as well as raw shell observed, suggest that this is a large scale business, and its sudden eradication would harm substantial investments of the shops involved. This, in turn would not create an incentive for them to abide by the law. In the particular instance of Sosúa, surveys reflected the efforts carried out by the Marina de Guerra (Dominican Navy), which met with tortoiseshell shop owners in order to establish a time period after which all shell items found for sale would be confiscated. This is the only locality in which such a dialog has been attempted, and it shows that regulation of this trade can be obtained if both the authorities and the trade stakeholders are involved. The estimated size of the individual hawksbills providing the shell for the hand craft industry seems to be within the range of adult animals. Most nesting females studied in the world have a minimum of 75 cm of carapace length (IUCN 2001). However, there are problems in determining sexual maturity status from size alone. In fact, reports of adult Caribbean females with less than 60 cm straight carapace length have been documented (Moncada el al. 1999). Thus, at this point we can only say that it appears that most of the animals targeted by the industry were well into the adult size range. The only recent study on the status of Dominican hawksbills indicates a near absence of such adult-sized individuals in foraging areas as well as in historical nesting grounds in southeastern DR (León and Mota 1997, León and Diez 1999). These authors attributed this scarcity to many years of over-exploitation. Thus, it is not clear where such large animals are being harvested from or if current tortoiseshell stocks are made up of individuals collected a long time ago. Nevertheless, the sources need to be established and the trading routes understood. Given the slow growth of hawksbills along with the depleted status of their nesting populations in the Caribbean, current harvest practices to supply the Dominican shell industry could represent a serious threat to the species' regional survival outlook.

RECOMMENDATIONS

(1) Start dialogs with tortoiseshell shop owners, artisans and traders or their associations that lead to an agreement for the regulation of the tortoiseshell industry at tourist localities in the DR; (2) Conduct an inventory of tortoiseshell finished and unfinished products (raw shell) on a national level to determine a reasonable period for regulating or phasing out this trade; (3) Determine the source and dates of raw tortoiseshell sold to Dominican artisans and gift shops and understand the routes and linkages involved in its trade; (4) Develop an education campaign for international tourists (through posters, brochures, etc.) on the origin of shell items and the status of this species; (5) Carry on studies on trade and commercialization of tortoiseshell in the DR, possibly also exploring subsistence and traditional use (aphrodisiac attributes to turtle penis and eggs) in coastal communities.

Acknowledgements. Special thanks to Yolanda León for her help with data analysis, poster preparation and translation; as well as to the David and Lucile Packard Foundation for providing travel funds to assist the Symposium.

LITERATURE CITED

Domínguez, T.G. and A. Villalba. 1994. Trade of Hawksbill carapaces in Santo Domingo, Dominican Republic. In: K.A. Bjorndal, A.B. Bolten, D.A. Johnson, and P.J. Eliazar, comps. Proceedings of the Fourteenth Annual Symposium on Biology and Conservation. NOAA Tech. Memo. NMFS-SEFSC-351. p. 34-35.

IUCN. 2001. Basic biological characteristics of hawksbill turtles: the importance of overlapping scales.

León, Y.M. and J.M. Mota. 1997. Aspectos ecológicos y estructura poblacional de la tortuga marina carey (*Eretmochelys imbricata*) en el Parque Nacional Jaragua y areas adyacentes. Tesis para optar por el título de Licenciado en Biología. UASD. Santo Domingo.

León, Y.M. and C.E. Diez. 1999. Population structure of hawksbill turtles on a foraging ground in the Dominican Republic. Chelonian Conservation and Biology 3:230-236.

Moncada, F., E. Carrillo, A. Saenz, and G. Nodarse. 1999. Reproduction and nesting of the hawksbill turtle, *Eretmochelys imbricata*, in the Cuban archipelago. Chelonian Conservation and Biology 3:257-263.

Ottenwalder, J.A. 1981. Status, estimados de población y biología reproductiva de las tortugas marinas en la República Dominicana. Tesis para optar por el título de Licenciado en Biología. UASD. Santo Domingo.

Stam S. and R. Stam. 1992. Problemas para las tortugas en la República Dominicana. Noticiero de Tortugas Marinas 57:18-19.

TRAFFIC. 2001. Swimming Against The Tide. Recent surveys of exploitation, trade and management of marine turtles in the Northern Caribbean.

van Dam, R.P. and C.E. Diez. 1998. Caribbean hawksbill turtle morphometrics. Bulletin of Marine Science 62:145-155.

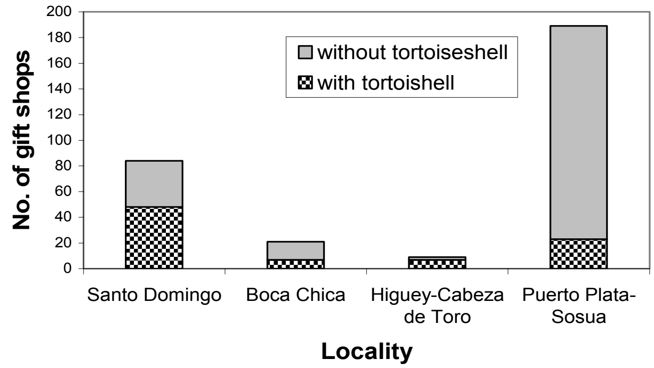

Fig. 1. Availability of tortoiseshell items in gift shops by locality.

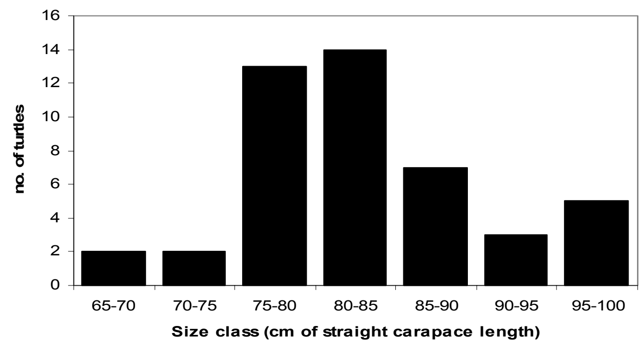

Fig. 2. Size-class distribution of hawksbill individuals involved in tortoiseshell hand crafts estimated from anteriormost right costal scutes. The allometric equation was taken from van Dam and Diez (1998), and is given by: y=0.2269 x 1.1185 , where y represents costal scute length (curved) and x represents straight carapace length (r^2=0.9895, n=272).

Sea turtles in Connecticut and Rhode Island: information from strandings (1987-2001)

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INTRODUCTION

Sea turtles occur in southern New England primarily during the late summer (Bleakney 1965, Lazell 1980). Much of what is known about their distribution and seasonality between Cape Hatteras and Nova Scotia was elucidated by the Cetacean and Turtle Assessment Program, conducted by the University of Rhode Island between 1978 and 1982 (CETAP 1982). The two most common species off New England, as shown by the CETAP data, are the leatherback (*Dermochelys coriacea*) and loggerhead (*Caretta caretta*) turtles (Shoop and Kenney 1992).

In addition to aerial surveys such as CETAP, another source of information on local sea turtle populations are stranding response programs. The Sea Turtle Stranding and Salvage Network (STSSN) includes organizations that collectively investigate sea turtle strandings along the United States coastline. The investigation of stranded sea turtles can yield such information as species, length, sex, stomach contents, and anthropogenic impacts. These data are difficult to collect from aerial surveys alone. This report is the first to summarize sea turtle stranding information from Connecticut and Rhode Island.

METHODS

Mystic Aquarium, a member of the STSSN, has exclusive coverage for Connecticut and Rhode Island (and Fishers Island, New York as well). A "stranding" was defined as a dead animal that was examined by a reliable investigator who could provide basic data, or as a live animal requiring medical intervention. A "sighting" was defined as an animal, dead or alive, that was reported to the Aquarium by someone not providing basic data. In the majority of stranding cases, an Aquarium biologist examined the carcass, collected morphometric data, took photographs, and conducted an external examination to document fisheries entanglement and/or boat collision. Given suitable logistical conditions, a necropsy was conducted and tissues were examined and sometimes sampled. Gastrointestinal tract contents were especially scrutinized, particularly in light of the well-documented role of plastic ingestion in sea turtle mortality (Balazs 1985, Carr 1987). Data collection efforts were limited by such factors as condition and/or size of the carcass, environmental variables (e.g. weather, location of carcass, beach conditions), and inexperienced personnel making some of the examinations.

RESULTS

From 1987 through 2001, reports were received on 229 sea turtles, 146 of which were considered to be stranding cases. Efforts were made to account for multiple reports of the same animal. Most stranded turtles were leatherbacks (120 of 146; 82.2%); other species observed were 23 loggerheads (15.8%), two greens (*Chelonia mydas*) (1.4%), and one Kemp's ridley (*Lepidochelys kempii*) (0.7%). In most years there were 15 or fewer strandings (Fig. 1), with the exception of 1995, in which there were 28 strandings (19.2% of all strandings during the 15-year study period) and 38 sightings (45.8% of all sightings). All leatherbacks were of adult size, while the other species were represented by mostly subadult animals.

The vast majority (124 of 146; 84.9%) of reported strandings occurred in Rhode Island, with the greatest concentrations along the south shore of the state or on Block Island. There were relatively few strandings within Narragansett Bay or along the Connecticut shore. There was a strong seasonal pulse, with 74.7% (109 of 146) of strandings occurring in August and September (Fig. 2). Sea surface temperature data from Long Island Sound correlated well with sea turtle stranding and sighting numbers (Fig. 2).

The evaluation of anthropogenic impacts on stranded turtles proved difficult because of the advanced stage of decomposition of many of the carcasses. Nevertheless, some turtles were determined to be affected by boat collision (31 turtles), fisheries entanglement (19 turtles), or plastic ingestion (15 turtles). In some cases the impacts were obvious, while in others the evidence was suggestive but not conclusive. In all, 65/146 turtles (45%) had at least possible evidence of human interaction.

DISCUSSION

Stranding data support the view that southern New England is an important seasonal habitat for sea turtles. Assuming that the number of stranded turtles represents a small fraction of those present in the area at any time, sea turtles must be quite numerous in Rhode Island waters in August and September. The greater numbers in Rhode Island compared to Connecticut is probably best explained by the topographical constriction to the entrance to Long Island Sound.

There is no clear trend in the number of stranded or sighted turtles over the 15-year survey. It is unclear why 1995 was a record year. Perhaps water temperature and/or other environmental factors favored higher densities of *Cyanea*, a scyphomedusan upon which leatherbacks prey (Lazell 1980). No cold-stunned turtles have been found in the study area, although many have washed up on Long Island and Cape Cod; prevailing northwest winds in the fall and winter appear to drive debilitated turtles onto northward facing beaches (Burke et al. 1991).

There are certainly anthropogenic causes of mortality of sea turtles in southern New England, most notably boat collision and fisheries entanglement. The observed frequency of such impacts is likely the low-end estimate; the extremely poor condition of many carcasses made cause-of-death determinations difficult to impossible. Increased awareness of anthropogenic mortality should encourage more aggressive data collection to further document the problem, as well as improved strategies for mitigation.

Additional work is needed to better assess human impacts on sea turtles in southern New England, as well as to better understand the ecological factors that determine the spatial and temporal distribution of sea turtles off Rhode Island and Connecticut.

Acknowledgements. We greatly appreciate the assistance of the staff, interns, and volunteers at Mystic Aquarium who helped with necropsies and data collection, as well as the help of such agencies as the Nature Conservancy (Block Island), the Rhode Island Department of Environmental Management, and the Connecticut Department of Environmental Protection. This is Contribution Number 140 of the Sea Research Foundation.

LITERATURE CITED

Balazs, G.H. 1985. Impact of ocean debris on marine turtles: entanglement and ingestion. In: R.S. Shomura and H.O. Yoshida, eds. Proceedings of the workshop on the fate and impact of marine debris. NOAA-TM-NMFS-SWFC-54. p. 387-429

Bleakney, J.S. 1965. Reports of marine turtles from New England and eastern Canada. Can. Field Nat. 79:120-128.

Burke, V.J., E.A. Standora, and S.J. Morreale. 1991. Factors affecting strandings of cold-stunned juvenile Kemp's ridley and loggerhead sea turtles in Long Island, New York. Copeia 1991:1136-1138.

Carr, A. 1987. Impact of nondegradable marine debris on the ecology and survival outlook of sea turtles. Mar. Poll. Bull. 18:352-356.

CETAP. 1982. A characterization of marine mammals and turtles in the mid- and North Atlantic areas of the U.S. outer continental shelf. Cetacean and Turtle Assessment Program, University of Rhode Island. Contract AA551-C78-48, Bureau of Land Management, Washington, D.C. 538 p.

Lazell, J.D., Jr. 1980. New England waters: critical habitat for marine turtles. Copeia 1980:290-295.

Shoop, C.R., and R.D. Kenney. 1992. Seasonal distributions and abundances of loggerhead and leatherback sea turtles in waters of the northeastern United States. Herp. Monogr. 6:43-67.

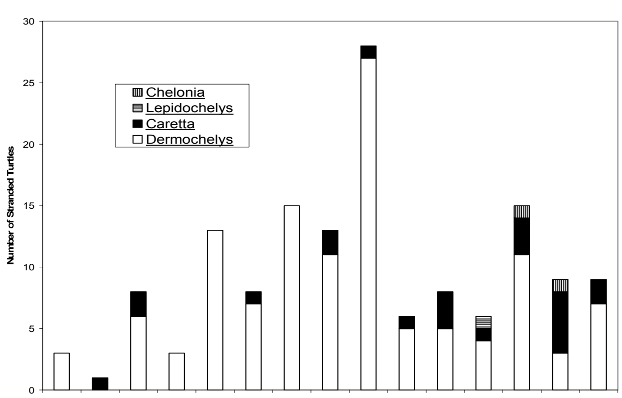

Fig. 1. Number of sea turtle strandings by year.

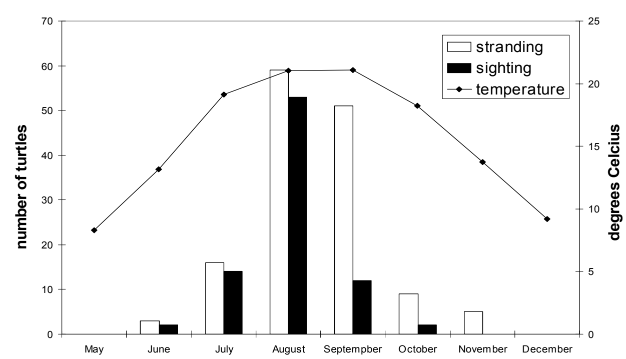

Fig. 2. Number of sea turtle strandings and sightings by month, along with sea surface temperature of Long Island Sound by month.

Sea turtle mortality associated with red tide events in Florida

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Red tide is a term used to describe a higher-than-normal concentration of a microscopic alga, usually *Karenia brevis*, that discolors sea water. *K. brevis* produces a toxin that has been documented as a mortality factor in fish, birds, and marine mammals and is a suspected mortality factor in sea turtles. We examined trends in sea turtle strandings along the Gulf coast of Florida and found that the number of dead loggerheads (*Caretta caretta*), Kemp's ridleys (*Lepidochelys kempii*), and green turtles (*Chelonia mydas*) increased markedly during four recent red tide events compared to the average number of strandings during the previous five years. Necropsies of some of the Kemp's ridleys found during these events suggested that the turtles had been in the vicinity of the red tide shortly before death because their guts contained a high prevalence of fish, an otherwise rare gut content, presumably killed by red tide. Sea turtles that washed ashore alive during these red tides displayed symptoms that were consistent with acute brevetoxicosis: they were uncoordinated and lethargic but otherwise robust and healthy in appearance. All of them recovered completely within days of being removed from the area of the red tide. The concentrations of brevetoxin in the livers of eight turtles--four Kemp's ridleys, three green turtles, and one loggerhead-- that were found dead during red tides were similar to the concentrations of brevetoxin in the livers of 15 Florida manatees (*Trichechus manatus latirostris*) determined to have died from brevetoxicosis (83.4 ng/g ± 104.3, range 10-330 vs. 57.6 ng/g ± 34.4, range 9.9-117.1; respectively). Two dead loggerheads that washed ashore along the northeast coast of Florida, an area without a recent red tide event, were used as controls; the brevetoxin concentrations in the livers of these control animals were both <0.05 ng/g.

Preliminary investigation into the bycatch of leatherback turtles (*Dermochelys coriacea*) in UK waters

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INTRODUCTION

Five species of marine turtle have been recorded in UK seas including the leatherback turtle (*Dermochelys coriacea*), which is the most frequently encountered marine turtle species in the UK and is widely considered to be a natural member of British fauna (Penhallurick 1990, Godley et al. 1998, Pierpoint 2000). It has long been established that leatherbacks interact with some fisheries while in Uk waters, often resulting in turtle mortality (Penhallurick 1990).

Recent analysis of 'TURTLE', a database of marine turtle records in UK waters revealed that 83% (n=129) of 154 turtle bycatch records within TURTLE involved leatherback turtles. 58.3% (n=50) of recorded leatherback entanglements in UK waters, where the gear type was specified, involved leatherbacks entangling in the buoy ropes of bottom-set, static gear such as pots set for crabs or whelks (Pierpoint 2000). A generic diagram of a crab pot buoy rope set-up is shown in Fig. 1. Tangle net buoy ropes tend to be similarly arranged. Pierpoint (2000) also confirmed that the majority of UK leatherback records are from the western coasts of the UK and Eire.

As a contribution to the UK Marine Turtles Grouped Species Action Plan, the Marine Conservation Society (MCS) is initiating a participatory, national leatherback research programme involving UK fishermen. This paper presents some initial results from an ongoing survey of turtle/ fishery interactions within the shellfishery based in Cornwall, South West England, which is being conducted in preparation for the research programme.

METHODS

As part of a wider study, in December 2001 the Marine Conservation Society (MCS) distributed marine turtle entanglement questionnaires to 402 Cornish fishermen via the Cornwall Sea Fisheries Committee's (CSFC) annual shellfishery license-renewal mailing. The questionnaires sought information regarding fishing practice (including relevant fishery descriptions, gear specifications, fishing locations, soak times etc,) turtle sightings, turtle entanglements and attitudes towards and awareness of turtle conservation measures in the UK. CSFC requested that fishermen voluntarily complete and return the forms, regardless of whether or not they had seen or caught a turtle. All fishermen in this study operate at least one shellfishery (e.g. crab pots, crab tangle nets). In March 2002 the data included in the returned questionnaires was entered into a database and subjected to preliminary analysis. Further returns of completed questionnaires are expected.

RESULTS

To date, 146 fishermen have returned completed or partially completed questionnaires representing a response rate of 36%. The responses represented at least 3021 years of fishing. The average age of the respondents was 46.8 years and the average fishing career spanned 20.7 years. 60% (n=86) of the respondents operated more than one fishery and the respondents described a total of 233 individual fisheries of 9 different fishery types as shown in Fig. 2.

37% (n=61) of respondents reported a turtle encounter (entanglement and/ or sighting). 14% (n=20) of the respondents reported a total of 25 turtle entanglements (occurring between 1982 and 2001). 36% (n=52) of respondents reported 61 sightings of turtles at sea or stranded on shore (occurring between 1960 and 2001). 88% (n=22) of entanglements involved leatherback turtles whereas in 12% (n=3) of entanglements the turtle species was not positively identified. The most common entanglement scenario (48%, n=12) involved leatherbacks entangling in the surface buoy ropes of bottom-set, static gear such as crab pots and tangle nets. 68% (n=17) of entanglements involved the buoy ropes of both pot or tangle net gear and at least 64% (n=16) of entanglements occurred at the surface. In 76% (n=19) of entanglements, the turtle was reported to be found and released alive.

An initial Chi-squared treatment of the number of entanglements incurred by pot, tangle net, undefined nets, shark lines and other fisheries showed significant differences between the observed and expected frequencies of entanglement for each fishery type, indicating that the pot fishery type incurs significantly more entanglements than the other fishery types (X^2=9.819, df=4, P=0.0436). A preliminary Mann-Whitney U test on buoy rope length of pot and tangle fisheries (where buoy rope length was specified, n=74) indicated that pot and tangle fisheries using longer buoy rope lengths are more likely to entangle turtles than those using shorter buoy rope lengths (Z=2.230, N=74, P=0.0257).

29% (n=43) of the respondents recognised that marine turtles are endangered and 28% (n=41) were aware that marine turtles are protected under UK law. Only 7% (n=10) of the respondents felt that turtle bycatch in the UK was a problem that needs to be addressed. 48% (n=71) of respondents felt that the percentage of marine turtle entanglements actually reported is low and 55% (n=80) felt that the percentage of marine turtle sightings reported is low. 56% (n=82) expressed a willingness to take part in surveys of marine turtles in UK waters.

DISCUSSION

This survey suggests that Cornish shell fishermen seldom encounter leatherback turtles. Although 37% of respondents reported a turtle encounter, each encounter represents over 35 man-years of fishing effort. The average fishing career of respondents was 20.7 years. 25 entanglements were reported and with such low sample sizes, the interpretation of this data should be treated with caution. However, this survey suggests marine turtle encounters by fishermen are underreported. Marine turtles are fully protected under Britain's Wildlife and Countryside Act 1981, but there is a low level of awareness amongst fishermen regarding the legal and conservation status of turtles in UK waters.

The initial statistical treatment of the entanglement data suggests that pot-type fisheries incur the most bycatch, concurring with Pierpoint's (2000) findings and that leatherback entanglement in surface buoy ropes is the most common entanglement scenario. Buoy rope length may be a contributing factor to the likelihood of leatherback entanglement. However, Cornish fishermen use various systems of ropes and buoys to mark their gear and therefore this hypothesis requires further investigation The contribution of buoy rope length is intuitive when one considers that buoy rope slackens and floats in coils at the surface of the water during low tide, presenting a surface hazard to leatherbacks.

While Pierpoint estimated mortality for UK leatherback bycatch (in all fishery types) to be around 60%, this study suggests that buoy rope entanglement mortality may be significantly lower (24%), probably because most entanglements occur at the surface. Caution is advised in interpreting this data as there may be a response bias from fishermen who were willing to report successful releases as opposed to those who were unwilling to report mortality. Furthermore, there is no post release mortality data from this survey.

While only 51% of fishermen had encountered marine turtles, 56% of fishermen are willing to take part in further surveys of marine turtles in UK waters. This willingness bodes well for future research into leatherback ecology and bycatch in UK waters. In March 2002, UK fishermen and academics participated in a workshop at the University of Wales, Swansea, to formulate a participatory national leatherback research plan. A UK Turtle Code, an advice document that encourages the reporting of UK turtle encounters, was also launched during the workshop. It is hoped that through the distribution of the Code to fishermen and through the active participation of fishermen in a national research plan, a more thorough understanding of the actual status of marine turtles in UK waters, as well as bycatch mechanisms, may come to light in coming years.

Acknowledgements. Thanks to all Cornish fishermen that helped with this survey, the Cornwall Sea Fisheries Committee, Cheltenham and Gloucester plc and the Symposium Travel Grant Committee.

LITERATURE CITED

Godley, B.J., M.J. Gaywood, R.J. Law, C.J. McCarthy, C. McKenzie, I.A.P. Patterson, R.S. Penrose, C.S. Reid, and H.M. Ross. 1998. Patterns of marine turtle mortality in British waters (1992-1996) with reference to tissue contaminant levels. J. Mar. Biol. Ass. UK, 78.

Penhallurick, R.D. 1990. Turtles off Cornwall, the Isles of Scilly and Devonshire. Truro, Cornwall, Dyllansow Pengwella, ISBN 0 9515785 0 2.

Pierpoint, C. 2000. Bycatch of marine turtles in UK and Irish waters. JNCC Report No. 301.

Turtle Implementation Group. 2002. The UK Turtle Code. Marine Conservation Society.

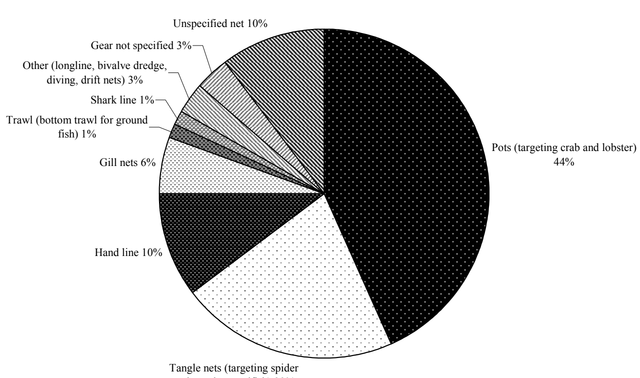

Fig. 1. Percentages of fisheries (n=233) operated by the 146 fishermen who completed and returned the MCS survey questionnaires.

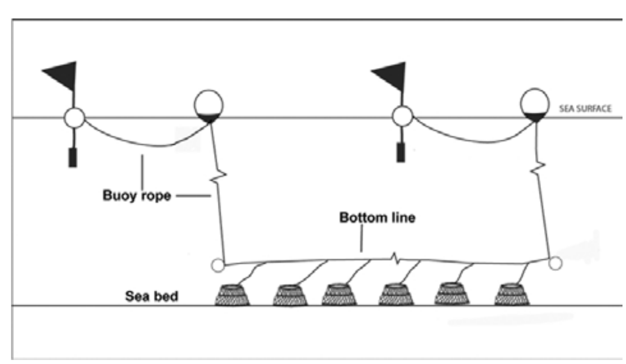

Fig. 2. Generic diagram of a Cornish crab pot buoy rope setup (tangle net buoy ropes are arranged similarly to those of crab pots).

Investigating causes of sea turtle mortality in Virginia state waters

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Elevated sea turtle strandings have been documented annually in Virginia during the Spring migration period in May and June. The magnitude of this stranding event has increased in recent years and includes primarily moderately to severely decomposed loggerheads and secondarily, Kemp's ridley, leatherback, green and unidentified turtles. In 2001, the National Marine Fisheries Service (NMFS) undertook a comprehensive investigation of possible factors contributing to this mortality, with the goal of instituting an effective management plan to reduce future mortalities. This program consisted of: (1) inshore and offshore aerial surveys to record sea turtle sightings and commercial fishing activity; (2) 41% observer coverage in the large mesh monkfish gillnet fishery; (3) alternative platform coverage of the large mesh black drum and sandbar shark gillnet fisheries; (4) alternative platform surveys of pound net leaders; and (5) support for sonar surveys of pound net leaders and gillnets. Data collected under these initiatives and previous studies of Chesapeake Bay turtle entanglements suggest that pound nets with large mesh and stringer leaders contributed to sea turtle strandings in Chesapeake Bay during the spring of 2001. In 2002 NMFS has proposed a restriction on the use of all pound net leaders measuring 12 inches and greater stretched mesh and all pound net leaders with stringers in the Virginia waters of the main stem Chesapeake Bay from May 8 to June 30. NMFS will also continue to monitor and investigate other factors that may contribute to sea turtle mortality during this time period.

THE PROBLEM

The Sea Turtle Stranding and Salvage Network (STSSN) has documented high sea turtle strandings in Virginia waters during the spring for the past 23 years. From 1994 to 2001, the average date of the first reported stranding was May 15, and the highest number of strandings typically occurred during the second half of May through the end of June, when turtles migrate into Chesapeake Bay. The magnitude of this stranding event has increased in recent years. Strandings during the spring of 2001 were exceptionally high; preliminary data provided by the STSSN indicate that 265 turtles stranded on VA beaches during May and June. This was twice the average number of turtles that stranded annually during this time period from 1995-2000. The circumstances surrounding the spring strandings are consistent with fishery interactions: the stranding event is an annual occurrence; a large number of animals strand in a short time period in a geographically distinct region; the turtles are relatively healthy prior to the time of their death; there is no evidence to suggest disease as the main cause of death; and some turtles have fish in their stomachs. There is a complex matrix of fisheries active in Virginia waters during this time period, including: large and small mesh gillnet fisheries; whelk and crab pot fisheries; haul seine fisheries; scallop dredge and trawl fisheries (offshore) and the pound net fishery.

2001 MONITORING PROGRAM

In response to the long term trend in elevated sea turtle strandings, NMFS instituted a program to investigate interactions between sea turtles and Virginia fisheries during the historical stranding period. This program included: (1) Inshore and offshore aerial surveys to record sea turtle sightings and commercial fishing activity; (2) 41% observer coverage in the large mesh monkfish gillnet fishery and coverage of small mesh gillnet fisheries; (3) alternative platform coverage of the large mesh black drum and sandbar shark gillnet fisheries; (4) alternative platform surveys of pound net leaders; and (5) support for sonar surveys of pound net leaders and gillnets.

CONCLUSIONS FROM FISHERIES INVESTIGATIONS

NMFS did not detect significant sea turtle mortality in a number of the fisheries active in Virginia at the time of the 2001 strandings. In 107 observed large mesh monkfish gillnet trips off Virginia during the month of May, only 1 dead and 2 live loggerhead turtles were incidentally captured. The large mesh black drum fishery in state waters had 8% observer coverage during May and June and no turtle takes were observed. NMFS also observed 2% of the Atlantic croaker fishery and 12% of the dogfish fishery during May and June 2001 and no turtle takes were observed. The amount of small mesh gillnet (< 6" mesh size) occurring in Chesapeake Bay waters in May and June appears to be relatively small, findings confirmed by aerial surveys in the Bay.

While a number of fisheries may contribute to sea turtle strandings, based on the nature and location of turtle strandings; the type of fishing gear in the vicinity of the greatest number of strandings; the dearth of observed takes in other fisheries operating in Virginia waters during the 2001 stranding period; the known historical interactions between sea turtles and pound net leaders with stretched mesh greater than or equal to 12" and leaders with stringers; and several documented sea turtle entanglements in pound net leaders, NMFS concluded that pound nets were a likely cause of a significant number of sea turtle strandings in Virginia in May and June 2001.

As a result of information obtained in 2001, NMFS implemented an emergency rule that required all pound net leaders measuring 8" or greater stretched mesh and all pound net leaders with stringers, to be tied up in the Virginia waters of the main stem Chesapeake Bay and the tidal waters of the James, York and Rappahannock Rivers from June 19 to July 19, 2001. Sea turtle strandings declined after this rule was in effect, but delays in implementing management measures resulted in the rule being enacted after the period of highest sea turtle strandings.

PROPOSED RULE MAKING

NMFS has issued a proposed rule that prohibits the use of all pound net leasers measuring 12" and greater stretched mesh and all pound net leaders with stringers in the Virginia waters of the mainstem Chesapeake Bay and portions of the Virginia tributaries from May 8 to June 30 of each year. This measure is necessary to protect threatened and endangered sea turtles from future entanglement in pound net leaders, while minimizing the economic impacts to the pound net fishery. NMFS has also issued an interim final rule that implemented seasonally-adjusted closures to fishing with gillnets larger than 8" stretched mesh, effective on March 15, 2002. The intent of this rule is to reduce the impact of larger mesh gillnets, primarily monkfish gillnets, on sea turtles off of North Carolina and Virginia during times when sea turtles are likely to be present (when sea surface temperatures are 11EC or greater).

PROPOSED 2002 MONITORING PLAN

NMFS will continue to monitor and investigate other factors that may contribute to sea turtle mortality during this time period by conducting and supporting the following activities: (1) Observer coverage of the large mesh monkfish gillnet fishery and smaller mesh gillnet fisheries; (2) Alternative Platform observation of the large mesh black drum and sandbar shark fisheries; (3) Alternative Platform observation of pound net leaders < 12" that are unaffected by the closure; (4) Further investigations into methods to observe pound net leaders remotely at depth: including sonar, video and ROV; (5) Inshore and offshore aerial surveys to record sea turtle distribution, SST and fishing gear ; (6) Support for improved real time stranding network coverage on the eastern shore; (7) Research and development of whelk pot gear modifications to address entanglement; and (8) Analysis of genetic samples obtained in 2001 and 2002 (ongoing).

PRIORITIES FOR FUTURE RESEARCH AND MONITORING

(1) Oceanographic modeling to better understand the origin and transport of stranded turtles; (2) Observer coverage of the whelk/crab pot fisheries, scallop dredge and haul seine fisheries; (3) Studies to better understand the behavior and ecology of turtles as they enter the Bay; (4) Development of methods to obtain real time information on mortality, since most animals are reported as moderately to severely decomposed.

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Twenty-two years of data on sea turtle mortality in Florida: trends and factors

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From 1980 through 2001, 18,709 dead or debilitated sea turtles (i.e. sea turtle strandings) found in Florida were documented by the Florida Sea Turtle Stranding and Salvage Network. These strandings included loggerheads (*Caretta caretta*, N=11,351), green turtles (*Chelonia mydas*, N=4,542), Kemp's ridleys (*Lepidochelys kempii*, N=1,193), hawksbills (*Eretmochelys imbricata*, N=355), leatherbacks (*Dermochelys coriacea*, N=430), and olive ridleys (*Lepidochelys olivacea*, N=3). The number of sea turtle strandings documented each year rose, with distinct peaks in 1989, 1990, 1996, and 2001. The number of strandings in 2001 (N=1,338) was the highest ever documented in one year. Boat-related injuries were the most common anomaly noted among the strandings and were seen in almost one-third of the stranded turtles found in recent years. The most commonly observed disease was green turtle fibropapillomatosis. About 25% of stranded green turtles had fibropapilloma-like tumors. An epizootic involving 49 live-stranded loggerheads and characterized by healthy-looking (robust) but lethargic (almost paralyzed) animals occurred in south Florida during 2000 and 2001. At least another 100 loggerheads found dead during the same time were probably associated with this epizootic. Almost 5% of the stranded turtles were entangled in fishing line or had a hook in the mouth or other part of the body. Almost 30% of the stranded turtles showed no evidence of injury or disease, and in some cases necropsies showed that these animals had been feeding normally right up until the time of death. These observations are consistent with mortality associated with commercial fishing activities. About 1% of the stranded turtles showed evidence of entanglement in lobster or crab-trap buoy lines. Another 1% of the stranded turtles were partially or completely covered with tar or oil. Most (80%) of the tar- or oil-covered turtles were lost-year-sized (<25 cm CCL) hawksbills, green turtles, and loggerheads. Three percent of the 1503 turtles that were necropsied had ingested plastic.

Sea turtle mortality by artisanal fisheries along the northern coast of the state of Santa Catarina, South Brazil

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Data on sea turtle bycatch in artisanal fisheries in south Brazil have remained limited. Information about this problem has been collected between 1994 and 2001, through analysis of 35 specimens of *Chelonia mydas* (32.5 to 65.6 cm CCL, mean of 41.6 cm, n=27) or through interviews with fishermen in the localities of Penha, Navegantes, Itajaí and Balneário Camboriú, State of Santa Catarina, south Brazil. In these localities shrimp-trawls are used by a small boat (4-6 m). The whole fishing area span from 26º45'S to 27º00'S, between 100 and 2,000 m from the coast. The fishing effort is concentrated in spring and summer and the size of nets range from 10 to 12 m long and from 3 to 5 m wide. The mesh size varies from 1 to 2 cm and the number of boats is approximately 115. This fishery is focused on shrimp, squid and small fishes, and it is used for subsistence by resident families. Sea turtles captured are only juveniles of *C. mydas*. Due to the small time of the trawl, a lot of turtles are released alive, a small number are consumed and/or made into souvenirs and some dead strandings are found at the beaches. The number of specimens captured it is not still known, but we estimate that up to 920 specimens/year, are captured by the small fisheries boats that operate in the study area.

Beach strandings of sea turtles in the state of Rio Grande Do Sul: an indicator of gillnet Interaction along the southern Brazilian coast

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Fishing bycatch is the principal cause of sea turtle mortality in the southern Brazilian coast. The State of Rio Grande do Sul, is the focus of the largest fishing effort in Brazil, including practically all coastal and pelagic marine ecosystems. Beach stranding are one of the indicators of mortality, mainly due to coastal fishing. Between January 1994 and July 1998, expeditions (n=23) along the coast of Rio Grande do Sul (29º19′13″S to 33º44′22″S) were sporadically realized with a total of 6,078 km coastline. The species recorded were: *Caretta caretta* (n=108, 52.1%); *Chelonia mydas* (n=63, 30.4%); *Dermochelys coriacea* (n=34, 16.4%); *Eretmochelys imbricata* (n=1, 0.5%); and *Lepidochelys olivacea* (n=1, 0.5%). The size of carapaces (carapace curve length=CCL) were: *C. caretta* (60.6 to 123.0 cm, mean 81.6, n=69); *C. mydas* (28.9 to 48.5 cm, mean 36.9, n=36); *D. coriacea* (125.0 to 165.0 cm, mean 137.4, n=10); *E. imbricata* (31.0 cm, n=1); and *L. olivacea* (70.4 cm, n=1). The sex of the specimens was not determined, but the size of carapaces indicate that *C. caretta* was represented by adults and subadults, *C. mydas* by juveniles, *D. coriacea* by adults, *E. imbricata* by a juvenile, and *L. olivacea* by a probable adult. The highest frequency of strandings was recorded in spring and summer. The majority of the specimens showing marks that indicate interactions with gillnet fishery, very common in this region, between 2 to 32 nautical miles of the coast and directioned to small sharks and bottom fishes.

Sea turtle mortality in pelagic driftnets off the southern Brazilian coast

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Data on sea turtle bycatch in Brazilian driftnetting operations are limited. Information about this problem has been collected through VHS tapes made by shipowners or through interviews with fishermen in the localities of Itajaí and Navegantes, State of Santa Catarina. The whole fishing area spans from the State of Rio de Janeiro to Uruguay (21ºS to 34º30′S), between 100 and 250 nautical miles of the coast. The fishing effort is concentrated in spring and summer and the size of nets ranges from 3000 to 4300 m long and from 6 to 13 m high. The mesh size vary from 32 to 44 cm and the number of boats is highly variable (11 to 36). The southern Brazilian pelagic driftnet fishery is focused on *Xiphias gladius* and pelagic sharks. Sea turtles captured are adults of *Dermochelys coriacea* and both adults and subadults of *Caretta caretta*. It was observed that in operations where the height of the net was smaller than 8 m, the great majority of captured *Dermochelys* were released alive, however, most *Caretta* were found dead. The number of specimens of sea turtles captured is not still known, but we estimate that up to 3,920 specimens/year are captured by ships that operate in Itajaí and Navegantes. To date, there is no information concerning the use of the carcasses for consumption.

Discoveries of olive ridley turtles (*Lepidochelys olivacea*) on the Pacific coast of Costa Rica

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INTRODUCTION

Sea turtles are a basic and important component in global biodiversity. Distributed throughout tropical and subtropical oceans, their populations once reached millions. Yet no sea turtles are free from human impact. Such anthropogenic factors affecting the lives of sea turtles include commercial over fishing, incidental capture during craftsmanship and industrial fishing activities, destruction of critical feeding, nesting and resting habitats, and more recently ocean pollution; boat strikes causing head and shell injuries, loss of limbs and other trauma; and the ingestion of foreign bodies. Natural factors are also important when considering sea turtle mortality, such as the increasing incidence of fibropapillomatosis, the extent and severity which is thought to be influenced by the aforementioned anthropogenic stressors (IUCN 1995).

This paper addresses anthropogenic and natural causes of mortality in sea turtles, by necropsies on dead individuals stranded on various nesting beaches of Costa Rica's Pacific Coast whenever possible or by simple visual observations by informally trained observers. macroscopic and histopathologicals discoveries in the mortality of causes in sea turtles will help to elaborate protocols for the Regional as a diagnostic guide of cause of death.

METHODS AND RESULTS

Three beaches were selected (Nancite, Ostional and Grande or Baulas) and were assessed using different methodologies and time spans, depending on resources and personnel training. Fieldwork for necropsies between the months of August 2000 and January 2001 assessed causes of death in sea turtles. For the purposes of collecting valid and useful samples for histopathologic studies, carcasses must be categorized by postmortem state or condition. Only those with minimal or no autolysis could be used for histopathology evaluation. In this study we followed in order to the necropsies the manual by Wolke and George (1981). The rapid postmortem autolysis in turtle carcasses in the tropics permitted only 8 samples in acceptable condition for histopathologic evaluation. Tissue samples for histopathology were preserved in 10% buffered formalin and submitted to the pathological laboratory of National University in Costa Rica. Fixed tissues were prepared using standard microtome procedures and stained with Hematoxilin and Eosin.

A total of 93 dead turtles were registered in the study. Mortality in 73/93 (78.49%) was due to anthropogenic causes. Mortality from "natural" causes was identified in 20/93 (21.50%). these stranded and dead sea turtles were all found in Nancite beach, an Environmentally Protected Area regulated by the government. natural mortality was caused by natural predation by crocodile (60%), coyote (30%), and shark (10%). Gross and histopathologic discoveries in olive ridley (*Lepidochelys olivacea*) in Grande, Nancite and Ostional beaches in the Pacific coast of Costa Rica, Oct. 2000 – Jan. 2001.

CONCLUSIONS AND RECOMMENDATIONS

The results suggest anthropogenic factors are an important source of sea turtle mortality, such as: capture and forced immersion by shrimp nets, entanglement in nylon lines, cranial traumas, boat strikes that may cause injuries, and slaughter to harvest eggs and meat for consumption by humans. The natural factors such as: predation by coyotes, crocodiles and sharks in Nancite beach, unfortunately, many causes of mortality in dead turtles found on the beaches could not be evaluated due to extensive postmortem autolysis.

In general, anthropogenic factors are an important source of sea turtle mortality. For this reason research must be increased in order to achieve the active participation of all individuals and ensure efficient management and conservation strategies for sea turtles.

It is possible that secondary infections and other disease complications resulting from injuries by hooks, internal traumatic hemorrhages, and entrapment in fishing nets contributed to turtle (Lutcavage et al. 1997). in this research we identified macroscopic lesions in dead turtles such as hooks e encrusted in mouth, esophagus, and flippers with corresponding histopathologic changes of ulcerative esophagitis, tissue necrosis with pus and bacteria suggesting these injuries and lesions contributed to the mortality of sea turtles.

The finding of fishing hooks in the mouth and esophagus of dead sea turtles suggests an attraction of the turtles to the bait used in commercial fishing, with the most common bait being fish and squids (Achaval et al. 1997). the predominant species of turtle injured by fishing hooks in this study are the olive ridley (*Lepidochleys olivacea*), an omnivorous species (Barragán et al. 1992) that feeds on primarily crabs, shrimp and mollusks (Wynne and Schwartz 1999), and could be easily attracted by fish bait. thus, it is very important to increase the observers in boats who can confirm the causes of mortality in sea turtles, and who can collect samples for medical studies that would contribute in all management plans of sea turtle.

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LITERATURE CITED

Achaval, F., Y.H. Marín, and L.C. Barea. 1997. Captura Incidental de Tortugas con Palangre Pelágico Oceánico en Atlantico Sudoccientai. 8 p.

Barragán, A., C. Lopez, M. Mata. A. Quintana. E. Santos y L. Sarti. 1992. Estudio de los contenidos estomacales de *Lepidochleys olivacea* en la costa Sur del Estado de Michoacan, México. En: Publ. Soc. Herpetol. Mex. # 1 (1992). p. 39-50.

IUCN, 1995. Global strategy for Sea Turtle Conservation. Balmar, Arlington, VA, USA.

Lutcavage, M.E., P. Plotkin, B. Witherington, and P.L. Lutz. 1997. Human impact on sea turtle survival. In: P.L. Lutz and J.A. Musick, eds. The Biology of Sea Turtles. CRC Press. Boca Raton, FL. p. 387-409

IUCN. 1995. Estrategia Mundial para la Conservación de las Tortugas Marinas. Preparado por el grupo de especialistas en Tortugas Marinas. Balmar, Arlington, VA, USA

Wolke, R. and A. George. 1981. Sea Turtle Necropsy Manual. Marine Pathology Laboratory. Department of Aquaculture and Pathology. University Rhode Island. Kingston, RI 022881. NOAA Tech. Memo. NMFS-SEFC-24. 20 p.

Wynne, K. and M. Schwartz. 1999. Guide Marine Mammals and Turtles of the U.S. Atlantic and Gulf of Mexico. Rhode Island Sea Grant. University of Rhode Island. 115 p.

Implications for carbon isotopic profiles of sea turtle humeri and epizoic barnacle communities

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Stable carbon isotope analyses of bone are performed primarily to trace dietary carbon. Bone carbonate from sequential growth layers of humeri recovered from stranded green turtles (*Chelonia mydas*) and leatherbacks (*Dermochelys coriacea*) in Costa Rica and Guyana was isotopically analyzed using standard techniques. *C. mydas*, an herbivore, was found to be 13-C-enriched by an average of 6 per mil compared to *D. coriacea*, which has a carnivorous diet. Most delta 13-C values found for *C. mydas* humeri (-1.2 to 1.7 per mil) were consistent with the range of delta 13-C values for their epizoic barnacles. Shared delta 13-C values for *C. mydas* and its barnacles suggest a common external carbon source. The range of delta 13-C values found for *D. coriacea* (-5.7 to –11.2 per mil) compares with values found for cetaceans in previous studies. The delta 13-C values for *D. coriacea*, and its relative 13-C-depletion compared to *C. mydas*, cannot be explained by dietary carbon alone, and suggest an additional internal (physiological) process of fractionation within the taxon. This is significant, as it indicates that stable carbon isotopes may not universally reflect dietary input in all vertebrate taxa.

Foraging zone for *Caretta caretta* in the Mediterranean Sea of Morocco

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INTRODUCTION

Studies of marine turtles of Morocco are very rare. For this reason we carried out an investigation near M'diq-Martil (2000-2001) in northwestern Morocco to seek the importance of this zone for *Caretta caretta*. The fishermen of the area confirmed the presence of *C. caretta*, especially during June-July-August Because of the richness of the area for shellfish and molluscs (preferred diet of *C. caretta*), it seems that Moroccan Mediterranean water constitutes a significant foraging zone for *C. caretta*. The present work aims at confirming this assumption. The presence of *C. caretta* in the area correlated with the abundance of shellfish and molluscs will allow us to confirm this hypothesis.

METHODS

We provided a questionnaire to local fishermen to learn: (1) the number, size and state of the turtles observed; (2) the date of these observations; and (3) the strandings observed.

RESULTS

Results of the survey indicated that there are accidental captures of *C. caretta* in fish nets (but the fishermen do not declare them by fear of the law) in addition to the observations of large turtles seen at the surface while fishing (one of size about 80 cm in 03/08/2000 and another of size about 1 m in 13/07/2001). These accidental captures of *C. caretta* must be regarded as underestimates and probably show that the Mediterranean zone of Morocco constitutes an important foraging area for *C. caretta*. Invertebrate richness in the Moroccan Mediterranean, in particular shellfish and molluscs near the Straits of Gibraltar (migration crossing point of the loggerheads from Atlantic towards the Mediterranean) support the idea. Stranding of one turtle at the Sebta town (April 1999), another in Marina-Smir (March 2000) and another dead in Martil coast (of size about 1.20 m in 10/08/2001) were noted.

CONCLUSION

It is clear that more investigations are necessary to confirm that the Mediterranean coast of Morocco is an important foraging zone for *Caretta caretta*. However in the current state, the hypothesis is very probable especially considering that several international references (Gerosa and Casale 1999), indicate this. Also, the geographical position of Mediterranean Morocco beside Straits of Gibraltar and its biodiversity affirm the hypothesis that the Mediterranean coast of Morocco can be a foraging zone for the marine turtle. The rare cases of stranding can be had with pollution, in particular by plastics.

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LITERATURE CITED

Gerosa, G. and P. Casale. 1999. Interaction of Marine Turtles with Fisheries in the Mediterranean. UNEP, RAC/SPA.

A geographic information system for Venezuela's turtles

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Geographic information systems (GIS) are an information technology with the capacity to store, analyze, and display both spatial and nonspatial data. Essentially GIS are databases that can be filled with the information as soon at its becomes available. A GIS with the available data on Marine Turtles in Venezuela is being developed using Mapinfo and Idrisis software. The GIS includes type of coastline, bathymetry and geomorphology in Venezuela's Caribbean and Atlantic coasts. It also includes the reported nesting beaches for each species as line maps discriminating the relative importance of each beach. In the future it will have links to browsers for the databases containing the available information of years and number of nests. It will also include the references and links to views at lower scale of the main beaches and the research and conservation projects working in each. LANDSAT 7 Thematic Mapper images of Margarita Island in the eastern Venezuelan coast are used. The region was selected as pilot area for the development and test of the GIS capability. Another series of layers contain the threats and pressures, including artisanal and shrimp trawler fisheries, pollution from coastal sources and of continental origin, front beach light intensity, Tourist infrastructure, habitat destruction etc. In later phases we will use satellite images, to create another series of layers to illustrate the dominant ocean current fronts and eddies formed by thermal differences, surface height deviation and upwelling, as well as river influence, showing in this way important feeding habitats for, hatchlings and pelagic stages. The AVHRR images courtesy of CARIACO (Carbon Retention In A Colored Ocean) project being developed in the area, will show the complex mix of upwelling, oceanic and river influence in the region used as pilot area for this GIS. The combination of the potential or reported areas of presence, with the threats types and intensity, will provide the distribution of critical zones and be a useful tool for coastal zone management.

Discovery of a large hawksbill turtle (*Eretmochelys imbricata*) nesting beach in the Lesser Antilles: Trois Ilets Beach in Marie-Galante (Guadeloupean Archipelago, FWI)

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INTRODUCTION

A marine turtle conservation program was established in the Guadeloupe Archipelago in 1999. One of the priorities of the Guadeloupe program is to prospect and identify the main nesting beaches currently used by sea turtles along the 565 km coastline of this Archipelago. One major result has been the identification of an important number of nesting sites, mainly for hawksbill turtles (*Eretmochelys imbricata*), but also for green turtles (*Chelonia mydas*) and leatherback turtles (*Dermochelys coriacea*). The biggest surprise was the recognition that Trois Ilets beach in Marie-Galante hosts a regionally important hawksbill nesting area.

METHODS AND RESULTS

The nesting beach Trois Ilets beach is 2 km long and ranges from 1 to 9 m in width. A dense forest zone runs parallel to the beach, except for some open areas in the Southern half, where sheds have been installed for public visitors. Nesting hawksbills on Trois Ilets beach were first noted in June 2000. Surveys and inquests conducted before this date in the Guadeloupe Archipelago failed to report any nesting activity on this beach 2, 3. The data collected on this beach in 2000 and 2001 allow an initial synthesis on the status of the population nesting there.

2000 nesting season. Methods: Partial survey from 16/06/00 to 05/09/00. Results: 17 adult females identified and around 117 nests counted. Estimates for the season: between 22 and 35 adult females and between 150 and 220 nests.

2001 nesting season. Methods: Intensive survey from 07/07/01 to 19/09/01, partial survey the rest of the year. Results: 35 adult females identified and around 130 nests counted. Estimates for the season: between 38 and 45 adult females and between 170 and 220 nests.

The beaches located at each side of Trois Ilets also host important numbers of nests: (1) 29 nesting activities were counted during 35 surveys (between 19/07/01 and 12/09/01) on Folle Anse beach located 100 m north of Trois Ilets; and (2) 15 nesting activities were counted during 23 surveys (between 20/07/01 and 12/09/01) on Sucrerie beach located 400 m south of Trois Ilets. It is likely that these 3 beaches combined host a single hawksbill nesting population.

Other basic biological data collected during the beach studies since 2000 include mean curve carapace length (CCL): 87.8 cm (n=48; SD=4.01; max=96; min= 79) and the mean internesting interval : 14.58 days (n=50; SD=1.07; max= 17; min=13).

DISCUSSION

Based on the data gathered in 2000 and 2001, Trois Ilets beach appears to host annually about 30-40 adult females and around 200 nests. Assuming that these results will be confirmed during the coming years, this beach hosts a major nesting population in the Lesser Antilles, comparable to the other important populations of the main Lesser Antillean nesting sites already identified. For example, at Jumby Bay (Antigua), the annual mean from 1987 to 1997 was 29.27 females (max: 38 ; min: 21) or 112.18 nests 5, 6 while at Buck Island (USVI) the mean annual number of nests was of 106.25 between 1987 and 1998 5.

It should be noted that the threats on Trois Ilets beach are low. Poaching of adult females that had been common at the beginning of the survey (2 females poached in 2000) is now stopped, thanks to the presence of volunteers on the beach at night. The beach and the bordering forest are protected and managed by the ONF, which is greatly involved in the marine turtle conservation program in Marie-Galante.

CONCLUSIONS

The discovery of a new important hawksbill nesting beach in the Lesser Antilles is encouraging news. It also underlines the weakness of the actual knowledge of marine turtles populations nesting in this zone. The Guadeloupe Archipelago is far from being the least surveyed geographical entity in the Lesser Antilles, so it is likely that other important nesting beaches in this region are still waiting to be discovered. These results are particularly interesting in light of the following facts: The data available to assess the current status of marine turtle populations in the Lesser Antilles are often old and long out of date. For instance, in the review of Meylan 1999 5 on the status of hawksbill turtles in the Caribbean, all the references relative to the Lesser Antilles have publication dates prior to 1990, except for USVI and WIDEACST STRAPs which are generally syntheses of older data). The general improvement of the status of marine turtles populations at sea in the Lesser Antilles: almost all fishermen and divers questioned recently in the Guadeloupe Archipelago, Martinique, St Martin and St Barth reported a very clear increase of the numbers of observations of turtles at sea since the middle of the 1990's. Taken together, this underlines the need for more accurate studies of marine turtle populations nesting in the Lesser Antilles, in order to provide more reliable and realistic accounts of their current status.

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Assessment of sea turtle observation data collected by volunteer divers

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The Reef Environmental Education Foundation (REEF), is a grass-roots, non-profit organization of recreational divers who regularly conduct fish surveys during their dives. Each year thousands of surveys are completed by REEF volunteer divers who record the species and abundance of positively identified fish. These data are made available through the REEF website in the form of reports and data summaries. Currently REEF divers carry out surveys in the Caribbean, the Gulf of Mexico, along the US Atlantic and Pacific coasts, the Tropical Eastern Pacific (Mexico - Galapagos Islands), and Hawaii. REEF data have been used by marine park managers, NOAA ecologists, the State of Florida, the Nature Conservancy, and island governments and universities. In cooperation with seaturtle.org, REEF began asking their volunteer divers in February 2001 to report sea turtles observed during their dives. REEF divers do not interact with the turtles, but only record each turtle observed during the course of their normal fish survey. Species, relative abundance, and presence of fibropapillomatosis are recorded. These data provide a unique opportunity to collect a great deal of monitoring data on species that are typically difficult to study. To date (15 November 2001) REEF volunteer divers have reported turtle sightings during 250 surveys. These and additional data obtained between now and the symposium will be analyzed to identify potential uses and benefits of this dataset, as well as possible limitations. It is hoped that these data may provide an index of distribution and relative abundance throughout the areas monitored by REEF.

The sea turtle research and conservation project in Senegal begins to yield good results

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Four species have been confirmed in the waters of Senegal: *Caretta caretta*, *Eretmochelys imbricata*, *Chelonia mydas* and *Dermochelys coriacea*. Nesting information for the loggerhead and the hawksbill is outdated, and nesting of these species cannot be confirmed at present. The leatherback appears to nest sporadically on several beaches (Popenguine, Palmarin, Guéréo-Ndoss, Sangomar), while the green turtle nests regularly on the beaches of the Delta du Saloum and possibly in Casamance. Number of nests is still unknown. Despite anecdotal evidence, the presence of *Lepidochelys kempii* is unlikely. Although *Lepidochelys olivacea* strandings have been reported in Cape Verde and its presence in Senegalese waters is certain, nestings reported by fishermen are still unconfirmed. Sea turtle meat, fat and sex organs are exploited by certain coastal populations, but not by others. Carapaces are often used as containers for livestock and are sold to tourists in marketplaces. The current project is primarily focused on raising awareness and on attempting to stop illegal practices based on the 1986 law.

Current status of marine turtles in Argentina

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For Argentinean waters three species of marine turtles are reported: the green turtle (*Chelonia mydas*), loggerhead turtle (*Caretta caretta*) and leatherback turtle (*Dermochelys coriacea*). The stranding and direct observations are reported from Buenos Aires state to Chubut state (Río de la Plata and Atlantic Ocean), one the southernmost areas for all species of marine turtles in the Southwest Atlantic ocean. The green and loggerhead turtles that inhabit our waters are juveniles and subadults, and the leatherback turtles that could be found are adults. During the '90s there have been several reports of stranded turtles and also of captured turtles by fishermen. These were taken to different private aquariums where they were rehabilitated and then released. National and international laws protect these species. The national resolution Nº 144/83 categorizes all sea turtles as species in danger of extinction, under the category of "rare" species. The import and export of parts of turtles is regulated by CITES, which Argentina has formed part since 1981. The most important conservation problems for sea turtles are: fisheries (sport, artisanal, trawl and longline), illegal trade, water contamination and boat strikes. At the moment with the participation of biologists, veterinarians, students and local and international investigators, the first investigation project for the conservation of sea turtles (Peyu Project) has been created in Argentina.

A sea turtle century in Uruguay: antecedents and geographic distribution

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INTRODUCTION

Until December 2000, only 15 specific articles about sea turtles have been published in Uruguay. Most cases are status revision works, stranded reports, taxonomic works, diet analysis, Chelonian and Perciformes interaction, incidental capture and sporadic observations. Four species: green turtle (*Chelonia mydas*), loggerhead turtle (*Caretta caretta*), olive ridley turtle (*Lepidochelys olivacea*), and leatherback turtle (*Dermochelys coriacea*) have been seen in waters of Uruguayan seas.

OBJETIVES AND METHODS

The objective of the present work is to gather and to update all data reports referring to marine turtles that were found in Uruguay, with special focus on their geographic distribution. Several activities were carried out as important part of the present research. In the first place, there was an exhaustive revision of published data in articles about Uruguay and files from museums and research centres (ZVCR, MNHN, MZDAL, MHNIAVA, MM, MME). There was also biometrical verification of the specimens found in collections of these centres and of that found stranded along the Uruguayan coast. The database used in this work was collected in the Proyecto Karumbé campaign during the yeas 1999-2000. In addition, collection of data from fisherman communities, fish shops, nautic clubs, biologists and collaborators was made. The research consisted on the search and analysis of the following data: date (day, month, year), geographic locality, species, curved carapace length notch to tip (CCLn-t) and curved carapace width (CCW) measured in cm (Bolten 1999). This work also updates all sea turtles common names used by the fishermen and local people.

RESULTS

A total of 210 specimens were examined (*C. mydas* n=120; *C. caretta* n=66, *D. coriacea* n=22), which were distributed in 27 localities along six departments: Rocha and Maldonado (Atlantic Ocean) and Canelones, Montevideo, San José and Colonia (Rio de la Plata Estuary) (Figs. 1,2). Five specimens captured in the Exclusive Economic Zone (EEZ) are also included.

Green Turtle, *Chelonia mydas* (Linnaeus 1758). In all the country the green turtle is called Tortuga Verde or Tortuga Marina. The first register in our country is an exemplar of MNHN with the following information: March 1898, Río de la Plata, 27 cm of CCLn-t. (Achaval 1965). The mean CCLn-t of green turtles ranges from 29 to 79 cm, with an average of 35.5 cm. (n=120) (Fig. 3). An interesting fact is that 60% of the individuals are between 35 and 45 cm of CCLn-t, which shows they belong to an immature stage of the specie (Musick and Limpus 1997). Registers from all months of the year were found, but they were more often during summer. In the department of Rocha 59 exemplars were found, in seven different locations (points 22/27 map). The area between La Coronilla - Santa Teresa (point 26 map) show a high level of stranded and captured exemplars (Fallabrino et al. 2000b). The department of Maldonado presents also a substantial number of registered turtles (n= 36), especially in the area Piriápolis - Punta del Este (point 18/20 map). Several reports show that green turtles enter the Rio de la Plata, where they are often seen by fishermen from Montevideo and Canelones. In 1978 a juvenile with 30.5 cm LSC was found in Artilleros, a small village in Colonia (Gambarotta 1979) (point 1 map). Another remarkable fact is the capture of three exemplars in Valizas' brook, Rocha (point 24 map) by shrimp nets between 1996 y 1997. They were juveniles with 35 cm. de LSC. (Gambarotta et al. 1999).

Loggerhead Turtle, *Caretta caretta* (Linnaeus 1758). Locally known as tortuga cabezona or tortuga de cabeza grande. Academically, it is also called tortuga falsa carey (Achaval 1976). The first bibliographic reference found to this species is from November 1912, making reference to numerous adult exemplars seen eastwards of the Uruguayan coast (Murphy 1914). The oldest exemplar was seen in March 1915, and it was given to the MNHN. It had 63 cm of CCLn-t (Frazier 1984). A total of 66 exemplars was found, ranging from 49 to 111 cm. of CCLn-t (Fig. 4). Due to the big size of the exemplars and the irregularity of their capture, there are lost of bone rests and skulls, making more difficult the evaluation of the stage of the exemplars (n=18). Sixty-five percent of the exemplars come from Rocha (points 22/27 map). In the departments of Maldonado, Canelones and Montevideo isolated cases were reported. No individuals were reported in the departments of Colonia and San José (points 1/4 map). It is worth mentioning the stranding of an adult female in Punta del Diablo, Rocha (point 25 map), in April 1999. This turtle had been tagged in Espiritu Santo, Brasil (19º14´S, 39º41´W) in 1991 by technicians of TAMAR Project (Almeida et al. 2000).

Leatherback turtle, *Dermochelys coriacea*, (Vandelli 1761). Commonly known as tortuga siete quillas by the local fishermen. Others common names include tortuga laúd, tortuga galápago, tortuga gigante and tortuga negra. The mean CCLn-t of leatherback turtles ranges between 127 to 210 cm with an average of 153 cm (n=22) (Fig. 4). Although many historical reports don't include exact measures, or they are directly omitted, we can easily assume whether they are immature or adult turtles (Fallabrino et al. 2001a). The oldest register of this species is from 1928, with no reference to locality or measures (Frazier 1984). The total number of exemplars taken into account in this research were found between 1965 and 2000. The reports are placed in 18 localities; in the departments de San José, Montevideo, Canelones, Maldonado and Rocha (Fig. 1). Because of its pelagic habits, this animal is more frequently captured by industrial fishers (Achaval et al. 1998).

Olive Ridley Turtle, *Lepidochelys olivacea* (Eschscholtz 1829). The common name in Spanish is tortuga olivácea. It is the rarest of sea turtles found in Uruguayan waters. The first Uruguayan record of *L. olivacea* was found in 1983 in Punta del Diablo, Rocha (point 25 map) is mentioned in Frazier (1985). It was an immature turtle of 51.5 cm CCLn-t (Frazier 1991). The other specimen is a posterior third of the carapace, deposited in ZVCR (Frazier 1991). Since December 2000, no new specimens have been reported for the entire Uruguayan coast.

Hawksbill Turtle, *Eretmochelys imbricata* (Linnaeus 1766). Locally called tortuga carey in the Spanish countries. For the analysis of this species two individuals were found in the collections of MNHN and MHNIAVA. The exemplar placed in the MHNIAVA was proved to be foreign (catalogue nº 2976, year 1924). The Southeast register for this specie was made in Río Grande do Sul, Brasil; 290 km. northward the Uruguayan frontier (Soto and Beheregaray 1997). There are no individuals stranded or captured in Uruguayan waters. As for the exemplar in MNHN, its revision and verification was not possible.

CONCLUSIONS

Because of the geographical position and the climate, Uruguayan beaches are not nesting areas. In spite of that, the presence of sea turtles in Uruguay is very common. Green Turtle, Loggerhead Turtle and Leatherback Turtle can be seen in our coasts more often that was thought several years ago. Green Turtle swim high seas in Rio de la Plata, but most reports take place in localities in Maldonado y Rocha. All the cases are juveniles but two, that were found in 1999 and correspond to immature exemplars. Most Loggerhead registers are from oceanic coast (Rocha and Maldonado), but some individuals get to enter the Plata estuary (Rio de la Plata). The historic population is conformed by adults and immature, while juveniles are rare and not frequently seen. The Leatherback exemplars are founded along the whole coast, although it is strange to find exemplars westwards of Montevideo. They are all estimated to be adults and immature. There have not been new registers of Olive ridley turtle in the last 19 years. As for the Hawksbill turtle, the foreignness of one of the exemplars has been proved.

Acknowledgements. This work would not have been possible without the Proyecto Karumbé team. Special thanks to Ms. M. Meneghel, Mr. Maneyro, Mr. Loureiro, Mr. Naya and all the team of Sección Zoología de Vertebrados. We thank to Mr. Siciliano, Director of MHNIAVA; to MZDAL team; to Mr. Etchegaray, Director of MM and Mr. Medina, director of MME. To Mr. Tesore, Director of SOS – Rescate de Fauna Marina, for the time and patience given. Mr. Gambarotta provides us whit papers. AE wishes to thank to his family for moral and economic helpful. Carmen Estrades helped with the English translation.

LITERATURE CITED

Achaval, F. 1965. Hallazgo de *Chelonia mydas mydas* (Linne) (Tortuga Verde) en el Uruguay. Revista Oficial del Club Ancap. 108:27-28.

Achaval, F. and C. Prigioni. 1988. Reporte de colisión de Marlin (*Makaira nigricans*) a una tortuga Laúd (*Dermochelys coriacea*). Memorias de la Reunión Iberoamericana de Conservación y Zoología de Vertebrados. Montevideo, Uruguay. Resumen.

Achaval, F. and A. Olmos. 1997. Anfibios y Reptiles del Uruguay. In: E. Barreiro and S.A. Ramos, eds. Serie fauna N° 1; Montevideo, Uruguay. 128 p.

Achaval, F., Y.H. Marin and L. Barea. 1998. Incidental capture of turtles with pelagic longline. In: F.A. Abreu-Grobois, R. Briseño-Dueñas, R. Márquez-Millan, and L. Sarti-Martinez, comps. Proceedings of the Eighteenth International Sea Turtle Symposium. NOAA Tech. Memo. NMFS-SEFSC-436. p. 83-84.

Almeida A., C. Baptistotte and J.A.P. Schineider. 2000. Loggerhead turtle tagged in Brazil found in Uruguay. Marine Turtle Newsletter 87:10.

Bolten A. B. 1999. Techniques for measuring sea turtles. In: K. L. Eckert, K.A. Bjorndal, F.A. Abreu-Grobois, and M. Donnelly, eds. Research and Management Techniques for the Conservation of Sea Turtles IUCN/SSC Marine Turtle Specialist Group Publication N° 4. p. 110-114.

Fallabrino A., A. Bager, A. Estrades, and F. Achaval. 2000a. Current Status of marine Turtles in Uruguay. Marine Turtle Newsletter 87:4-5.

Fallabrino A., A. Bauzá, M. Laporta, M.N. Caraccio, C. Lezama, V. Calvo, M. Hernández and A. Estrades. 2000b. Resultados del 1° Campamento Tortuguero realizado en el Parque Nacional Santa Teresa, Rocha, Uruguay. Informe final de Investigación. Proyecto Karumbé. 24 p.

Frazier, J.G. 1984. Las tortugas marinas en el Atlántico sur occidental. Serie divulgación Asociación Herpetológica Argentina. 2:2-21.

Frazier, J.G. 1991. La presencia de la tortuga marina *Lepidochelys olivacea* (Eschscholtz) en la República Oriental del Uruguay. Revista de la Facultad de Humanidades y Ciencias, Serie Ciencias Biológicas, 3 época; 2. 6:1-4.

Frazier, J.G., M. Meneghel, and F. Achaval. 1985. A clarification on the feeding habits of *Dermochelys coriacea*. Journal of Herpetology 19: 159-160.

Gambarotta J.C. and E. Gudynas. 1979. A new record of the green turtle, *Chelonia mydas* from Uruguay. Centro Educativo Don Orione. Contribución Biologíca 1:9-10.

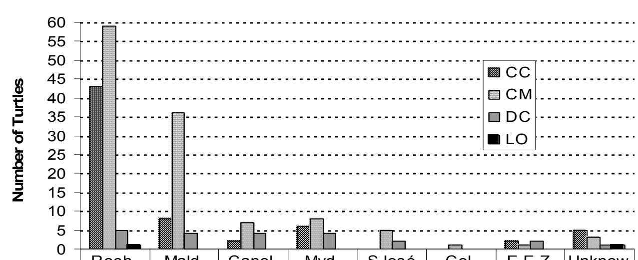
Gambarotta J.C., A. Saralegui, and E.M. González. 1999. Vertebrados tetrapodos del refugio de fauna Laguna de Castillos. Relevamientos de biodiversidad. Boletín Vida Silvestre 3:1-31.

Murphy, R.C. 1914. *Thalassochelys Caretta* in the South Atlantic. Copeia.

Musick, J. and C. Limpus. 1997. Habitat utilization and migration in juvenile sea turtles. In: P.L. Lutz and J.A. Musick, eds. The biology of sea turtles. CRC Press, Boca Raton, Florida. 432 p.

Soto, J.M.R. and R.C.P. Beheregaray. 1997. New records of *Lepidochelys olivacea* (Eschscholtz 1829) and *Eretmochelys imbricata* (Linnaeus 1766) in the Southwest Atlantic. Marine Turtle Newsletter 77:8-10.

Fig. 1. Map of study area.



	Roch.	Mald.	Canel.	Mvd.	SJosé	Col.	E.E.Z.	Unknow
CC	43	8	2	6	0	0	2	5
CM	59	36	7	8	5	1	1	3
DC	5	4	4	4	2	0	2	1
LO	1	0	0	0	0	0	0	1

Zone

Fig. 2. Geographic distribution of turtle records.

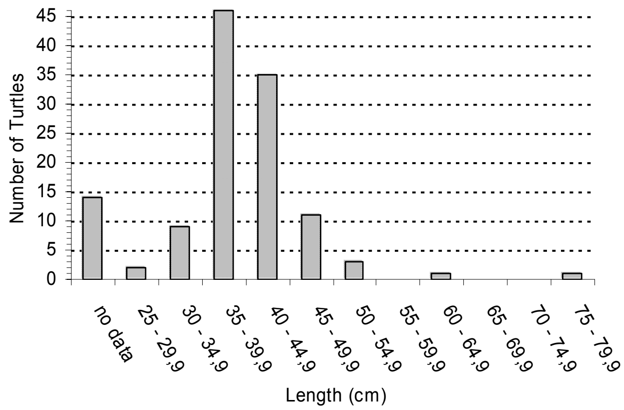


Fig. 3. Size histogram for green turtles (*Chelonia mydas*) recorded during this study.

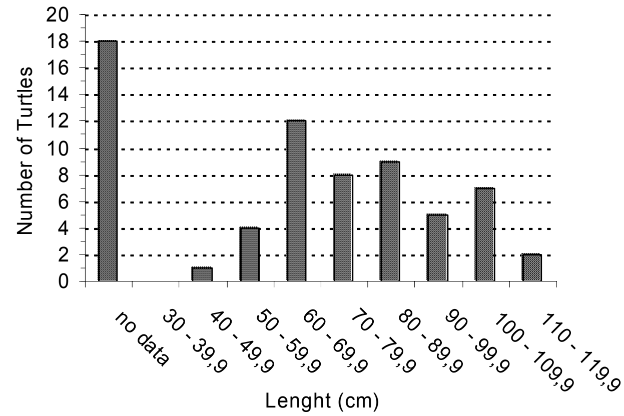


Fig. 4. Size histogram of loggerhead turtles (*Caretta caretta*) recorded during this study.

Temporal and spatial distribution of the loggerhead sea turtle, *Caretta caretta*, in the eastern Adriatic Sea: a seasonal migration pathway?

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Two species of sea turtle reproduce in the Mediterranean: the green turtle (*Chelonia mydas*) and the loggerhead turtle (*Caretta caretta*), the last one being the only species resident in the Adriatic Sea. The Adriatic was classified as an important overwintering and/or foraging habitat for loggerheads (Groombridge 1986, Argano et al. 1992, Affronte and Scaravelli 2001, Lazar and Tvrtkovic, in press). Bycatch is the main threat to marine turtles in the region. An annual bycatch rate of 2,500 specimens has been estimated for the eastern Adriatic (Lazar and Tvrtkovic 1995), and additional 3,600 sea turtles are caught incidentally in the western Adriatic waters (Casale et al. 2001).

The Adriatic Sea is the northernmost part of the Mediterranean basin. It contains a wide shallow continental shelf in the northern and middle Adriatic sub-basins (<200 m in depth), and a little extent slopes in the southern sub-basin (Fig. 1). Sub-basins differ in oceanographic characteristics such as sea floor topography, salinity, composition of benthic communities, and particularly in the temperature regimes (Fig. 2).

We analyzed data on loggerhead sea turtle bycatch in the eastern Adriatic Sea (Slovenia and Croatia) along about 1,000 km of straight coastline in the period 1992-2002. We had two objectives: (1) To provide information on interactions of marine turtles with the different fishing gears, and (2) to present additional analyses of distribution patterns related to environmental conditions. For the spatial distribution analysis, the study area was divided into five regions (Fig. 1). Based on the differences in temperature regimes of the Adriatic Sea (Fig. 2) the year was divided into two periods: the "warm period" (May - October), and the "cold period" (November - April).

Out of 132 turtles analyzed, 44.69% were caught in gill nets, followed by trawls (40.15%) and longlines (0.76%), while 14.4% of turtles were caught in unidentified types of net. Direct mortality was 54.9% for gill nets (n=51), and 12.5% in trawls (n=32). A higher frequency (60%) of adults (CCL>70cm) were caught in trawls (Chi sq.=30.6, p<0.001, d.f.=3) (Fig. 3). On the other hand, a significantly higher proportion of juveniles with CCL ranging between 30 and 50 cm are affected by gill nets (Chi sq.=8.33, p<0.03, d.f.=3). There is a high significant association between certain kinds of fishing gear and a particular period (G-test=14.94, P < 0.001, d.f.=1). Bycatch in gill nets is associated with the warm period (May-October)(Chi sq.=4.33, p=0.03, d.f.=1), while captures in trawls are associated with the cold period (Chi sq.= 10.87, p < 0.001, d.f.=1)(Fig. 3).

Trawls and gill nets are the fishing tool with the major level of interaction with sea turtles in the eastern Adriatic Sea. Direct mortality in trawls seems to be low and comparable to the 0-10% registered in the Mediterranean (see review by Gerosa and Casale 1999). In contrast, high direct mortality (54.9%) has been recorded in gill nets.

Temporal and spatial distribution analysis shows that loggerheads are not homogeneously distributed in five regions between the warm and the cold period (G-test=34.59, p<0.001, d.f=4). If we analyze bycatch data in the warm vs. the cold period separately, we find that during the warm period a significantly higher number of turtles were recovered in regions 1 and 2, while lower numbers than expected were caught in regions 3 and 4 (Chi sq.=17.65, p=0.001, d.f.=4). The frequency of bycatch is also not equally distributed among the study regions (Chi sq.= 19.35, p < 0.001, d.f.=4) in the low temperature conditions. More loggerheads are caught in regions 3, 4 and 5, and low numbers are recovered in the regions 1 and 2. That suggest the existence of a seasonal loggerhead movement in the Adriatic Sea. During the warm period, loggerheads are present along the whole eastern Adriatic coast. A wide, shallow continental shelf, rich benthic communities and the summer surface temperature (24-26 °C) makes this area a favorable habitat for loggerheads' nutrition (Spotila et al. 1997, Lazar et al. 2002). There is a significantly higher number of turtles recovered in the two northernmost regions, but such high concentration of data and unexpected low numbers of captures in the regions 3, 4 and 5 are probably the result of a higher sampling effort in regions 1 and 2.

During the cold period there are major temperature differences between the northern and middle Adriatic (Fig. 2). In the northernmost part of the Adriatic temperature may drop even to 8°C, which is within the cold-stunning temperatures for loggerheads (Shoop and Kenney 1992). Hence, it was expected that turtles would move southward to overwinter. A significantly higher number of cold period registers came from regions 3, 4 and 5, while low numbers were recorded in the two northernmost studied regions (Fig. 1). This means that loggerheads leave Slovenian waters and the NW coast of Istria Peninsula (regions 1 and 2), and head toward southern areas where they overwinter. The overwintering seems to occur south of about 45° N, in temperatures >11-12 °C. It is likely that loggerheads are lethargic in such low temperature regimes. That would explain the statistical association between bycatch in bottom trawls and the cold period. With increasing sea temperature in spring loggerheads become more active, and a part of the overwintering population returns to foraging and developmental habitats in regions 1 and 2. During this time of increased activity, turtles become intensively involved with gill nets (Fig. 3).

In summary, when sea temperature decreases, loggerheads migrate from the northernmost part of the Adriatic Sea to regions south of about 45° N, where they overwinter. With the increase of the sea temperature turtles become more active, and a part of the overwintering population returns to foraging and developmental habitats in the northern Adriatic. Gill nets are the most lethal fishing tool to marine turtles in the region. Therefore, management of gill net fisheries should be underlined as a priority in a loggerhead conservation strategy in the Adriatic Sea.

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LITERATURE CITED

Affronte M, and D. Scaravelli. 2001. Analysis of stranded sea turtles in the north-western Adriatic Sea. Zoology in the Middle East 24. 101-108.

Argano R., R. Basso, M. Cocco, and G. Gerosa. 1992. New data on loggerhead (*Caretta caretta*) movements within Mediterranean. Bollettino del Museo dell' Instituto di Biologia dell' Universita di Genova 56/57. 137-164.

Casale P, L. Laurent, and G. De Metrio. 2001. Incidental capture of marine turtles in the Northern Adriatic Sea by Italian trawlers. In: D. Margaritoulis and A. Demetropoulos, comps. Proceedings of the The First Mediterranean Conference on Marine Turtles. Rome, 24-28 Oct 2001.

Gerosa G. and P. Casale. 1999. Interaction of marine turtles with fisheries in the Mediterranean. UNEP/MAP, RAC/SPA, Tunis.

Groombridge B. 1989. Marine turtles in the Mediterranean. A report to the Council of Europe. Environment Conservation and Management Division. Document T-PVS (88) 42.

Lazar B. and N. Tvrtkovic. 1995. Marine Turtles in the eastern part of the Adriatic Sea: Preliminary Research. Natura Croatica 4:59-74.

Lazar B. and N. Tvrtkovic. In press. Corroboration of the critical habitat hypothesis for the loggerhead sea turtle *Caretta Caretta* in the eastern Adriatic Sea. In: D. Margaritoulis and A. Demetropoulos, comps. Proceedings of the First Mediterranean Conference on Marine Turtles. Rome, Italy, 24-28 October 2001.

Lazar B., D. Zavodnik, I. Grbac, and N. Tvrkovic. 2002. Diet composition of the loggerhead sea turtle *Caretta caretta* in the northern Adriatic Sea: a preliminary study. In: A. Mosier, A. Foley, and B. Brost, comps. Proceedings of the Twentieth Annual Symposium on Biology and Conservation. NOAA Tech. Memo. NMFS-SEFSC-477.

Spotila J.R., M.P. O'Connor, and F.V. Paladino. 1997. Thermal biology. In: P.L. Lutz and J.A. Music, eds. The Biology of Sea Turtles. CRC Press, Boca Raton, Florida. p. 297-314.

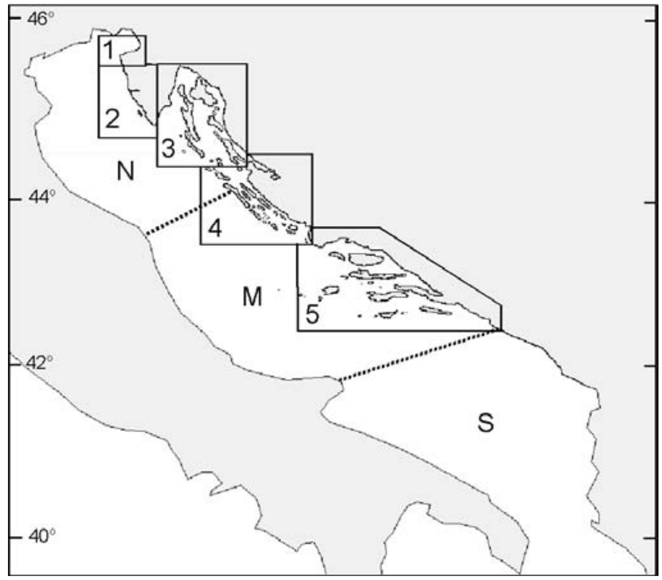

Fig. 1. Division of the Adriatic Sea into three sub-basins (N - north Adriatic, M - middle Adriatic, S - south Adriatic) with study regions in squares (1 – Slovenian waters, 2 - W coast of Istra Peninsula, 3 - Kvarner Archipelago, 4 - Zadar Archipelago, 5 - Middle Adriatic).

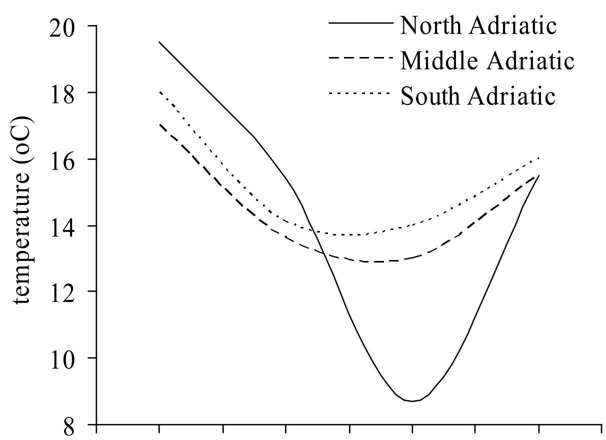

Fig. 2. The mean temperature fluctuation of three Adriatic sub-basins between September and April.

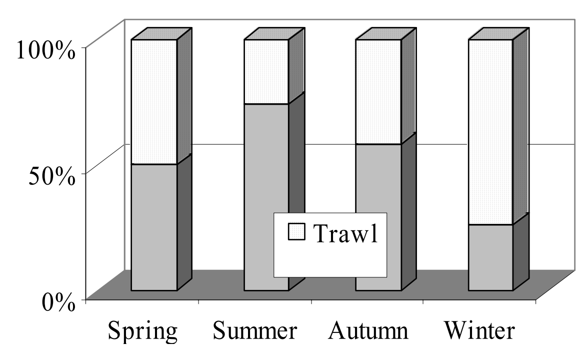

Fig. 3. Seasonal frequency distribution of bycatch in trawls and gill nets (n=105).

Migration and dive behavior of female hawksbills (*Eretmochelys imbricata*) in the Yucatan Peninsula

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Four hawksbill turtles were tagged with Platform Transmitter Terminals (PTTs), in Las Coloradas, Yucatan, Mexico (Lat. 21.7º; Long. 88.1º) to study their post-nesting migration. All of them moved toward the west. They persist in front of the Northwest coast of the Yucatan Peninsula. In that zone are several reef banks. We received the first data 7 days after we deployed the PTTs. Three (8350, 8365 8366) were already in the forage area. The fourth (8364) was in Las Coloradas. Turtle 8364 traveled parallel to the shore over 258 km an average 16.6 km/day. Turtle 8350 traveled on 8 days over 187 km, an average of 23 km/day. Turtle 8365 traveled over 413 km in 9 days, averaging 45 km/day. Turtle 8366 traveled over 366 km in 11 days, averaging 33 km/day. Analyzing the location classes 1, 2, and 3, Turtle 8350 yielded 67 positions, 46 km^2 is considered the homerange (95% of the positions), the core area (50% of the positions) was calculated at approximately 10 km^2. Turtle 8364 yielded 36 positions, the homerange was 8 km^2 and the core area was 4.6 km^2. Turtle 8365 yielded 47 positions, homerange was 21.1 km^2 and the core area was 4.3 km^2. Turtle 8366 had problems with the PTT so few data were collected. Average submergence times were analyzed according to changes in temperatures: cold temperatures increased submergence time and vice versa.

Characterization of inter-nesting habitat, migratory corridors, and resident foraging areas for loggerhead turtles (*Caretta caretta*) from a South Carolina nesting beach using GIS and remote sensing applications

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Five adult female loggerhead turtles were instrumented with Telonics ST-14 satellite transmitters on Cape Island, Cape Romain National Wildlife Refuge, South Carolina in 1998. Internesting habitat: Four turtles remained in the inter-nesting habitat for 12 - 17 days. Most turtles remained near the nesting beach in water depths of 0.5 – 18 m. Migration corridors: Three turtles migrated south and two migrated north. Turtles traveling south, took between 5 – 17 days to reach resident foraging areas with speeds ranging from 1.43 – 2.63 km/hr. Distance traveled ranged from 285 – 669 km in mean water depths ranging from 26.5 – 39.8 m. Mean distance to the Atlantic Coast ranged from 48 – 77 km. One turtle migrated north and then after seasonal declines in water temperature migrated back south to a second resident foraging area. The northern migration lasted 22 days, covering 598 km at a mean speed of 1.38 km/hr. Mean water depth was 27.8 m. Mean distance to the Atlantic Coast was 50 km. The southern migration lasted 31 days, covering 650 km at a mean speed of 1.07 km/hr. Mean water depth was 39.1 m. Mean distance to the Atlantic Coast was 51 km. Another turtle migrating northward provided only limited data. Her migration distance was 871 km, at a mean speed of 1.82 km/hr, and mean water depth of 29.1 m. Mean distance to the Atlantic Coast was 53 km. Resident foraging areas: Resident foraging areas were located on the mid to outer Continental Shelf. Four turtles provided useful data from which to characterize these habitats. We used the Minimum Convex Polygon (MCP) and Kernel Density Estimates (KDE) to determine core (50%) and home ranges (95%). MCP resident foraging area sizes ranged from 204 – 1342 km^2. KDE core area sizes ranged form 17 - 201 km^2 with home ranges varying from 87 - 1,468 km^2. The size of the home range and core area may be related to habitat quality. Mean water depth was between 25.5 and 81.0 m. One turtle had both a fall and winter/spring resident foraging area. Mean temperatures in which the turtles were found varied by 4.9ºC. This fairly constant temperature regime seems to be a combination of latitude, distance to the Gulf Stream, and seasonal turtle behavior.

Presence of sea turtles in Sierra Leone (West Africa)

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Only very little historical data on sea turtles in Sierra Leone were available until recently. The nesting of *Lepidochelys olivacea* and *Dermochelys coriacea* had been confirmed only on the Turtle Islands and on Sherbro. The University and the Conservation Society of Sierra Leone are leading their research at the moment in the western continental region, from Goderich to Sussex. Inquiries are led among the village people. The present work shows the existence of 11 nesting sites in the region as well as growing areas for *Caretta Caretta*, *Chelonia mydas*, *L. olivacea* and *Eretmochelys imbricata* situated along the coasts. The question remains as to know where these juveniles come from. The juvenile *C. caretta* could be coming from the nesting sites situated on the Cabo Verde Archipelago. All the species are killed at sea and on the land for their meat and their shell (used for decoration). The eggs are frequently eaten and sold on the markets.

Carapace characteristics of hawksbills (*Eretmochelys imbricata*) at Buck Island National Monument, U.S. Virgin Islands: long term remigrants vs. neophytes

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INTRODUCTION

The beautiful carapace of the hawksbill sea turtle (*Eretmochelys imbricata*) has led to its endangerment worldwide. The hawksbill has been harvested for the overlapping scutes, commonly known as tortoiseshell or bekko in the Japanese trade, for a variety of decorative uses. One of the few protected places left in the Caribbean where hawksbills nest in any numbers is Buck Island (BUIS) Reef National Monument, St. Croix, U. S. Virgin Islands. The Buck Island Sea Turtle Research Program (BISTRP) began in 1988 and is carried out by the Department of the Interior, National Park Service (NPS). The nesting area on BUIS consists of 1500 meters of sandy beach backed by shoreline vegetation and beach forest. This program, a saturated tagging program, has focused on hawksbill sea turtles since 1990.

METHODS

The nesting season for *E. imbricata* is from July to October. Patrols are conducted nightly, from 18:00 to 06:00 hours, to record and tag every nesting hawksbill. BISTRP has tagged and obtained data on 150 nesting hawksbills. Long term remigrants (LTR) were defined as turtles that have been seen nesting at Buck Island four seasons or more and neophytes as first time nesters. For the present study, diagnostic data (both recent and previously recorded) was collected in order to determine and record changes in carapace length and width, ectobiota coverage, and differential carapace markings. Then, LTR and neophytes to be used in the study were identified and it was determined if the characteristics to be analyzed were significant through comparative analysis.

Diagnostic data collected on nesting hawksbills included length and width measurements, carapace photos, posterior marginal scute descriptions (serrated or fused), and carapace drawings which include the number and species of ectobiota present. BISTRP has collected information on many long term remigrants since 1988, resulting in tremendous amounts of information throughout the hawksbills' adulthood.

This study of carapace characteristics of adult nesting *E. imbricata* looked at LTR and neophytes on Buck Island to compare number and longevity of barnacle attachment (specifically *Chelonibia testudinaria*), length and width growth of the carapace, changes in post-marginal scutes (serrated to fused), and frequency of shed ('sloughing') when it could be observed or detected. By looking at how long term remigrants have changed over the years and also comparing LTR data with neophyte information, various differential carapace characteristics and changes can be determined. Through this study, it was hoped that a method for easily distinguishing LTR and neophytes would be established and that more would be learned about carapace growth patterns after sexual maturity.

RESULTS AND DISCUSSION

Ectobiota and Longevity. The Buck Island hawksbill sea turtle carapace is often covered with ectobiota, specifically algae and barnacles. *C. testudinaria*, a common species of barnacle often found on sea turtles, is the most widespread. After analyzing data sheets from previous years, it was determined that the number of barnacles were not significant between neophytes and LTR. Nevertheless, barnacles can provide us with information about the carapace characteristics of the hawksbill sea turtle.

When analyzing the slides from previous years, for example those of QQD-100, a long term remigrant who was first seen nesting on Buck Island in 1988, it is evident that BUIS hawksbills often retain barnacles for many years. By comparing the carapace photos of QQD-100 from 1996 and 2001, it was observed that at least three small groups of barnacles were the same. The *C. testudinaria* on vertebral scutes 1 and 2 (which were removed for measurement in 2001) and on right costals 1 and 2 had survived and grown on the turtle's carapace through at least five years. This long term attachment is evidence that the turtles are not shedding their scutes very often. Data collected from photos and carapace drawings implies that *E. imbricata* does not shed all scutes at once. Rather, scute parts or single scutes are 'sloughed' off. This 'sloughing' explains the longevity of barnacle attachment and the carapace thickness.

Curved Carapace Length. The curved carapace length (CCL) of LTR and neophytes was examined to determine if there is a significant difference in the older hawksbills. When analyzing the measurement data, both the nuchal-scute to notch length and the nuchal-scute to tip length were looked at. The BUIS data illustrated that older turtles, in this case LTR, have CCL's that are significantly larger than those of neophytes. The nuchal-notch CCL average measurements ranged from 82.1cm to 88cm in the neophytes and 87.9cm to 93.2cm in LTR. The nuchal-tip CCL average measurements ranged from 85.6cm to 90.3cm in neophytes and 90.2cm to 95.7cm in LTR.

Posterior Marginal Scutes: Serrated vs. Fused. The serrated post marginal scute characteristic of hawksbills is widely observed in juvenile *E. imbricata*. Yet, as the turtles mature and grow in curved carapace length (CCL), their posterior carapace becomes fused. As the turtle ages, determined in this case by how many seasons the turtle was encountered nesting on BUIS, the posterior marginal scutes are unlikely to be serrated. In 2001, hawksbills that had returned more than four times (LTR) were all fused. Therefore, when a hawksbill is first encountered on BUIS, its relative status (neophyte or LTR) can be determined by observing the state of the posterior carapace. This classification also has a direct relationship with length (CCL). Since length increases with age, fused turtles also have a greater CCL and serrated hawksbills are smaller.

Through this ongoing study of the carapace characteristics of adult nesting *E. imbricata*, it is hoped that a simple method for distinguishing neophytes and long term remigrants in the field will be established. This study also was intended to discover more about hawksbill carapace growth patterns after sexual maturity.

Acknowledgements. We are grateful to Philippe Mayor, Kimberly Woody, Brendalee Phillips, BISTRP volunteers, Marcia Taylor, and the University of the Virgin Islands. This analysis was carried out with the Department of the Interior, National Park Service in Christiansted, St. Croix.

First estimation of the loggerhead sea turtle (*Caretta caretta*) stock at the Columbretes Islands Marine Reserve, Spanish Mediterranean

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INTRODUCTION

Conservation in foraging habitats is considered a priority for population management and survival of sea turtles (Bjorndal 1999). Western Mediterranean waters provide important feeding grounds for juvenile loggerheads from two different rookeries, the Eastern Mediterranean and the Western Atlantic (Laurent et al. 1998). Several anthropogenic threats affect this species in these waters, being two of them particularly serious. First, fisheries cause thousands of incidental captures of sea turtles each year (Godley et al. 1998). The second of these threats is marine pollution. Marine debris is found in high occurrence in Spanish Mediterranean loggerheads (Tomás et al. 2002). Columbretes (39º55′N-0º43′E) is a Western Mediterranean archipelago of volcanic origin situated 35 nm from mainland Spain. The waters surrounding this archipelago were protected in 1990 as a marine reserve with a total surface of 4400 ha. This reserve represents an important breeding area for many local marine species. This fact contributes to the high biodiversity in the waters surrounding it, which in turn lead to the concentration of most of the local fishing fleet. Currently, the regional and national governments plan to extend the protected area and to propose it as a marine site of community importance (SCIs). However, further information about biology, conservation status and threats of the species in the area is needed. In fact, data about abundance and distribution of loggerheads in the area is very scarce. To date, the only information on this aspect in the area is limited to opportunistic sampling from captures by the Spanish long-line fishery (Camiñas and de la Serna 1995). This sampling entails a large bias related to the different fisheries used, different fishing areas or different fishing effort in each season. In order to estimate abundance, the transect line methodology (Buckland et al. 2000) provides robust estimations with less bias and allows to evaluate the variance associated with the natural variability and with the processes of gathering information. In this study we estimate the absolute abundance and distribution patterns of *C. caretta* in the marine reserve and in the adjacent waters, in different seasons, using line transect aerial surveys. These data will be of special interest for current and future conservations plans.

MATERIALS AND METHODS

The study area comprises the pelagic area between the coordinates 40º14′N-0º20′E, 39º52′N-1º02′E, 39º50′N-0º40′E and 39º27′N-0º02′W, where the marine reserve is included. This area stretch as far as 50 nm from the coast, with depths ranging from 30 m to 1000 m. The total studied area is approximately 1,200 nm^2 (4,107 km^2). We conducted four seasonal surveys from June 2000 to July 2001 following the transect line methodology. The track design was different in the two years but in both the transects were oriented approximately perpendicular to the bathymetry. Surveys were taken from a high-wing aircraft ("push-pull" Cessna 337) that allowed a side-viewing platform. Thus, the flight line was not visible. Survey altitude was maintained at 152 m (500 ft) and transects were flown at a groundspeed of approximately 166 Km/h (90 Kn). Turtle density (D) was estimated using the standard distance sampling methods applied to single animals (Buckland et al. 2000). Data were analyzed using the program DISTANCE 4.0 (Thomas et al. 2001). We pooled all the observations to estimate f(0) due to the low number of sightings recorded in some flights. Furthermore, we subtracted 86 m (the blind distance under the plane due to the flat windows) to all the sighting distances. Three potential detection functions were initially considered: uniform, half-normal and hazard-rate, together with various adjustment terms. Models were compared with Aikake information criteria (AIC) and likelihood ratio test (Buckland et al. 2000). Variances of estimated density, abundance and encounter rate were calculated by nonparametric bootstrap (replicates=1000), using transect lines as sampling units. We calculated an average density in the study area, obtaining a mean from the densities of all the flights weighted by the total effort of each flight.

RESULTS AND DISCUSSION

We surveyed a total of 1387.5 Km in the four flights and 128 turtles were seen during the sampling effort. Detection model finally selected was the Half-normal through the comparison of the Akaike's Information Criterion (AIC=445.33). The distance frequency histogram is shown in Fig. 1. The densities estimated by flight ranged from 0.18 turtles/km^2 to 0.62 turtles/km^2 and abundances ranged from 789 to 2,571 animals (Table 1). The highest density was obtained in spring 2000 and the lowest in summer 2001. The average density in the study area was 0.322 turtles/km^2 and the mean abundance was 1,324 turtles.

We present evidence for the presence of loggerhead turtles in high numbers in the study area the whole year. Camiñas and de la Serna (1995) propose that the wintering population of loggerheads in the western Mediterranean is reduced to few specimens around the Balearic and the Columbretes Islands. However, in Table 1 it is shown that the densities in the winter surveys are similar or even greater than those of the summer surveys. This is the first estimation of the density of a sea turtle stock in western Mediterranean. Our results are comparable or greater than those reported in other aerial surveys of loggerheads in feeding waters of similar latitudes (Epperly et al. 1995, Shoop and Kenney 1992). We provided precise estimations, since coefficients of variations ranged from 10 to 30%. Furthermore, one must bear in mind that, these estimates are minimum estimates. Line transect models assume that the probability of sighting an animal on the trackline is 100%, but a high percentage of sea turtles are below the surface and not visible to observers. There are no studies of loggerhead diving behavior in western Mediterranean feeding waters providing percentages of time at surface to correct these estimates, however studies of loggerheads in various channels of southeastern United States show that this percentage varies between 4 and 20% (Nelson 1996). Other study carried out in North Atlantic offshore waters indicate that during pelagic state, loggerhead remain between 30-40% of time at surface (Dellinger et al. 1999). Based on these data we may assume that turtles in our study area will spend less than 50% of time at surface; thus, the density and abundance in the area should be at least twice of the estimated values. More surveys are needed to compare between seasons and to explore changes in density and distribution, particularly in fall. However, our data suggest some seasonal changes, with a greater number of turtles in spring. The overlap of the 95% confidence intervals of this season and those of the other flights was very low. This can be probably caused by the seasonal migration of loggerheads in western Mediterranean (Camiñas and de la Serna 1995). This migration model proposes that loggerheads proceeding from the Atlantic and from Central and Eastern Mediterranean migrate to Spanish waters in spring and leave these waters at the end of the summer. With these preliminary data we can state that Columbretes area is an important zone for Mediterranean loggerheads, and that the expansion of the marine reserve and the proposal to become marine site of community importance (SCIs) would be positive for the conservation of this species.

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LITERATURE CITED

Bjorndal 1999. IUCN/SSC Marine Turtle Specialist Group Publication No. 4. p. 12-14.

Buckland et al. 2000. Introduction to distance sampling: estimating abundance of biological populations. 432 p.

Dellinger et al. 1999. In: H.J. Kalb and T. Wibbels, comps. Proceedings of the Nineteenth Annual Symposium on Biology and Conservation. NOAA Tech. Memo. NMFS-SEFSC-443. p. 155-157.

Epperly et al. 1995. IUCN/SSC Marine Turtle Specialist Group Publication No. 4. p. 65-66.

Godley et al. 1998. Zoology in the Middle East 16:49-64.

Laurent et al. 1998. Mol. Ecol. 7:1529-1542.

Nelson. 1996. Subadult loggerhead sea turtle (*Caretta caretta*) behavior in St. Mary's entrance channel, Georgia, USA. 131 p.

Shoop and Kenney 1992. Herpetological Monographs 6:43-67.

Thomas et al. 2001. Distance 4.0. Beta 4. 432 p.

Tomás et al. 2002. Marine Pollution Bulletin. 44:211-216.

Camiñas and de la Serna 1995. Scientia Herpetologica 316-323

Table 1. Estimation summary per flight. Density, abundance and encounter rate.

Flight	Parameter	Estimate	%CV	df	95% C.I.
6/2/2000	ER	0.179	22.52	7	0.105 - 0.303
	D	0.624	23.06	8	0.370 – 1.106
	N	2571	23.06	8	1521 - 4346
7/19/2000	ER	0.055	15.91	7	0.039 - 0.080
	D	0.194	18.13	10	0.130 - 0.289
	N	798	18.13	10	535 - 1191
2/22/2001	ER	0.089	6.7	4	0.074 - 0.011
	D	0.311	10.17	12	0.249 - 0.388
	N	1280	10.17	12	1026 - 1597
7/25/2001	ER	0.051	29.31	4	0.023 - 0.114
	D	0.179	30.38	4	0.078 - 0.408
	N	737	30.38	4	323 - 1682
Average estimates	D	0.322	14.94	3	0.200 - 0.516
	N	1324	14.94	3	825 - 2124

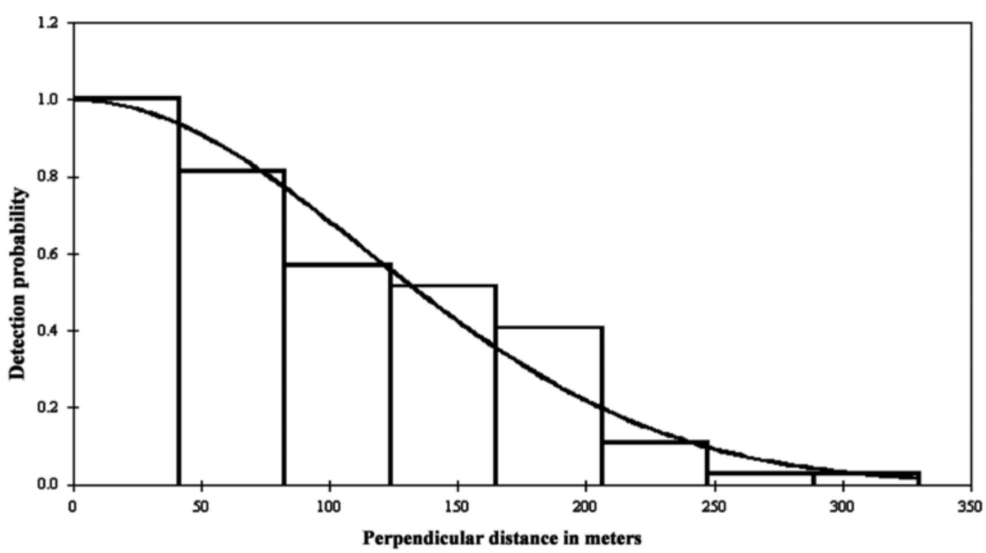

Fig. 1. Frequency distribution of perpendicular distances to sightings for *Caretta caretta* surveys. Continuous curve represents the detection probability function based on fit of Half-normal model to perpendicular distance data.

Home range and habitat analysis of green sea turtles, *Chelonia mydas*, in the Gulf of Mexico

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INTRODUCTION

Home range has been defined as the total area used by an animal in normal daily activities, excluding migrations, emigrations or erratic wanderings (Mendonca 1983). The home range utilization quantifies the degree to which individual animals frequent different units in space (Schoener 1981). The recent advent of merging statistical tools and mapping software, such as the development of ArcView's Animal Movement Analysis Extension (Hooge 1999a) enables biologists to examine the concept of home ranges and habitat utilization from a quantitative as well as qualitative point of view. Home range is considered to be an important predictable aspect of an animal's feeding strategy (Schoener 1981). Like any behavioral trait, home range and habitat utilization display adaptive value. It is predicted that home range sizes are inversely proportional to population densities (Schoener 1981). In striving to apply biological discoveries in a useful way for conservation actions, analysis of the habitat and the usage of the habitat is crucial. In order to effectively manage or protect an endangered species such as the green turtle, *Chelonia mydas*, knowledge and interpretation of the animals occupancy habits and likely foraging behavior is key effective conservation efforts. The majority of knowledge shared by the scientific community on the movements and general biology of sea turtles is based on adult females in the inter-nesting environment and post-nesting migrations. Relatively little is known or represented in the literature of the animals behaviors, requirements or dynamics while occupying the feeding grounds. Satellite telemetry and analysis of occupancy patterns will likely elucidate key pieces of the conservation puzzle. The objectives of this study are to combine information on location, occupancy and spatial use as it applies to green turtle, *Chelonia mydas*. By applying statistical analysis to data obtained with satellite telemetry, it is possible to estimate the amount and type of habitat necessary to maintain a healthy population of green turtles.

RESULTS

Estimated home range estimates as determined from the Minimum Convex Polygon for Roberta and Zyanaya were 2,745.63 km^2 and 336.317 km^2 respectively (Fig. 1). Zyanaya's estimated home range, based on the Minimum Convex Polygon is 12.25% as large as Roberta's (Table 1). Analysis of the Minimum Convex Polygon home ranges over satellite images of benthic habitat composition indicate the turtles are occupying areas comprised predominantly of seagrass beds. Roberta's home range overlays a habitat which is comprised of 72.43% patchy or continuous seagrass beds. Zyanaya's foraging grounds are within an area consisting of 84.55% patchy or continuous seagrass beds. Nonparametric statistical analysis of the home range data using the Kernel Density Estimator (ArcView's Animal Movement Analysis Extension 1997) indicates that Roberta's occupancy encompasses a 95% utilization distribution of 1,712.99 km^2 with a 50% utilization distribution or core area of 368.126 km^2. The data for Zyanaya indicate a 95% utilization distribution, home range of 830.871 km^2 and a 50% utilization distribution, or core area of 224.933 km^2 (Fig. 2). Using the Kernel Density Estimator, Zyanaya's home range, defined as the 95% utilization distribution, is equivalent to 48.50% of the size of Roberta's home range (Table 1). Comparing the core areas of the two turtles based on 50% utilization distribution, Zyanaya occupies a central area of activity that is 61.10% as large as Roberta (Table 1).

DISCUSSION

Both sexually mature turtles were captured on the same nesting beach, and despite the variation in route taken to traverse the Gulf of Mexico, both took up residency in the same foraging grounds within the Marquesas Keys located in the Florida Keys National Marine Sanctuary. Travel speeds are reported rather than swim speeds, as many variables and potential errors make estimation of swim speed using satellite data highly inaccurate. These factors include errors in location from the satellite fixes, described as location classes, variations in current speeds and possible serial autocorrelation from satellite readings. Analysis of distance covered per unit of time reported a maximum travel speed of 8.38 km/hour and was recorded in the area known as the Yucatan Channel, between Mexico and Cuba. Current speeds for this portion of the Gulf Stream have been measured at a maximum of 250 cm/sec or 9 km/hour (Knauss 1978). The notable increase in the Zyanaya's travel speed was probably enhanced upon entering the Gulf Stream Current. According to van Dam and Diez (1998) turtles take up residency in a feeding area and become relatively sedentary. The purpose of this study was to estimate the total area utilized by a mature sea turtle as a home range, defined as the total area used by an animal in normal daily activities, excluding migrations, emigrations or erratic wanderings (Mendonca 1983). These turtles met the assumptions of the individual home range model as they exhibit site fidelity (Hooge et. al. 1999). Home range estimates showed variation according to method used for calculation. The wide disparity in estimates of home range size for the two turtles using the Minimum Convex Polygon is most likely attributable to a correlation between sample size and home range size (Seaman and Powell 1996). The Kernel Density Estimator has been found to be a more accurate and less biased method in terms of results due to the smoothing of parameters and independence from sample size (Seaman and Powell 1996). The core areas as determined with the kernel density estimator were closest in range, with the smaller sample size for Zyanaya producing a 50% habitat utilization (core area) of a size approximately 61.10% of Roberta's. Future studies should focus on increasing sample sizes and comparing home ranges based on a variety of sampling protocols, including VHF telemetry and acoustic telemetry as used by Seminoff et. al. (2002). to estimate home ranges of the East Pacific green turtle. Future plans include analysis of incremental area curves to determine minimum numbers of relocations via satellite telemetry necessary to accurately estimate home ranges of green turtles. The analysis of the home ranges when superimposed over satellite photographs highlighting the benthic substrate indicates that these turtles are occupying areas of the Marquesas Keys predominated by seagrass. It is known that these animals are major grazers in their ecosystems and have major effects on nutrient cycling and community structure (Bjorndal 1997). Knowledge of their occupancy in terms of total area utilized and habitat assessment in terms of primary foraging areas can be crucial information for conservation of an endangered species inhabiting a complex and highly vulnerable ecosystem.

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LITERATURE CITED

Bjorndal, K.A. 1997. Foraging ecology and nutrition of sea turtles. In: P.L. Lutz and J.A. Musick, eds. The Biology of Sea Turtles, CRC Press.

Environmental Systems Research Institute. 1995. ArcView 3.2 software and User's Manual. Redlands, California.

Hooge, P.N., W. Eichenlaub and E. Solomon. 1999. Using GIS to analyze animal movements in the marine environment. United States Geological Survey.

Hooge, P.N. and E. Solomon. 1999. Animal Movement Analysis Extension. Software Extension for ArcView 3.2 mapping tools w3.absc.usgs.gov/glba/gistools.index.htm.

Knauss. 1978. Introduction to Physical Oceanography. Prentice-Hall, Englewood Cliffs, NJ.

Mendonca, M. 1983. Movements and feeding ecology of immature green turtles (*Chelonia mydas*) in a Florida Lagoon. Copeia 1983:1013-1023.

Rohmann, S. 1999. Benthic Habitats of the Florida Keys. CD-ROM of Digital Habitat Images of the Florida Keys. NOAA and ESRI Software.

Seaman, D. and R. Powell. 1996. An evaluation of the accuracy of kernel density estimators for home range analysis. Ecology 77:2075-2085.

Schoener, T. 1981. An empirically based estimate of home range. Theoretical Population Biology, 20:281-325.

Seminoff, J.A., A. Hidalgo and W.J. Nichols. 2002. Home range of the green turtle (*Chelonia mydas*) at a coastal feeding area in the Gulf of California, Mexico. Marine Ecology Progress Series 242:253-265.

van Dam, R. and C. Diez. 1998. Home range of immature hawksbill turtles (*Eretmochelys imbricata* (Linnaeus)) at two Caribbean islands. J. Exp. Mar. Bio. Ecol. 220:15-24.

Table 1. Comparison of home range estimates for both turtles, and estimate of seagrass cover

	ROBERTA	ZYANAYA	RATIO-ZYANAYA: ROBERTA
#Satellite Relocations	n=31	n=6	19.35%
Minimum Convex Polygon (Home range)	2,745.63 km^2	336.317 km^2	12.25%
Kernel Density Estimator (95% utilization)	1,712.99 km^2	830.87 km^2	48.50%
Kernel Density Estimator (50% Utilization)	368.13 km^2	224.93 km^2 61	.10%
Habitat Composition-% Sea-grass	72.43%	84.55%	

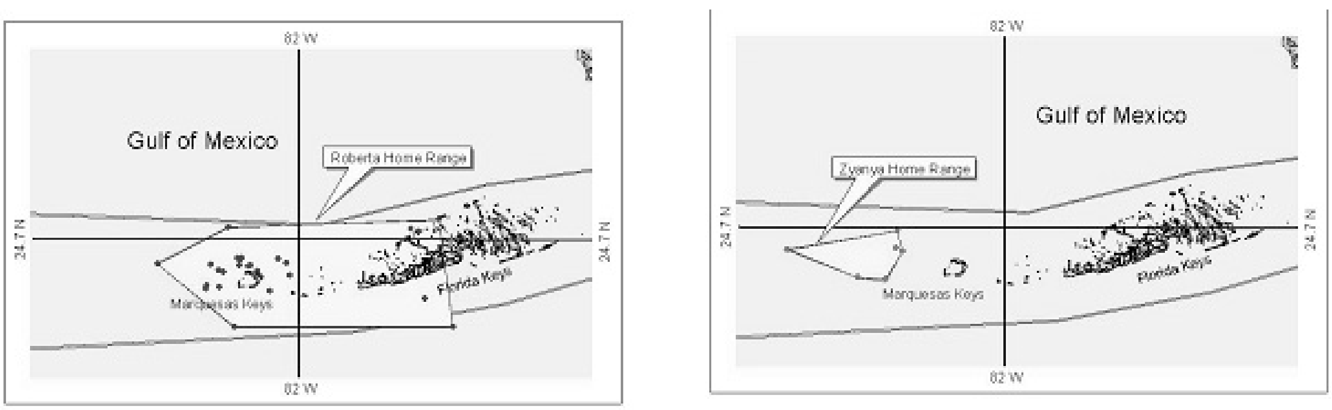

Fig. 1. Minimum convex polygon estimates of turtles' home ranges.

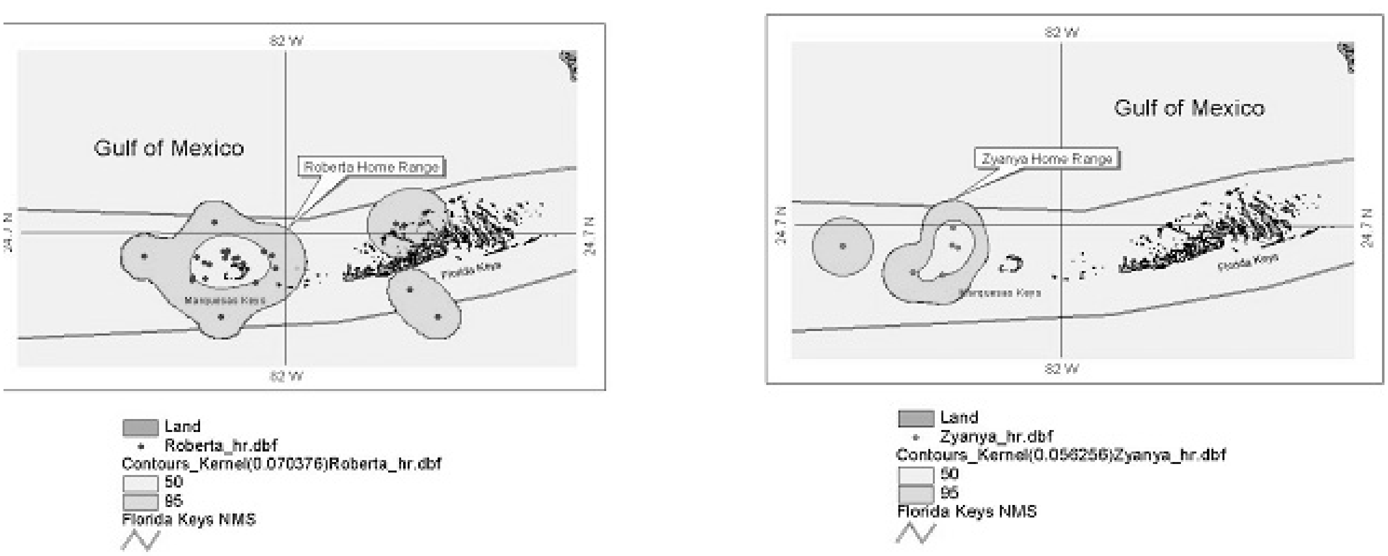

Fig. 2. Kernel density estimates of turtles homeranges.

Abundance of sub-adult green turtles (*Chelonia mydas*) captured in the Gulf of Venezuela

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INTRODUCTION

The Gulf of Venezuela, with its great *Thalassia testudinum* prairies, constitutes the most important feeding area for the green turtle (*Chelonia mydas*) in the country (Barrios-Garrido 2000). The marine turtles are reptiles that have experienced an evolutionary success, adapting to all the changes presented from remote times until the present. They are a long living species, of late sexual maturation and of itinerant nature, as well as excellent navigators so that during their migrations, travel thousands of kilometers (Pritchard and Trebbau. 1984, Pritchard et al. 1993). The lack of technical and scientific knowledge in the zone about the condition of the marine turtle that uses the Gulf of Venezuela, the same as that of the zone for feeding, forage, or migratory corridor impelled the present investigation, which has as the objective: To determine the sections with the most abundance of green turtles present in the Gulf of Venezuela. Unfortunately, the massive sacrifice of marine turtles on the part of the residents of the area, mainly indigenous Wuayuú and the indiscriminate capture of individuals that have been made in its migratory routes has caused a drastic decrease of the number of individuals in the population. The consumption of turtle meat and their commercial by-products, such as: oil, fat, tortoiseshell shell, and decorative shells are activities that are deeply ingrained in the customs of the indigenous population Wuayuú (Rueda-Almonacid. et al. 1996).

METHODS

From 1997 to 2001, the group Tortugueros of the Gulf of Venezuela (TGV) has finally brought environmental education, investigation and extension with respect to marine turtles to the study area. During this period the corresponding measurements were taken: maximum length of shell (LMC) and maximum width of shell (AMC) of 121 green turtles in different locations of the Gulf of Venezuela; for this, measuring tape was used, following the methodology proposed by Pritchard et al. 1993. The age category was established according to the proposal of Hirth (1971) for *C. mydas*. The obtained data were analyzed with the Statistics for Windows program and compared with the data of animals captured in different areas of the Caribbean: Nicaragua, Costa Rica and Colombia (Rueda-Almonacid et al. 1996).

DISCUSSION OF RESULTS

The actual levels of direct capture of marine turtles in feeding zones should be evaluated. There was a measured total of 121 corresponding shells to green turtles captured in the Gulf of Venezuela, of which 29% corresponded to individual sub-adults, 36% to large individual sub-adults, and 35% to mature individuals. This area is characterized by the presence of extensive meadows of *T. testudinum*, food of the green turtle (Barrios-Garrido et al. 2001b). A great contingent of sub-adult and adult *C. mydas* females from Tortugueros-Costa Rica is present in the study area, this is evidenced by the metallic badges recovered from that area. The abundance of individuals in these developmental stages can be explained in various ways: ecologically, the distance already existent between the study zone and the principal nesting colony of the Caribbean of Tortugueros in Costa Rica, determines that the individuals that migrate near the distant feeding zones, as that of the Gulf of Venezuela, are juveniles, female adults and subadults, and in the case of the males, the mature males that should stay near the reproductive zones in order to guarantee that their genes are transmitted in the next season. On the contrary, females reproduce every three years, and can migrate toward more distant feeding zones and even arrive on time for the reproductive season. This is evidenced by the presence of the almost exclusive number of adult females in the Gulf of Venezuela season this for the presence of almost exclusively female adults in the Gulf of Venezuela. The average intervals (minimum and maximum) for the corresponding measurements of Maximum Shell Length (LMC) and Maximum Shell Width (AMC) of the green turtles captured in the Gulf of Venezuela (Fig. 1) are not similar to the intervals for the measurements of green turtles captured in other locations of the Caribbean, indicating that although the majority correspond to individual adults and large sub-adults, also exists a group of individuals among the small sub-adults and juvenile converging in this area.

LITERATURE CITED

Barrios-Garrido, H. 2000. Aspectos generales sobre la biología de las Tortugas Marinas. I Taller sobre Nociones Básicas para el estudio de la Biología y Conservación de Tortugas Marinas. Maracaibo-Venezuela,

Barrios-Garrido, H., M.G. Montiel-Villalobos, T. León, and J. Hernández. 2001. Distribución de especies y tamaños de las tortugas marinas capturadas en el Golfo de Venezuela. II Congreso de Biodiversidad, Fragilidad, Impacto y Estrategias de uso de áreas protegidas. Maracay-Estado Aragua.

Hirth, H. 1971. Synopsis of the Biological on the Green Turtle *Chelonia mydas* (Linnaeus 1758). Food and Agriculture Organization of the United Nations. 85 p.

Rueda-Almonacid, J., J. Mayorga, and G. Ulloa. 1996. Observaciones sobre la captura comercial de tortugas marinas en la península de la Guajira, Colombia. Contribución al conocimiento de las tortugas marinas de Colombia. 22 p.

Pritchard, P.C.H., P. Bacon, F. Berry, A. Carr, J. Fletmeyer, R. Gallagher, S. Hopkins, R. Landford, R. Márquez, L. Ogren, W. Pringle, H. Reichart and R. Witham. 1983. Manual sobre técnicas de investigación y conservación de tortugas marinas. 2da Edición. K. Bjorndal y G. H. Balazs, eds. Centre for Environmental Education. Washington D.C.

Pritchard. P, and P. Trebbau. 1984. The Turtles of Venezuela. Society for the Study of Amphibians and Reptiles. p. 253-399.

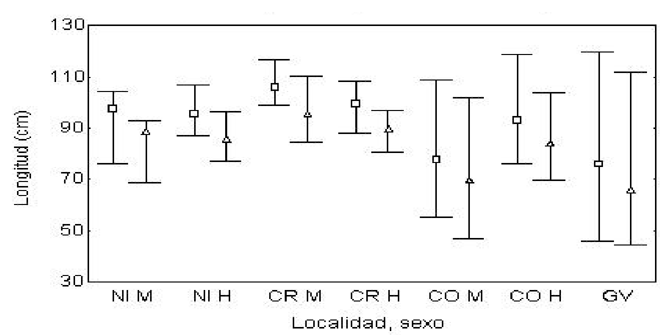

Fig. 1. Averages and intervals of size of the green turtles (*Chelonia mydas*) captured in several towns of the Caribbean (Rueda-Almonacid et al. 1996, Barrios-Garrido et al. 2001b). LMC signified by squares, AMC signified by triangles.

Leatherback turtles, *Dermochelys coriacea* (Vandelli 1761), from Italian shores and seas

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The Museum of Zoology of the University of Padua (Italy), founded in 1734 by Antonio Vallisneri junior, preserves the holotype of the leatherback turtle, *Dermochelys* coriacea (Vandelli 1761) (Minelli 1996, Turchetto and Nicolosi 2000). The specimen, captured near Rome (Italy) in 1760, was donated by Pope Clemente XIII to the University of Padua and carried to the city in the same year (Fig. 1). Antonio Vallisneri junior, the museum masterchief, drew and measured the turtle and one of his disciples, Domenico Vandelli, described and illustrated it, sending his work to Linnaeus (Vandelli 1761). The species was reported as "*Testudo coriacea*" in the XII edition of Systema Naturae (Linnaeus 1766), so that it has been attributed, until 1980, to Linnaeus (Fretey and Bour 1980). In the Museum of Padua there is also a complete skeleton of a leatherback turtle captured in the Adriatic Sea, out from the Po River mouth (near Ferrara, Italy) in 1958 (D'Ancona 1958, Turchetto and Nicolosi, in press). The skeleton is set with flayed carapace (Fig. 2) and some of its organs are preserved in alcohol.

The presence of such important evidence encouraged us to run an inventory of the species among the Italian Natural History Museums and Scientific Institutions and a historical-bibliographical search about strandings and catches along Italian seas and shores. The research about the stored turtles was carried out both by means of a mailing questionnaire and by personally visiting the most important Natural History Museums, public collections and zoological institutions in Italy. Data about strandings and captures along Italian coasts, were gathered from literature (including some articles from newspapers), some recent data (from 1981 to 2000) were collected both by the Sea Turtle Project of WWF and University of Rome "La Sapienza" and the Italian Centre for Cetacean Studies, which for many years has been involved in sea turtle rescue and research. The potential shortcomings of this investigation may be due to the existence of turtles in private collections and to the precision in referring the site and/or the date of the findings, especially for the oldest specimens. According to our investigation 34 findings of leatherback turtles are kept in 19 museums or scientific institutions (Fig. 3). The different ways for preserving the specimens or part of them, calculated in percentage, reveal a prevalence of the stuffed form. In total there were 16 stuffed findings, 4 entire skeletons (3 not assembled and the set up one from Padua), 1 skull, 1 head with anterior limbs, 4 carapaces, 4 whole specimens preserved in formalin (3 adults in Genoa and a new-born in Florence) and various organs preserved in liquid in the Museums of Padua and Comiso (Sicily). The most important findings in the Italian Museums are: - the stuffed adult male from the Museum of Bologna's University captured near Nettuno (Rome) in 1755 and presented by Pope Benedetto XIV to the University; this is the most ancient specimen in the Italian Museums (Alessandrini 1838); - the holotype from the Museum of Padua captured near Ostia (Rome) 1760 and sent to Padua by Pope Clemente XIII in the same year; - the entire skeleton and the respective organs stored in the Museum of Padua: this is the northernmost finding in the Mediterranean Sea, fifteen miles away from the Po river mouth (North-Western Adriatic Sea) - the new-born leatherback turtle kept in the Museum of Florence, but captured near Messina (Sicily 1896). This finding suggests oviposition on a Mediterranean shore, maybe in one Sicilian beach.

As the specimens are often stored in museums far from the sites where they are been found (for example the new-born in the Museum of Florence or the ones kept in the Museum of Trieste but coming from Tripoli in Libya), we decided to analyse not only the location in the museums, but also captures and strandings along Italian coasts and seas, excluding completely the categories of sightings with the purpose of eliminating any erroneous information. From the clues that cover three centuries (from the XVIII to the whole XX) starting from the first identification in 1743 (whose specimen was unfortunately lost), there are 99 individuals. The Italian leatherback turtle distribution is well depicted in Fig. 4, where it clearly appears that the most of the findings come from Ligurian, Southern Tyrrhenian and Sicilian Seas. The lack of data around the Sardinia Island is surely due to the failing of reports. The species rarely pushes on as far as the Adriatic, where it was sporadically found along the Eastern coasts (ex Yugoslavia), while that one identified North of the Po River mouth is rare and probably caused by currents, that lead even big fish and marine mammals towards the seaside. In the semilogarithmic diagram the number of reports in the time is shown (Fig. 4). The exponential growth stresses the strandings and fishing have increased in the last fifty years. In our opinion this increase can be attributed not only to the development of sea traffic and fishing activities, together with a more widespread ecological attention, but also to a real rise of the number of turtles coming from the Atlantic Ocean. This may be due to global weather changes on one hand and heavy human intervention on the other, which are causing a rise in water temperature (opening the Suez Channel) and salinity (building the Assuan Dam).

LITERATURE CITED

Alessandrini, A. 1838. Cenni sulla Storia e sulla Notoria della Testuggine Coriacea Marina. Nuovi annali delle scienze naturali. Anno I, Tomo II, tav. IX, X, XI:356-384.

D'Ancona, U. 1958. Cattura di un esemplare di *Sphargis coriacea*. Archivio di oceanografia e limnologia, 1957-1960, Vol. XI, 430.

Fretey, J. and R. Bour. 1980. Redècouverte du type de *Dermochelys coriacea* (Vandelli) (Testudinata, Dermochelyidae). Boll. Zool. 47:193-205.

Linnaeus, C. 1766. Systema Naturae per Regna Tria Naturae, secundum Classes, Ordines, Genera, Species, cum Characteribus, Differentiis, Synonymis, Locis, I. Ed Duodecima, Reformata. Holmiae, Imp. Dir. Laur. Salv.

Minelli, A. 1996. Il Museo Zoologico. In: I Musei, Le Collezioni scientifiche e le sezioni antiche delle Biblioteche, C.I.S.M.S. Università di Padova Ed. 183 p.

Turchetto, M. and P. Nicolosi. 2000. Animali. In: La curiosità e l'ingegno. Collezionismo scientifico e metodo sperimentale a Padova nel Settecento, Centro Musei Scientifici Università degli Studi di Padova Ed. 257 p.

Turchetto, M. and P. Nicolosi. In press. *Dermochelys coriacea*: storia e documentazione dell'olotipo conservato al Museo di Zoologia dell'Università di Padova e dello scheletro di un esemplare pescato nell'Alto Adriatico. Abstracts First Italian Meeting on Sea Turtle Biology and Conservation, 19-20 Ottobre 2000, Marine Turtle Rescue Centre Policoro (MT), p. 16-18.

Vandelli, D. 1761. Epistola de Holothurio, et *Testudine coriacea* ad Celeberrimum Carolum Linneum. Conzetti, Padova.

Fig. 1. The holotype of *Dermochelys coriacea* (Vandelli 1761) preserved in the Museum of Zoology of the University of Padua.

Fig. 2. The complete set skeleton of *Dermochelys coriacea* (1958) kept in the Museum of Zoology at University of Padua.

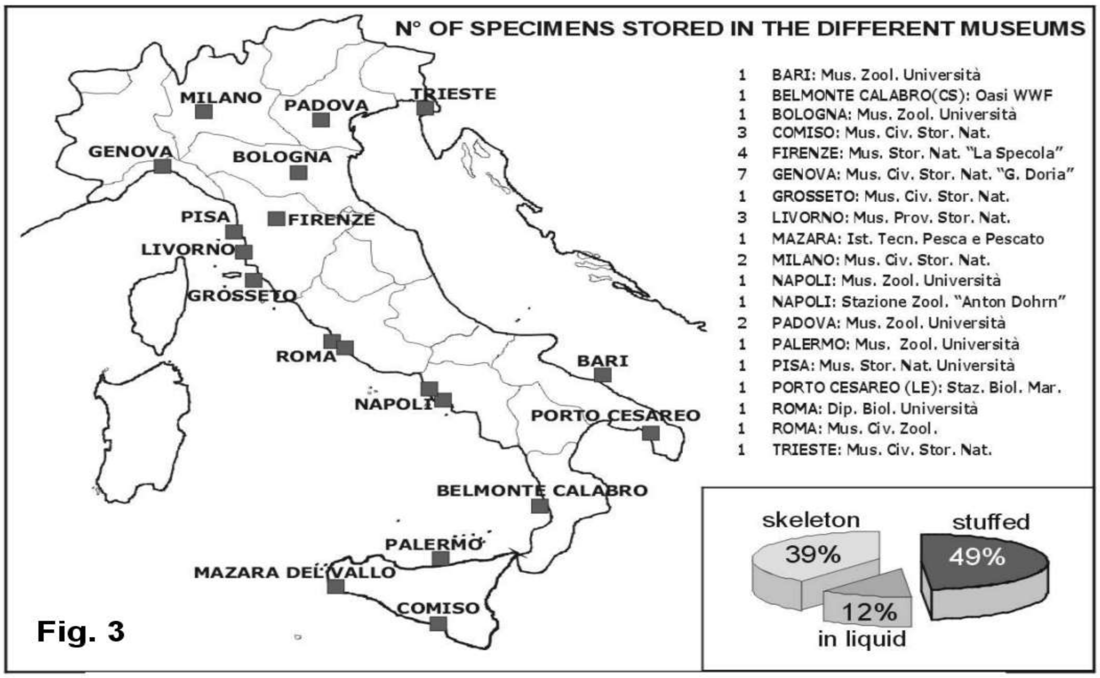

Fig. 3. Italian Natural History Museums in which are stored the leatherback turtles. On the right, the different ways of preservation.

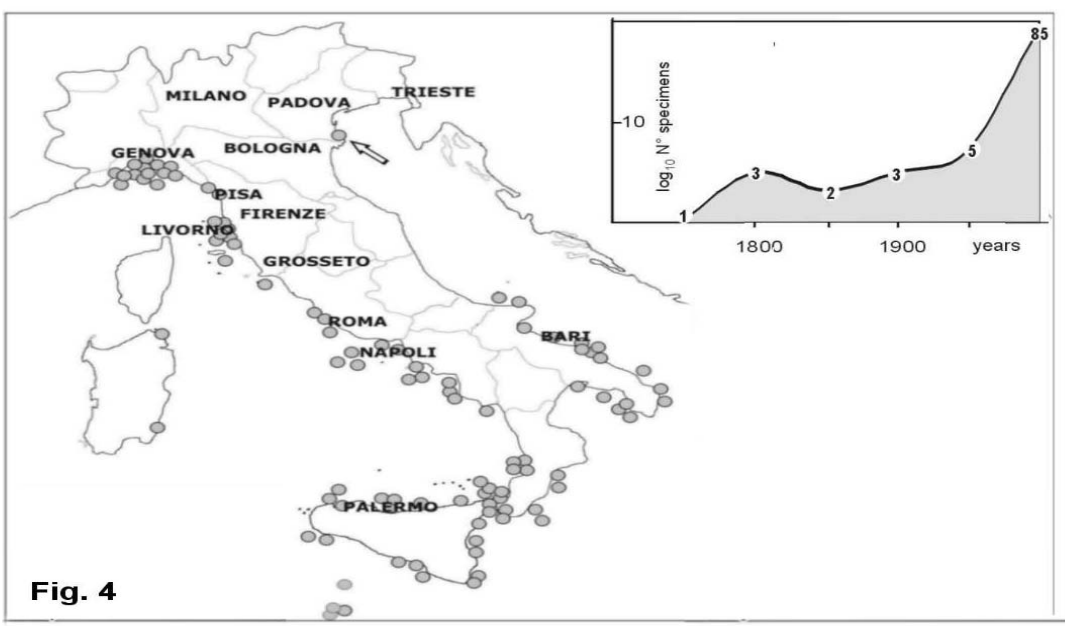

Fig. 4. Strandings and captures along the Italian coasts and seas (the arrow indicates the northernmost finding). The semilogarithmic curve on the left shows the turtle number from 1700 to 2000.

The lost years: long-term movement of a maturing loggerhead turtle in the Northern Pacific Ocean

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Loggerheads are a highly migratory circumglobal species. Analysis of mitochondrial DNA (mtDNA) has shown that loggerheads make transoceanic movements in both the Atlantic and the Pacific oceans (Bowen et al. 1995, Bolten et al. 1998). The life history of loggerheads from hatchlings on nesting beaches to their return to coastal benthic foraging habitats has been known as the "lost year" (Carr 1982). The growth rates of Atlantic and Pacific pelagic stage loggerheads suggest that a "lost decade" is more likely (Bolten and Balazs 1995, Zug et al. 1995). Recent satellite tracking of loggerheads incidentally caught by commercial fishermen in the Hawaii-based longline fishery have indicated that pelagic juvenile and sub-adult loggerheads in the North Pacific move along temperature isotherms of frontal zones swimming against weak geostrophic currents based on tracks from 1-10 months in duration (Balazs et al. 2000, Polovina et al. 2000). In this paper, we examine the movement of an exceptional sub-adult loggerhead over a 20-month period in relation to frontal zones, temperature, and currents.

In March of 2000, a 60-cm straight carapace length (SCL) sub-adult loggerhead was incidentally captured in the Hawaii-based commercial longline fishery. This turtle was cataloged as deeply hooked hence the hook could not be safely removed from the turtle. A Telonics ST-18 satellite transmitter (ID 22150), with a duty cycle of 12 hours on and 48 hours off, was attached to the carapace by trained National Marine Fisheries Service observers using fiberglass cloth and polyester resin. Positional data were received through the Argos system. Distance traveled was computed using a great-circle formula for distance with LC 0, 1, 2 or 3 positions (150->1000m accuracy). One position from each 12-hour period was used, roughly one position every three days. Speed of travel was computed using the calculated distance data and the time between each position used and speeds were averaged. Geostrophic currents were computed from satellite altimetry data from TOPEX/Poseidon with a 10-day and 0.5 degree of latitude and longitude resolution. Sea surface temperature (SST) data were multichannel SST (MCSST) from the GODAE server. A composite of daily SST data were created for the month of September 2001.

Loggerhead 22150 was followed via satellite telemetry for nearly 20 months from March 2000 to October 2001 across the Central North Pacific Ocean (Fig. 1). The turtle covered a distance of approximately 13,900 km, traveling at a mean speed of 1.0 km/hr. Seven months were spent traveling near the 17°C SST isotherm, within the Subtropical Frontal Zone in the Central North Pacific Ocean. During March - June 2000, the turtle traveled at an average speed of 0.8 km/hr, likely swimming against a weak geostrophic current. Loggerhead 22150 exhibited a north-south movement seen in Fig. 1 that followed the seasonal north-south movement of the 17°C SST. In July and August 2000, a month was spent in an eddy around 165°W as the turtle traveled at an average speed of 1.0 km/hr before continuing to move westward. Another month was spent in a meander around 170° W during October-November before continuing west (Polovina et al., in press). In January 2001, after a total of 10 months of travel, the turtle reached the area of the Emperor Seamounts and stopped its direct westward travel. Here, 22150 spent an extended period traveling within eddies created by the Kurishiro Extension Current (KEC) around 170°E and 165°E (Fig. 2, Polovina et al., in press). The average speed of travel for January to September 2001 was 1.0 km/hr. During this time increases in speed were seen when the turtle was traveling eastward with the currents (average turtle speeds of up to 2.6 km/hr). The turtle also continued a seasonal north-south movement and was found near the 20°C SST isotherm during the end of August and beginning of September (Fig. 3a). During the latter part of September 2001, the turtle started to again move on the edge of an eddy (Fig. 3b). In October of 2001, loggerhead 22150 moved into a direct stream of the KEC and moved eastward for about a week before traveling directly northward continuing to move within the eddy created by the KEC. During the eastward movement in the KEC, travel speeds up to 3.0 km/hr were attained; the current accounted for 1.8 km/hr of this with the turtle swimming at a rate of 1.2 km/hr.

The 10 months 22150 spent west of the Emperor Seamounts suggests that this area is an important foraging region for pelagic juvenile and sub-adult loggerheads. Zug et al. (1995) skeletochronology of Pacific loggerheads suggests that 40-cm SCL loggerheads are nearly 8 years of age and evidence is accumulating that some loggerheads in the Pacific are mainly pelagic until they become sexually mature and return to their nesting beaches, after which the decades old adult loggerheads most likely start a benthic existence. This hypothesis is supported by the track length of this 60-cm SCL loggerhead which spanned 20 months, and also by data compiled from 1994-2000 in the Hawaii-based commercial longline fisheries in which relatively few large adult-sized loggerheads were captured (N=163, mean 57.7 ± 11.5 cm, range 38-90 cm SCL). More research involving tracking pelagic movements over extended periods of time will help to better understand loggerhead behavior, ecology, and life history to protect this declining species in the Pacific.

LITERATURE CITED

Balazs, G.H., D.R. Kobayashi, D.M. Parker, J.J. Polovina and P.H. Dutton. 2000. Evidence for counter-current movement of pelagic loggerhead turtles in the North Pacific Ocean based on real-time satellite tracking and satellite altimetry. In: H.J. Kalb and T. Wibbles, comps. Proceedings of the Nineteenth Annual Symposium on Sea Turtle Biology and Conservation. NOAA Tech. Memo. NMFS-SEFSC-443. p. 21.

Bolten, A.B and G.H. Balazs. 1995. Biology of the early pelagic stage: the "lost year". In: K.A. Bjorndal, ed. Biology and conservation of sea turtles, revised edition, Smithsonian Institution Press, Washington, DC, USA. p. 575-581.

Bolten, A.B, K.A. Bjorndal, H.R. Martins, T. Dellinger, M.J. Biscoito, S.E. Encalada and B.W. Bowen. 1998. Transatlantic developmental migrations of loggerhead sea turtles demonstrated by mtDNA sequence analysis. Ecological Applications 8:1-7.

Bowen, B.W., F.A. Abreu-Grobois, G.H. Balazs, N. Kamezaki, C.J. Limpus, and R.J. Ferl. 1995. Trans-Pacific migration of the loggerhead turtle (*Caretta caretta*) demonstrated with mitochondrial DNA markers. Proc. Natl. Acad. Sci. 92:3731-3734.

Carr, A. 1982. Notes on the behavioral ecology of sea turtles. In: K.A. Bjorndal, ed. Biology and Conservation of Sea Turtles. Smithsonian Institution Press. Washington, DC. p.19-26.

Polovina, J. J., D. R. Kobayashi, D. M. Parker, M. P. Seki and G. H. Balazs. 2000. Turtles on the edge: movement of loggerhead turtles (*Caretta caretta*) along oceanic fronts spanning longline fishing grounds in the Central North Pacific, 1997-1998. Fish. Oceanogr. 9:71-82.

Polovina, J.J., G.H. Balazs, E.A. Howell, D.M. Parker, M.P. Seki, and P.H. Dutton. In press. Forage and migration habitat of loggerhead (*Caretta caretta*) and olive ridley (*Lepidochelys olivacea*) sea turtles in the central North Pacific Ocean. Fish. Oceanogr.

Zug, G. R., G. H. Balazs, and J. A. Wetherall. 1995. Growth in juvenile loggerhead sea turtles (*Caretta caretta*) in the North Pacific pelagic habitat. Copeia 1995:484-487.

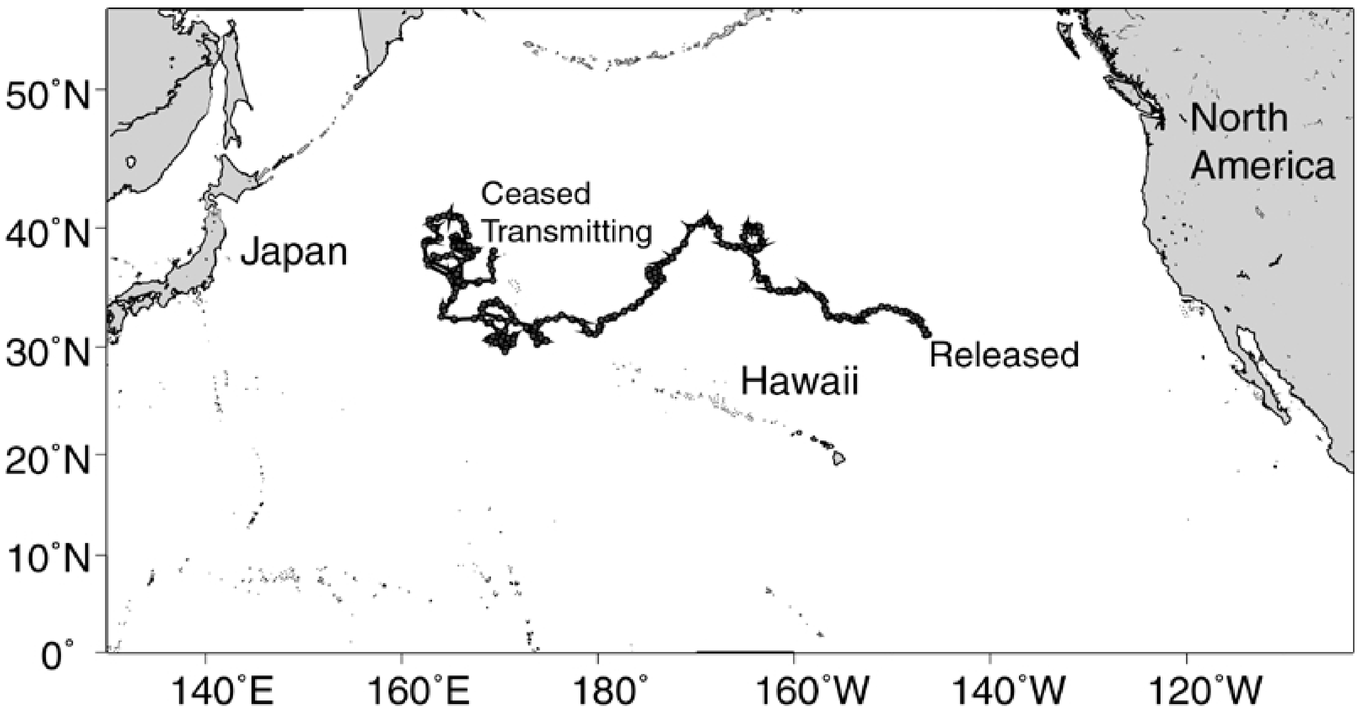

Fig. 1. Movement of 60 cm loggerhead 22150 as it traveled 13864 km across the Central North Pacific Ocean for 20 months during March 2000 to October 2001, from 31°N 146°W to 38°N 169°E, at an average speed of 1.0 km/hr.

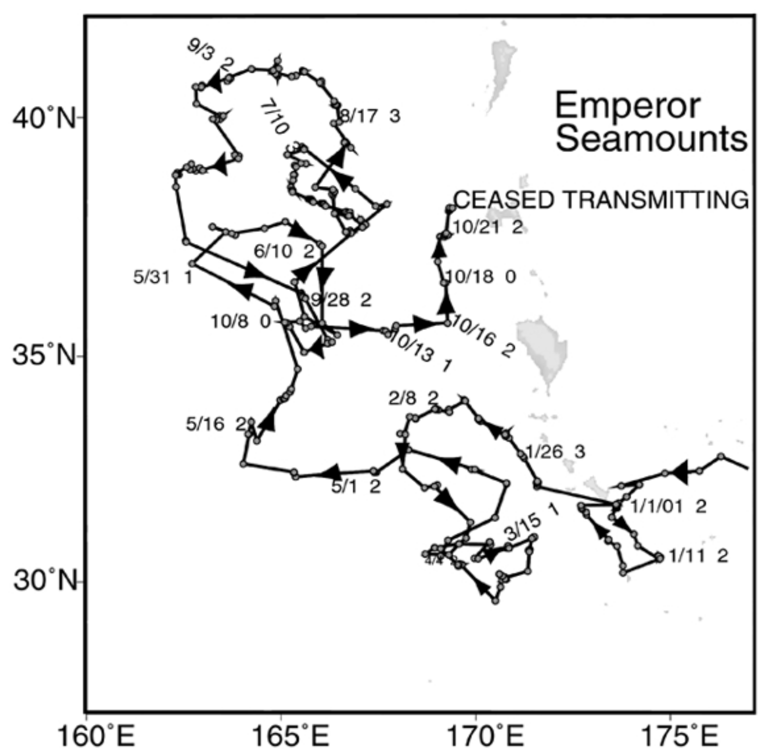

Fig. 2. Movement of loggerhead 22150 within eddies created by the Kurishiro Extension Current. Small arrows on track show direction of travel for loggerhead 22150 and large arrows show the direction and area of the Kurishiro Extension Current..

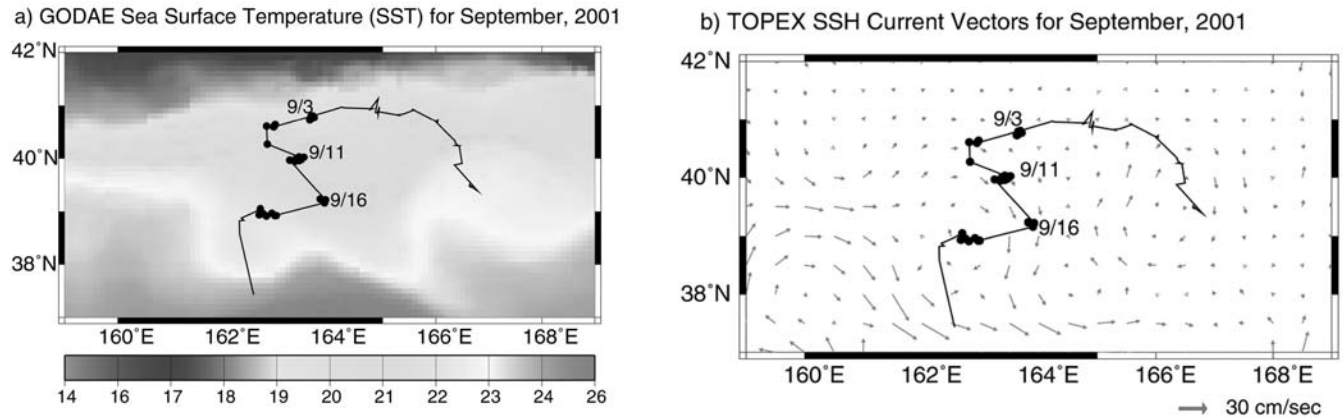

Fig. 3. (left) Movement of loggerhead 22150 during August-September 2001 together with sea surface temperature (SST) during the month of September 2001. (right) Movement of loggerhead 22150 during August-September 2001, together with geostrophic currents during 9-16 September 2001. Large circles on the track lines indicate position of the turtle during the same period for which the geostrophic currents were calculated. Arrows on the track lines show turtle movement direction.

A long journey: a Kemp's ridley sea turtle (*Lepidochelys kempii*) visits the Mediterranean Sea

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INTRODUCTION

The Kemp's ridley (*Lepidochelys kempii*) is the most endangered sea turtle species (Márquez 1994). In the second half of the 20th century the nesting population decreased from some 50,000 individuals to less than 5,000, with only a few hundred turtles nesting each season. However, a slow recovery of the nesting population has been detected in the last decade (Garundo Dionate et al. 2000). Nesting areas of this species are restricted to the Gulf of Mexico, mainly in Rancho Nuevo, Mexico, where mass nesting ("arribadas") occurs (Márquez 1994). Sporadic nesting also occurs in Veracruz (Mexico), and in the U.S. coast, particularly in Padre Island, Texas (Manzella and Williams 1992) and along the Florida coast (Johnson et al. 2000). Feeding grounds and nursery and developmental areas are distributed principally along the Gulf of Mexico and the Atlantic coast of the U.S. (Manzella et al. 1988). There is evidence of transoceanic migrations based on several recoveries of tagged turtles in the Atlantic coasts of Western Europe and Morocco (e.g., Manzella et al. 1988). There is even a report of *L. kempii* in the Mediterranean, off the island of Malta (central Mediterranean) (Brongersma and Carr 1983), which indicates that Kemp's ridleys may enter in the Western Mediterranean basin through the Strait of Gibraltar.

RESULTS

On October 15th 2001, fishermen brought a sea turtle to the Municipal Aquarium of the town of Santa Pola (38º12'N/0º34'W), Alicante (Spain). The turtle had been captured in a gill-net deployed from a small boat. The turtle was in good health condition. The fishermen did not provide the coordinates of capture, but said that it occurred in the coastal waters around Santa Pola, between the island of Tabarca (38º10'N/0º29'W) and the coastal village of Guardamar del Segura (38º06'N/0º39'W). We identified the turtle as L. *kempii* based on the presence of a small pore near the rear margin of the inframarginal scutes the coloration of the skin, the circular shape of the carapace, the presence of five pairs of coastal scutes, and the arrangement of head scales. Standard biometric variables are shown in Table 1. The age of the turtle was estimated to be 3-4 years based on carapace length (CL) measurements, following growth models derived from skeletochronological analysis (Chaloupka and Zug 1997, Zug et al. 1996). The specimen had only one pair of claws in its front flippers, instead of two as is typical for the species (Pritchard and Mortimer 1999). This reduction in the number of claws has also been observed in some adults, and has been interpreted as the result of a secondary loss (Pritchard and Mortimer 1999). Genetic analysis of mitochondrial (mt) DNA markers has been used within the context of phylogeographic studies of sea turtles worldwide. A small skin biopsy was taken from the dorsal side of the anterior left flipper and stored in 96% ethanol. DNA was subsequently extracted using a standard phenol:chloroform protocol (Sambrook et al. 1989) and preserved in TE buffer at -20°C. Polymerase Chain Reaction (PCR) was used to amplify a 460 base pair fragment of the mitochondrial (mt) DNA control region comparable to that analysed by Bowen et al. (1998), using primers LTCM2 (Encalada et al. 1996), HDCM1 (Allard et al. 1994), LTCM1.1 and HDCM1.1 (A. Formia unpubl. data). PCR products were double-sequenced with the ABI Prism Big Dye Terminator kit V.2 and analysed with an ABI 3100 sequencer (Applied Biosystems). Sequences were aligned and edited using Sequencher 3.1.2 (Gene Codes Corporation). The sequence obtained perfectly matched haplotype D previously observed in 5 individuals stranded on the Atlantic coast of the U. S. and Gulf of Mexico (Bowen et al. 1998) (GenBank accession number AF051777). However, since the control region haplotype distribution of Kemp's ridleys in nesting and oceanic habitats is still unknown, we cannot speculate on the origin of this individual, beyond the fact that its mt DNA was inherited from a female Kemp's ridley. Depending on its natal origin (Rancho Nuevo, South Texas or Florida), this specimen would have navigated a minimum distance of between 8,500 and 10,000 km. The actual distance could be even longer if the turtle rode the North Atlantic Gyre (see Márquez 1994).

This is the second report of a Kemp's ridley in the Mediterranean Sea, and confirms the passage of this species into this sea through the Strait of Gibraltar. Some authors suggest that pelagic juveniles leaving the Gulf of Mexico are lost for the breeding population. The present report provides a good opportunity to see whether this turtle, after tagging and release, is able to return to its natal breeding grounds to reproduce.

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LITERATURE CITED

Allard, M.W., M.M. Miyamoto, K.A. Bjorndal, A.B. Bolten, and B.W. Bowen. 1994 Support for natal homing in green turtles from mitochondrial DNA sequences. Copeia 1994: 34-41.

Bowen, B.W., A.M. Clark, F.A. Abreu-Grobois, A. Chaves, H.A. Reichart, and R.J. Ferl. 1998. Global phylogeography of the ridley sea turtles (*Lepidochelys* sp.) as inferred from mitochondrial DNA sequences. Genetics 101:179-189.

Brongersma, L.D. and A.F. Carr. 1983. *Lepidochelys kempi* (Garman) from Malta. Proceedings of the Koninklijke Nederlandse Akademie van Wetenschappen, Series C 86:445-454.

Chaloupka, M. and G.R. Zug. 1997. A polyphasic growth function for the endangered Kemp's ridley sea turtle *Lepidochelys kempi*. Fisheries Bulletin 95:849-856.

Encalada, S.E., P.N. Lahanas, K.A. Bjorndal, A.B. Bolten, M.M. Miyamoto, and B.W. Bowen. 1996. Phylogeography and population structure of the Atlantic and Mediterranean green turtle *Chelonia mydas*: a mitochondrial DNA control region sequence assessment. Molecular Ecology 5:473-483.

Garundo Dionate, M., J. Díaz Flores, R. Márquez-M, and M.A. Carrasco Aguila. 2000. Sequence of "Arribadas" of the Kemp's ridley sea turtle (*Lepidochelys kempi*) at the nesting beaches of Rancho Nuevo, Tepehuajes and Barra del Tordo, Tamaulipas, Mexico during the 1998 season. In: H. Kalb and T. Wibbels, comps. Proceedings of the Nineteenth Annual Symposium on Sea Turtle Conservation and Biology. NOAA Tech. Memo. NMFS-SEFSC-443, p. 247-250.

Johnson, S.A., A.L. Bass, B. Libert, M. Marshall, and D. Fulk. 2000. Kemp's ridley (*Lepidochelys kempi*) nesting in Florida. Florida Scientist 62:194-204.

Manzella, S.A. and J.A. Williams. 1992. The distribution of Kemp's ridley sea turtle (*Lepidochelys kempi*) along the Texas coast: an atlas. NOAA Tech. Memo. NMFS-SEFCSC-110. p. 1-52.

Manzella, S.A., C.W. Caillouet, and C.T. Fontaine. 1988. Kemp`s ridley, *Lepidochelys kempi*, sea turtle head start tag recoveries: Distribution, habitat, and method of recovery. Marine Fisheries Review 50:24-32.

Márquez, M.R. 1994. Synopsis of the biological data on the Kemp's ridley turtle *Lepidochelys kempi* (Garman 1880). NOAA Tech. Memo. NMFS-SEFCSC- 343, p. 1-91.

Pritchard, P.C.H. and J.A. Mortimer. 1999. Taxonomy, external morphology, and species identification. In: K.L. Eckert, K. A. Bjorndal, F.A. Abreu-Grobois and M. Donnelly, eds. Research and management techniques for the conservation of sea turtles. IUCN/SSC Marine Turtle Specialist Group Publication No. 4. p. 21-38.

Sambrook, J., E.F. Fitsch, and T. Maniatis. 1989. Molecular Cloning- A Laboratory Manual, Second Edition. Cold Spring Harbor Laboratory Press, New York.

Zug, G.R., H.J. Kalb, and S.J. Luzar. 1997. Age and growth in wild Kemp's ridley sea turtle *Lepidochelys kempi* from skeletochronological data. Biological Conservation 80:261-268.

Table 1. Biometric variables of a Kemp's ridley sea turtle (*Lepidochelys kempii*) incidentally captured in the coastal waters of Alicante (Western Mediterranean, Spain). All measurements in cm unless otherwise stated.

Variable	Value
Total length	40
Curved carapace length (notch to tip)	32.3
Curved carapace width	31.9
Straight carapace length	29.5
Straight carapace width	29
Plastron length	25
Plastron width	24
Head length	8.2
Head width	7
Total tail length	6.6
Post-cloacal tail length	2.1
Weight (kg)	4.6

Movements of loggerhead sea turtles from Wassaw National Wildlife Refuge, Georgia, USA

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INTRODUCTION

Much of what is known about sea turtle biology is limited to research conducted on nesting females and hatchling sea turtles, particularly due to the accessibility of these animals when on the beach. However, 100% of a turtle's life is spent in the water and it is here that turtles face their most deadly threats. Anthropogenic impacts on turtles include trawl net interactions (i.e. shrimp, whelk and horseshoe crab fisheries; NMFS-SEFSC 2001) and incidental capture by long-lines (Witzell and Cramer 1995), gill nets (TEWG 1998, 2000), pound nets and ingestion of anthropogenic debris (TEWG 1998, 2000). Therefore, it is essential that conservation programs refocus efforts to protect turtles in the water (Bjorndal and Bolten 2000). This is only achievable once the habitats and migratory routes that sea turtles utilize, and what time of the year turtles occupy these habitats, is known.

The purpose of this research was to identify the specific marine habitats occupied by Georgia's turtles between nesting events, as well as the post-nesting migratory pathways utilized by turtles away from the nesting beach. Satellite telemetry has been extremely successful in affording researchers the opportunity to determine movements and the in-water behavior of marine turtles. Such data are crucial for developing more effective management practices for the recovery of turtle populations.

METHODS

Turtles on Wassaw Island were observed during routine nightly beach patrols. Turtles were examined for existing tags, unusual markings and abnormalities. Carapace morphometrics were also recorded and untagged and tag-scarred turtles were outfitted with inconel tags as needed. Turtles were held in a 6'X6' wooden corral after they started to crawl back to the water. Refurbished satellite transmitters, from Telonics and Wildlife Computers, were attached using a two-part epoxy method (Sonic Weld) following Mitchell (1998).

RESULTS AND DISCUSSION

Three turtles were satellite tagged after nesting on Wassaw National Wildlife Refuge in May and July 2001. These time periods afforded us the opportunity to track turtles during inter- and post-nesting periods. The longest transmission duration from the refurbished transmitters was five months.

Big Momma was satellite-tagged on May 27th, 2001. She remained close to Wassaw Island throughout her inter-nesting intervals, primarily swimming up into the Odingsell and Vernon Rivers. After her last nest on July 4th, she progressed north and by her last transmission on August 12th, she was in the Delaware Bay, near Cape May, New Jersey. The relative site fidelity demonstrated by "Big Momma" during her interesting periods was not surprising as she was first tagged as a neophyte on Wassaw on July 4th, 1992 and has returned throughout subsequent nesting seasons, nesting twice in 1992 and in 1995, three times in 1997 and 4 times in 1999 and in 2001. In 2001, she stayed close to the south end of Wassaw Island and ventured up the adjacent tidal rivers, which is not unexpected as adult loggerheads are occasionally sighted in coastal rivers by recreational boaters.

Alessa was satellite-tagged on May 28th, 2001 after nesting on Wassaw. She then swam north, and based on her satellite location data, we suspect that she nested on Kiawah Island, S.C., another nesting beach utilized by Wassaw Island nesters as determined by inconel flipper tag recoveries. By Alessa's last transmission on July 30th she was off of Bald Head Island, N.C., where we have also gotten nesting reports of Wassaw's turtles.

Annie-O nested on Wassaw in late July, presumably after nesting on southern beaches earlier in the season, as we have identified numerous turtles on Wassaw that had previously been tagged on Little Cumberland, Jekyll, and Blackbeard Islands. She traveled as far north as Cedar Island, VA and remained in the Chesapeake Bay area from mid-August through mid-October. By the end of October she was off of Cape Hattaras and her last transmitted location was on Christmas Day, off of Bald Head Island, N.C.

These patterns of dispersal support evidence from tag returns reported to NMFS and UFL ACCSTR from various nesting beaches north and south of Wassaw National Wildlife Refuge (Williams and Frick 2001). There appears to be two distinct behavioral routes demonstrated by Wassaw Island nesters. That is, one group that shows a high level of site/area fidelity to Wassaw throughout the nesting season (May – August), whereas another group utilizes Wassaw to drop one clutch (either an early or a late clutch) before moving to another nesting beach or possibly to end of the season foraging grounds. Such "inter-island shifting" is common among loggerheads and occurs both within a nesting season and between seasons as previously reported in Bjorndal et al. (1983), Bell and Richardson (1978) and Williams and Frick (2001). All three turtles that were tagged after they had nested ultimately headed north, but their inter- nesting movements/behavior differed.

Our results also support the findings from two previous studies involving satellite tracking of Georgia's loggerhead sea turtles. Plotkin and Spotila (2002) and Mitchell (NOAA unpubl. data) attached a total of eight satellite transmitters to Wassaw's loggerheads in the summer of 1997. Seven of the eight transmittered turtles traveled north, similar to those from the present study, while one traveled south (Plotkin and Spotila 2002). This behavior (southward movement), while different than that displayed by this year's transmittered turtles, appears to be similar to other turtles that have been tracked off of the coast of Georgia. For instance, YOTO, an adult female captured at Gray's Reef National Marine Sanctuary on April 8th, 1998, displayed similar movements. When captured, she bore fresh wounds on her carapace, presumably evidence of a recent mating event. According to her satellite location data, it appears that YOTO returned to Gray's Reef in between what we suspect are nesting events on Jekyll, Wolfe, St. Simon's and Blackbeard Islands throughout the summer. Perhaps the southbound turtle from 1997 (Plotkin and Spotila 2002) displayed a behavior similar to YOTO's, utilizing more than one beach for nesting and remaining in Georgia waters throughout the season.

The movements of four of the aforementioned turtles led to the Chesapeake Bay/Delmarva Peninsula area before returning southward (to South and North Carolina area) in late fall (autumn), presumably as water temperature begins to drop (Coles and Musick 2000, Meylan et al. 1983, Shoop and Kenney 1992). One of Plotkin and Spotila's (2002) turtles moved to the Chesapeake Bay by early fall (September 10) but transmissions ceased at that time. Two of the three turtles tagged in 2001 (present study) showed similar movement from Wassaw. The Chesapeake Bay has long been documented as a productive foraging area for subadult and juvenile loggerheads (Coles and Musick 2000). However, the importance of this area to post-nesting loggerheads is not well known (Plotkin and Spotila 2002, present study).

Meylan et al. (1983) reports incidental sea turtle mortality in fishing gear set for commercial species. Such occurrences emphasize the need for the protection of turtles during their migrations to/or from breeding and foraging areas. Research on Australian loggerhead turtles indicates that at the end of the nesting season it is important for loggerhead sea turtles to migrate to foraging areas in order to replenish their fat reserves since they feed little or not at all for several months during their nesting cycle (Dodd 1988). It is presumed the same is true for Atlantic loggerheads as well. Currently these foraging areas and the corridors the turtles use to travel to these areas are unknown in the United States. Morreale et al. (1996) states the importance of locating post-nesting foraging areas and the routes or corridors utilized by turtles to these areas, primarily because the clustering of turtles in one area or route may render an entire population vulnerable to extirpation. More data on the migratory movements and preferred foraging habitats of loggerhead sea turtles are needed in order to protect turtles from in-water threats.

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LITERATURE CITED

Bell, R. and J.I. Richardson. 1978. An analysis of tag recoveries from loggerhead sea turtles (*Caretta caretta*) nesting on Little Cumberland Island, Georgia. Florida Mar. Res. Publ., 33:20-24.

Bjorndal, K.A., A.B. Meylan and B.J. Turner. 1983. Sea turtles nesting at Melbourne Beach, FL, I. Size, growth and reproductive biology. Biol. Cons. 26:65-77.

Bjorndal, K.A. and A.B. Bolten, eds. 2000. Proceedings of a workshop on assessing abundance and trends for in-water sea turtle populations. NOAA Tech. Memo. NMFS-SEFSC-445, 83 p.

Coles, W.C. and J.A. Musick. 2000. Satellite sea surface temperature analysis and correlation with sea turtle distribution off North Carolina. Copeia 2000:551-554.

Dodd, C.K. 1988. Synopsis of the biological data on the loggerhead sea turtle (*Caretta caretta*) (Linnaeus 1758). U.S. Fish and Wildl. Serv., Biol. Rep. 88. 110 p.

Meylan, A.B., K.A. Bjorndal and B.J. Turner. 1983. Sea turtles nesting at Melbourne Beach, Florida, II. Post-nesting movements of *Caretta caretta*. Biol. Cons. 26:79-90.

Mitchell, S.V. 1998. Use of epoxy in telemeter attachment. In: F.A. Abreu-Grobois, R. Briseno-Duenas, R. Márquez, and L. Sarti, comps. Proceedings of the eighteenth International Sea Turtle Symposium. NOAA Tech. Memo. NMFS-SEFSC -436, 293 p.

Morreale, S.J., E.A. Standora, J.R. Spotila and F.V. Paladino. 1996. Migration corridor for sea turtles. Nature. 384.

National Marine Fisheries Service Southeast Fisheries Science Center. 2001. Stock assessments of loggerhead and leatherback sea turtles and an assessment of the impact of the pelagic longline fishery on the loggerhead and leatherback sea turtles of the Western North Atlantic. NOAA Tech. Memo. NMFS-SEFSC-455, 343 p.

Plotkin, P.T. and J.R. Spotila. 2002. Post-nesting migrations of loggerhead turtles (*Caretta caretta*) from Georgia, U.S.A.: conservation implications for a genetically distinct sub population. Oryx. In press.

Shoop, C. R. and R. D. Kenney. 1992. Seasonal distributions and abundances of loggerhead and leatherback sea turtles in waters of the northeastern United States. Herp. Mono. 6, p. 43-67.

Turtle Expert Working Group. 1998. An assessment of the Kemp's ridley sea turtle (*Lepidochelys kempii*) and loggerhead (*Caretta caretta*) sea turtle populations in the Western North Atlantic. NOAA Tech. Memo. NMFS-SEFSC-409, 96 p.

Turtle Expert Working Group. 2000. Assessment update for the Kemp's ridley and loggerhead sea turtle populations in the Western North Atlantic. NOAA Tech. Memo. NMFS-SEFSC-4444, 115 p.

Williams, K.L. and M.G. Frick. 2001. Results from the long-term monitoring of nesting loggerhead sea turtles (*Caretta caretta*) on Wassaw Island, Georgia: 1973-2000. NOAA Tech. Memo. NMFS-SEFSC-446. 32 p.

Witzell, W.N. and J. Cramer. 1995. Estimates of sea turtle by-catch by the U.S. pelagic longline fleet in the western North Atlantic Ocean. NOAA Tech. Memo. NMFS-SEFSC-359.

First record of *Ozobranchus margoi* (Apathy 1890) (Annelida, Hirudinea) ectoparazitizing *Chelonia mydas* and *Caretta caretta* in the southwest Atlantic

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The genus *Ozobranchus* (Ozobranchidae) includes *O. branchiatus* (Menzie 1791) and *O. margoi* (Apathy 1890), being distinguished by the presence of 7 and 5 pairs of gills, respectively. With respect to geographic distribution and hosts, *O. branchiatus* can just be considered a rare circumglobal species, recorded in *Chelonia mydas*, while *O. margoi* was registered in Mediterranean and in tropical and subtropical waters of Atlantic and Pacific, ectoparasiting *Caretta caretta*, *C. mydas*, *Lepidochelys olivacea*, *Lepidochelys kempi* and *Eretmochelys imbricata*. In the southwest Atlantic, *O. margoi* was registered in the south of Brazil and Uruguay, in *P. blainvillei* (Cetacea) and *C. caretta*, respectively. Between 1995 and 2001, in the states of Santa Catarina and Rio Grande do Sul, collections of epibionts were made from *Dermochelys coriacea*, *C. caretta*, *C. mydas*, *L. olivacea* and *E. imbricata*, with all samples housed at the Museu Oceanografico do Vale do Itajai (MOVI). Hirudinean ectoparasites of the species *O. margoi* were registered in great number, paraziting both *C. mydas* and *C. caretta*. During this period, 8 cases of sea turtles were observed parasitized in the south of Brazil. In all the cases the specimens of *O. margoi* were mainly in the area of the cloaca, armpits, neck, eyes and mouth. The postures were observed in the flat parts of the host as, carapace, plastron and flippers.

Fibropapillomatosis on green turtles, *Chelonia mydas*, on the southern Brazilian coast

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Fibropapillomatosis (FP) is an illness that causes the growth of internal and external tumors. It is believed that the responsible agent is a herpesvirus. The first records of FP were in *Chelonia mydas*, later recorded in *Caretta caretta*, *Lepidochelys olivacea*, *Lepidochelys kempii*, *Natator depressus* and *Eretmochelys imbricata*. Around the world the number of infected sea turtles is quickly increasing and in certain areas such as Hawaii and Florida, the percentage of *C. mydas* infected surpasses 50%. In western South Atlantic, FP in sea turtles seemingly is not frequent, being just documented in *E. imbricata* in captivity. The Museu Oceanografico do Vale do Itajai (MOVI) has monitored the south coast of Brazil since 1989 and during this period there were two cases of FP, both in juvenile *C. mydas* (51.0 and 65.6 cm CCL) coming from the coast of Santa Catarina, between 26º45 S and 26º48 S. These turtles had external tumors up to 2.5 cm of length, located mainly at the base of the fins and neck. Both specimens were placed in the Section of Herpetology (MOVI 10372 and 16513). Of all examined (n=107), only two presented FP (1.8%), representing a low infection rate in specimens from the south of Brazil.

A documentation of the recovery efforts for three loggerhead sea turtles from boat-inflicted injuries

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Rehabilitation, up until a few years ago, was not an option for injured or sick sea turtles and many perished as a result. Now, facilities like the Karen Beasley Sea Turtle Rescue and Rehabilitation Center give those turtles a second chance at life. This report documents 3 different sea turtles cared for at the Center with differing boat propeller wounds. Each case study details the innovative surgical techniques, diligent daily care, and physical therapy treatments that aided each sea turtle's recovery. Since little is known about a sea turtle's healing response, this documentation is provided to not only increase our knowledge but also to act as a reference for other sea turtle rehabilitators. Boat propeller wounds are becoming more and more common; therefore, the more efficiently we can treat and release these turtles the quicker they can be back to normal and contribute to the growth of their population.

Trematode infection and resulting immunological mimetic in green sea turtles (*Chelonia mydas agassizii*) from Magdalena Bay, Baja California Sur, Mexico

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INTRODUCTION

Magdalena Bay, located on the west coast of the Baja California Peninsula, Mexico (25º43' N a 24º20' N), is an area with a constant presence of sea turtles. In this region, *Chelonia mydas agassizii* is commonly observed as fisheries bycatch, however their body conditions have rarely or never been reported (Gardner 2001). Single or mixed infection with trematodes of the family Spirorchidae (*Amphiorchis* sp., *Carettacola* sp., *Haemoxenicon* sp., *Neospirorchis* sp., *Monticellius* sp., *Hapalotrema* sp., *Learedius* sp. and *Squaroavetabulum* sp.) is the most common parasitic infection reported in sea turtles around the world. However, the life cycle for this parasite is unknown (Dyer 1991, Kinne 1985). Different regions have specific reports of trematode eggs and adult forms associated with clinical diseases (Caballero 1955, Dalley 1991, Dyer 1991, Glazebrook 1981, Rand 1983) including southwestern Mexico (Perez-Ponce de Leon 1996). This is the first histological report of severe parasitic infection in *Chelonia mydas agassizii* in Baja California Sur, Mexico.

METHODS

Necropsies were performed on 15 animals, collected as a result of incidental fishing mortality. Samples of organs and tissues were taken and processed by standard histological techniques and stained with eosin-hematoxylin to be observed under an optical microscope (Prophet 1992).

RESULTS

Parasitic trematode eggs were found dispersed in different tissues in 14 of 15 (93.4%) histological samples from sea turtles. Eggs were found in the brain, liver, lung, muscle, skin, spleen and kidney. The adult form of a trematode was found in intestine and heart. The parasitic egg structures were compatible with trematodes of the family spirorchidae (*Learedius* sp., *Hapalotrema* sp.). The eggs of this family are very similar in size and form: ovoid with polar filaments. In one turtle, 75 adults of *Learedius* sp. (Caballero 1955) were recovered in the heart chambers. Also, noteworthy was the observation that the parasitic structures found in muscle, lung, kidney, liver and skin were associated with low to no inflammatory response, based on the absence of granular cells, suggesting a lack of an immune response against this parasite. In one sample of pancreas and intestine a migratory line of eggs was found from pancreas to intestinal epithelium with low immunology response in connective tissue, but severe inflammatory response and necrosis in pancreatic tissue and the surface of the intestine villi associated with a high number of eggs in both tissues.

DISCUSSION

This is the first histological report of severe parasitic infection compatible with *Learedius* sp. in *Chelonia mydas agassizii* in Baja California Sur, Mexico. The lack of immune response to this parasite appears similar to parasitic infection in animals and humans by protozoans, using some factors inhibitors (Kretschmer 2000) and worms where the parasite presents an immunological mimetic when using cell proteins to cover its body, immunodepression is found associated with parasitic infection, that could be expected to cause metabolic alterations in different systems (respiratory, digestive, etc) of the animal (Pearce 1988). These findings differ from those of other investigators, where the parasitic eggs of marine spirorchids promote severe injuries to tissues (Glazebrook 1981, Rand 1985), hemodynamic changes (Aguirre 1998, Rand 1985), severe inflammatory infiltration and granulomatous response (Dyer 1991), immune and occasionally neoplastic response (Aguirre 1998, Dyer 1991, Rand 1985) and bacterial infection (Raidal 1998). The results from this work are in agreement with Glazerbrook's (1981) observations that the movement of Spirchids within the sea turtle body was through blood vessels. Moreover, in this work we observed that the eggs move and migrate across tissues. This study also found an increase in parasitic infection with increasing straight carapace length (Rand 1985). Other work reports egg migration across tissues outside of blood vessels, from parenquimal tissue to the intestinal lumen. This observation may provide meaningful information for determining the life cycle of trematodes (spirorchidae).

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LITERATURE CITED

Aguirre, A., T. Spraker, G. Balazs, and B. Zimmerman. 1998. Spirorchidiasis and fibropapillomatosis in green turtles from the Hawaiian islands. J. Wild. Dis. 34:91-98.

Caballero, E., D. Zerecero, and R. Grocott. 1955. Helmintos de la Republica de Panamá, Trematodos de *Chelone mydas* (L.) tortuga marina comestible del Océano Pacifico del Norte, 2a parte. An Inst Biol Mex XXVI, 1. p. 149-191.

Dalley, M., M. Fast, and G. Balazs. 1991. *Carettacola hawaiiensis* n. sp. (Trematoda: Spirorchidae) from the green turtle, *Chelonia mydas*, in Hawaii. J Parasitol. 77:906-909.

Dyer, W., E. Williams, and L. Bunkley-Wiliams. 1991. some digeneans (Trematoda) of green turtle, *Chelonia mydas* (Testudines: Cheloniidae) from Puerto Rico. J. Helmintol. Soc. Wash. 58:176-180.

Gardner, S. and W. Nichols. 2002. Assessment of sea turtles mortality rates in the Bahía Magdalena region, Baja California Sur, México. Chelon. Cons. Biology 4:197-199.

Glazebrook, J., R. Campbell, and D. Blair. 1981. Pathological changes associated with cardiovascular treamtodes (Dige nea: spirorchidae) in a green sea turtle *Chelonia mydas* (L). J Comp. Path. 9:361 368.

Kinne, O. 1985. Diseases of marine animal: volume 4, part 2. ed BAH. Germany.

Kretschmer, R. Rico, G, Giménez, J. 2000. Isolation and structural studies of the monocyte locomotion inhibitory factor (MLIF) produced by *Entamoeba histolytica*. Archives of Medical Research 31:76-77.

Pearce, J., P. Scott, and A. Sher. 1988. Immune Regulation in Parasitic Infection and Disease. In: W. Paul, ed. Fundamental Immunology 4th Lippincott-Raven.

Peréz-Ponce de León, L. García, and V. Leon. 1996. Gastrointestinal digenetic trematodes of olive ridley turtles (*Lepi dochelys olivacea*) from Oaxaca, México. Taxonomy and Infracomunity Structure. J. Helminthol. Soc. 63:76-82.

Prophet, E. 1992. Laboratory Methods in Histotechnology. Armed Forces Institute of Pathology. Washington, D. C. American Registry of Pathology.

Raidal, S., M. Ohara, R. Hobbs, and R. Prince. 1998. gram-negative bacterial infections and cardiovascular parasitism in green sea turtles (*Chelonia mydas*). Aust. Vet. J. 76:415-417.

Thomas, G. and Wiles, M. 1985. Histopathology of infections by *Learedius learedi* Price, 1934 and *Neospirorchis schistosematoides* Price, 1934 (Digenea: Spirorchiidae) in wild green turtles, *Chelonia mydas* L., from Bermuda. J. Wildl. Dis. 21:461-46.

Mercury contamination in loggerheads of the southeastern United States

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There is potential for heavy metals to have detrimental effects on marine vertebrates, and global sea turtle populations are all considered threatened or endangered. The long life span, high trophic level, and threatened status of loggerhead turtles, *Caretta caretta*, make them an ideal candidate for further mercury studies. This study uses blood and keratin collected from 34 loggerheads during a S.C. DNR in-water trawl survey from SC to Florida to provide non-lethal monitoring tissues from a broad range of sizes, and over a large geographic range. These results are combined with a more comprehensive tissue analysis (blood, keratin, skin, muscle, liver, kidney, nerve) performed on fresh stranded individuals to determine the relative proportion of mercury in a wider variety of tissues. Demonstrating the relationship between the Hg concentrations in blood and keratin and physiologically important systems such as the hepatic, renal, and nervous systems is crucial in understanding their utility in assessing sea turtle health. Sample analysis will be performed at the National Institute of Standards and Technology, Charleston, South Carolina, using isotope dilution cold vapor inductively coupled plasma mass spectrometry (ID-CV-ICP-MS). Unlike other analytical methods, ID-CV-ICP-MS combines the high accuracy technique of isotope dilution with the advantages of cold vapor sample injection. These results will provide baseline data for comparison to other populations, different life stages, to monitor changes in this population over time, to evaluate meso-scale geographic variation, and to provide a picture of the relative concentrations of Hg in various tissues for this species.

Rehabilitation of an adult leatherback turtle (*Dermochelys coriacea*)

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Clearwater Marine Aquarium

The Clearwater Marine Aquarium attempted to rehabilitate a severely injured adult female leatherback, *Dermochelys coriacea*, after stranding on Anna Maria Island, FL March 4, 2000. Rehabilitation efforts were focused on repairing the damaged flipper and treating the probable systemic infection resulting from wounds sustained to the carapace. Due to the logistics of caring for such a large and extremely delicate animal, several attempts were made to release this animal. All attempts failed. Eventually this animal began eating 14 lbs. of squid, however due to the nature of her wounds this animal eventually succumbed to system wide organ failure as a result of acute septicemia.

Prevalence of green turtle Fibropapillomatosis in three developmental habitats on the east coast of Florida

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All green turtles captured at study sites in the Indian River Lagoon (on Florida's Atlantic coast) from 1984 to 2000; over a nearshore reef off Indian River County, Florida from 1989 to 2000 and at a turning basin at Port Canaveral, Florida from 1993 to 2000, were examined for external fibropapilloma (FP) tumors. The complete absence of FP at Port Canaveral is in stark contrast to the prevalences in the lagoon (28-72%) and over the nearshore reef (8-21%). Just why FP has appeared in low frequency in the reef population in recent years but has remained completely absent in the Port Canaveral aggregation is an interesting epizootiological question. Physical characteristics (water quality, temperature, salinity, etc.) at the Port Canaveral basin are very similar to those of the nearshore reef habitat. One difference between the basin and the nearshore reef is that the reef habitat is located closer to the inlets that connect the Indian River Lagoon, where FP prevalence is constantly higher, to the ocean.

Pharyngeal nodules in the Hawaiian green turtle

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As part of an educational outreach program, Hawaiian green turtles (*Chelonia mydas*) from Sea Life Park on Oahu have been captive-bred and reared for display and released into the wild each year since 1990 at the Mauna Lani Bay Resort on the island of Hawaii (Balazs et. al. 2002). Prior to the anticipated ocean release on July 4, 2000, severe throat lesions resembling necrotic plaques and ulcers were noted in 17 of 18 two to three year old turtles ranging from 19.3 to 45.0 cm in straight carapace length. These turtles were returned to Sea Life Park and quarantined. The cause of the original lesions was never determined. They were speculated to be stomatitis possibly caused by bacteria, viruses, or parasites. Blood chemistries and complete blood counts of the turtles were normal.

After 18 months in quarantine, it was observed that most of the turtles had from 1-10 small throat nodules in the dorsal pharynx. These nodules could best be described as raised areas, some with erythema and others looking like a pimple with a white center (Fig. 1). The turtles had exhibited no other signs of illness and had thrived. Blood chemistries and complete blood counts continued to be normal. Throat cultures revealed various bacterial organisms, much the same as cultured from healthy wild green turtles in Hawaii. All viral cultures had been negative. The nodules did not resemble the original lesions, which were much more severe. No diagnosis as to the cause had been determined.

In January 2001 throat biopsies were obtained from five of the quarantined turtles placed under gas anesthesia at the Makai Animal Clinic. Samples were examined by the Armed Forces Institute of Pathology of the Department of Defense. The resulting histological diagnosis was stomatitis described as mild to moderate lymphohistiocytic and plasmacytic that was nodular and multifocal with epithelial hyperplasia and edema. One area of granuloma was seen associated with a trematode egg. No viral inclusions were noted. It was speculated that the lesions could be normal lymphoid aggregates that were enlarged from antigenic stimulation of unknown cause.

In September 2001 one of the affected turtles in quarantine with multiple nodules was placed under gas anesthesia for biopsies at the Makai Animal Clinic. Photos and tissue samples were obtained with endoscopic instruments (Fig. 1). The tissues were analyzed by the Veterinary Diagnostic Laboratory at Colorado State University. A diagnosis of nodular lymphoid hyperplasia was made. The aggregates of lymphocytes were considered benign and possibly normal. No viruses were isolated or detected by Douglas Docherty of the National Wildlife Health Center in Madison, Wisconsin.

Nodules similar to those present in the quarantined turtles at Sea Life Park were observed in healthy wild green turtles off the Kona Coast on the island of Hawaii. Many of the turtles sampled (30-80%) had one to five pharyngeal nodules. These nodules were discovered by careful deep oral exams using an intense light source. Biopsy samples from one of these turtles were obtained under gas anesthesia at the Makai Animal Clinic. The histological diagnosis by Colorado State University was nodular lymphoid hyperplasia with granulomas surrounding parasitic ova. Viral cultures by the National Wildlife Health Center were negative.

CONCLUSIONS

During the 18 months in quarantine the Sea Life Park turtles appeared healthy and showed no signs of illness. Blood chemistries and complete blood counts were normal. Appetite and growth rates were normal. No viruses were isolated. Because of these findings, and the observations of similar nodules in wild turtles, it was decided that the turtles could be safely released.

The accumulation of lymphocytes in the pharynx of green turtles may be normal, much like human tonsils. Antigenic stimulation from bacteria, viruses, or parasite ova may make the nodules more pronounced. Structures termed "pharyngeal tonsils" have been reported in green turtles (Winokur 1988, cited by Hirth 1997). They were described as five to seven "pits" in the median ventral pharynx, posterior to the glottis, consisting of large clusters of cells with densely staining basophilic nuclei. The pits reported by Winokur (1988) were not observed in the Hawaiian green turtles.

Spirorchid ova are common in the tissues of green turtles in Hawaii (Dailey and Morris 1995). Numerous species of bacteria inhabit the throats of normal Hawaiian green turtles (Morris unpublished data). This is the first description of pharyngeal nodules for green turtles in Hawaii. However, Douglas Mader (personal communication) has seen similar appearing nodules in some sea turtles in Florida. This study demonstrates the importance of a routine mouth exam, using a good light source, as a part of all sea turtle physical exams.

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LITERATURE CITED

Balazs, G.H., S.K.K. Murakawa, D.M. Parker, and M.R. Rice. 2002. Adaptation of captive-reared green turtles released into Hawaiian coastal foraging habitats, 1990-99. In: A. Mosier, A. Foley, and B. Brost, comps. Proceedings of the Twentieth Annual Symposium on Biology and Conservation. NOAA Tech. Memo. NMFS-SEFSC-477.

Dailey, M.D. and R. Morris. 1995. Relationship of parasites (Trematoda: Spirorchidae)and their eggs to the occurrence of fibropapillomomas in the green turtle (*Chelonia mydas*). Can. J. Fish. Aquat. Sci. 52 (suppl 1):84-89.

Hirth, H.F. 1997. Synopsis of the biological data on the green turtle, *Chelonia mydas* (Linnaeus 1758). Fish and Wildlife Service, Biological Report 97(1), 120 p.

Winokur, R.M. 1988. The buccopharyngeal mucosa of the turtles (Testudines). Journal of Morphology 196:33-52.

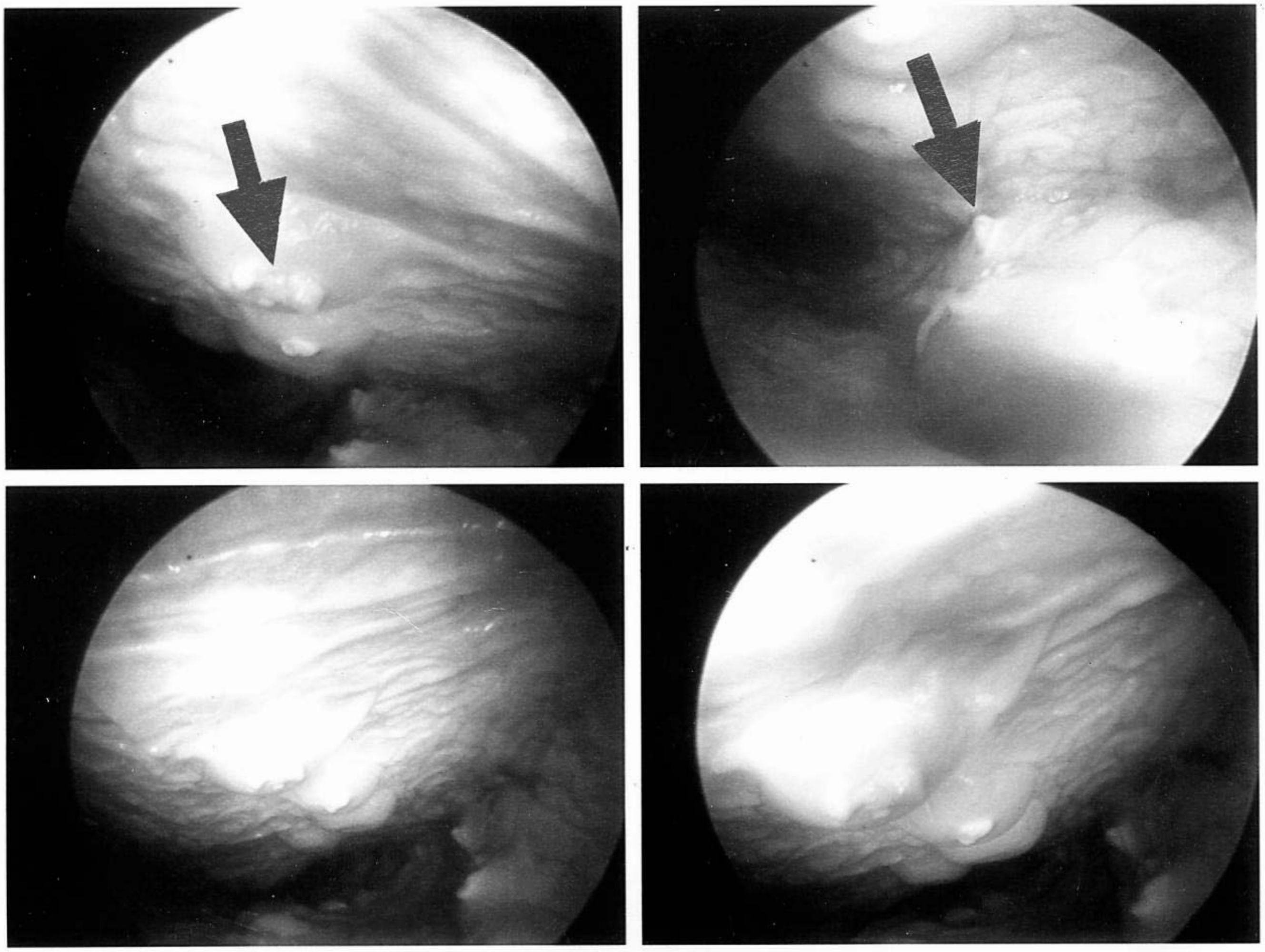

Fig. 1. Endoscopic photographs of pharyngeal nodules in the Hawaiian green turtle.

Heavy metals in marine turtles from the Adriatic Sea

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Loggerheads are endangered in the Mediterranean and one of the main threats is pollution. The Adriatic Sea is a semi-closed system and upon its shores impinge some relatively large centres of human population; levels of marine contaminants in this ecosystem are considered to be relatively high. Heavy metals are one of the potential contaminants in loggerhead turtles. To investigate the rate of this potential samples of liver, kidney, muscle, adipose tissue and bone from ten dead turtles were collected for heavy metals analysis. A range of cadmiun, chromium, lead, and mercury were determined using acid digestion (except for mercury) HNO_3 67% v/v (Suprapur Merck) and H_2O_2 30% v/v (Aristar – BDH) with microwave heating followed by analysis using atomic absorption spectrophotometry in a Zeeman graphite furnace for cadmiun, chromium, and lead. Total mercury was analysed using automatic solid/liquid analyzer AMA-254. All analyses were conducted under an analytical quality protocol requiring the analysis of blanks and reference materials. Maximum mercury concentrations are in liver and kidney tissues, respectively 2.62 (g/g and 2.64 (g/g dry weight and, on the contrary, low in bone (0.005 (g/g dry weight). Lead and chromium are high in bone, respectively 10.9 (g/g and 32.9 (g/g dry weight). Cadmium concentrations were the highest in liver tissue and present, in decreasing order, in kidney, muscle, adipose tissue and bone. Data recorded, although based on a relatively small number of turtles, provide evidence that concentrations of heavy metals in this species could be useful in environmental impact assessment.

Fungal colonization of sea turtle nests in eastern Australia

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During this investigation, loggerhead (*Caretta caretta*), green (*Chelonia mydas*), flatback (*Natator depressus*) and hawksbill (*Eretmochelys imbricata*) sea turtles nests at Heron Is., Mon Repos, Peak Is. Milman Is. and Wreck Is. in eastern Australia were examined for fungal colonization of eggs. The fungi *Fusarium oxysporum*, *Fusarium solani* and *Pseudallescheria boydii* were regularly isolated from failed eggs in nests of all turtle species at all rookeries. Fungi appeared as a black growth on the exterior of failed eggs. It was never observed on hatched eggshell. Since *F. oxysporum*, *F. solani* and *P. boydii* are all common soil saprophytes, their most likely source is the nest substrate. However, the cloacal mycobiota of nesting green turtles suggests acute, intra-seasonal contamination of the oviduct may occur and, therefore, inclusion of fungal hyphae and spores within the egg may be possible. Fungal colonization of the sea turtle nest begins at a naturally failed egg that acts as a nutrient source and subsequent focus of infection, from which hyphae spread to encompass adjacent, viable eggs. The resulting embryo mortality may be due to inhibition of the respiratory surface, calcium depletion of the eggshell or invasion of embryonic tissue by fungi. Analysis of neonate morphometrics suggests hatchlings emerging from infected nests have not been adversely affected by fungal colonization of adjacent eggs.

Marine debris ingested by green turtles in the Ogasawara Islands, Japan

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Artificial objects found at the gastrointestinal tracts of the green turtles in the Ogasawara islands were quantitatively investigated. The samples were collected from 25 adult males and 11 gravid females slaughtered in Hahajima island from March to May in 2001. The samples were firstly filtered by a sieve (1x1 mm), and divided into different material groups. The groups were scaled respectively. Plastic sheets, plastic blocks, monofilament lines, rubbers and Styrofoam were found. There are no significant differences on the frequency and amounts of the artificial objects between the sexes. In a sample of 36 adult greens, 11 (30.6%) contained the artificial objects at their stomach, and 25 (69.4%) had debris in their intestines. The plastic sheets which are remnants of plastic bags, are most common, and the maximum size was 20 x 75 cm. A green turtle had intestinal obstruction, and most turtles had some inflammations in the gastrointestinal tracts.

Lymphocyte proliferation in loggerhead sea turtles: seasonal variations and contaminant effects

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The immune system, the body's defense against invading pathogens, is vital to the health and survival of any animal. The effectiveness of the immune system to fight diseases can be reduced by a number of natural and anthropogenic factors, such as malnutrition, disease states, seasonal changes, and contaminant exposure. One common method of measuring the strength of the immune system is the mitogen-induced lymphocyte proliferation (LP) assay. The goals of our study were to optimize the LP assay for juvenile loggerhead turtles and to examine how natural and man-made factors influence the loggerhead immune system. Live, juvenile loggerheads were captured in the pound net fishery of Core Sound, North Carolina, USA. Blood samples were used for the LP assay, and both blood samples and fat biopsies were collected for contaminant analysis. Two different methods of measuring LP were compared; 1) the traditional radioactive 3H-thymidine assay and 2) a non-radioactive method utilizing MTT. The 3H-thymidine assay resulted in higher LP values and is recommended over the non-radioactive MTT method. A seasonal change in the immune system was observed. LP was generally lower in September and November than in July. Similarly, white blood cell (WBC) counts were lower during May and the fall months than during the summer (June to August). These changes were related to water temperature and photoperiod as observed in other reptile studies. Gender or body condition (weight to length ratio) did not influence LP. When LP from July samples was compared to organochlorine concentrations, the turtles with higher levels of organochlorines (total PCBs, mirex, dieldrin, oxychlordane, trans-nonachlor, and 4,4'-DDE) unexpectedly exhibited increased LP. This is the first study showing a seasonal change in the immune system of a sea turtle species and the first to examine possible contaminant effects on sea turtle immunity.

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Coagulatin and platelet aggregation in sea turtles

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INTRODUCTION

Leatherback turtles are an endangered species whose populations are declining rapidly at nesting beaches in the Indian and Pacific Oceans (Spotila et al. 1996). One of the few populations left in the Pacific is that at Las Baulas National Park in Guanacaste, Costa Rica. While there is considerable data on the physiology of these and other sea turtles, there is virtually no information of the properties of turtle blood. The need for an efficient hemostatic pathway in sea turtles is high due to their coexistence with sharks and other large predators in their natural habitat. The compositional analysis of turtle blood cell types and numbers along with the macro-molecules of their plasma is important to our understanding of hemostasis in these animals. With little known about turtle blood we need to look at other systems for potential background. The platelets and red blood cells of land, air and seagoing birds (O'Toole et al. 1994, DaMatta et al. 1999), of turtles and other reptiles (Daimon et al. 1987) and of amphibians (Gronert et al. 1995) are nucleated cells unlike their mammalian counterparts. Avian platelets aggregate in response to collagen, serotonin and thrombin, but not the mammalian agonist, ADP. They require fibrinogen (Stiller et al. 1975, O'Toole et al. 1994) for aggregation and while no mention is made, one would presume that a GP IIb/IIIa-like integrin is also involved. There have been a few reports dealing with coagulation factors in birds. Ostrich plasma was found to contain some coagulation factors that were presumably analogous to human factors but also was deficient in many corresponding factors (Frost et al. 1999). The cDNA sequence for ostrich prothrombin (Frost et al. 2000) and for the B chain of thrombin from nine different species, including chicken, gecko and newt (Banfield and MacGillivray 1992) contain a large amount of sequence identity with mammalian species. Our studies address platelet aggregation and coagulation in five sea turtle species.

METHODS

Whole blood samples are collected from the cervical sinus cavity and mixed with sodium citrate (3.2%) 9:1. Platelet aggregations, measured as a percent change in resistance (ohms), are conducted with whole blood samples by our recently developed microassay system (Goldenberg et al. 2001). Agonists employed include: ADP; alpha-, beta- and gamma-thrombins; collagen and the thromboxane A2 mimetic, U46619. Ristocetin is also employed to determine if turtles have von Willebrand factor (vWF)-GP Ib interactions.

Coagulation studies are conducted with turtle plasma prepared by centrifuging whole blood at 6000 RPM for 5 minutes. The cell free plasma is then tested for both the extrinsic and intrinsic coagulation pathways with standard PT (prothrombin time) and aPTT (activated partial thromboplastin time) kits from Diagnostic Stago according to their protocol. The turtle plasma is also tested as potential replacement for the coagulation factors in human factor deficient plasmas obtained from Sigma Diagnostics according to their standard protocols. Our preliminary studies were conducted with a single volume of turtle plasma (20 µl) plus 80 µL human factor-deficient plasma.

FACS analysis is conducted with turtle blood components employing a battery of antibodies against known platelet specific and RBC specific surface antigens exactly as we previously described (Morgan et al. 1997). Cells are analyzed using the laser cell sorter FACSort (Bectin-Dickenson, San Jose, CA).

RESULTS

Platelet Aggregation. Turtle platelets can be induced to aggregate by collagen and to a minor extent with thrombin but not by the commonly employed human agonist, ADP, as was also found with avian platelets. They were also insensitive to the thromboxane A2 mimetic, U46619, plus or minus epinephrine which is different than described for the nucleated platelets of rainbow trout, *Oncorhynchus mykiss*, (Hill et al. 1996). The Green turtle appeared to have the strongest response to collagen but the weakest response to ristocetin of all five species analyzed.

Human platelets posses three different thrombin receptors, GP Ib, PAR-1 and PAR-4. alpha-Thrombin activates GP Ib and PAR-1 while its proteolytic products beta- and gamma- thrombins only function with PAR-4 (Soslau et al. 2001, Soslau et al. 2001b). In sea turtles a-thrombin alone yields minimal or no reaction. Gamma- Thrombin alone induces no reaction. Ristocetin alone gives a variable but positive reaction. However, incubation of turtle blood for 2-4 min with alpha- plus gamma-thrombin followed by the addition of ristocetin gives an immediate, very large reaction. The beta-thrombin species induced a strong platelet response in preliminary studies with Leatherback samples.

Most of our platelet aggregation studies were conducted with freshly isolated blood. One study compared day old blood versus fresh samples and it was found that about 50% activity is lost. Therefore, it is essential to work with fresh whole blood samples. Finally, cultured turtle platelets, at times up to six days in culture, gave similar responses to whole blood.

Coagulation. Turtles possess coagulation factors that can replace human factors as functional enzymes. This latter point was ascertained by mixing studies where 20mL of turtle plasma was added to 80mL human plasma deficient in the different coagulation factors. All of the human factors could be replaced by turtle factors except for two factors in the intrinsic pathway, factors XI and XII. The PT data (extrinsic) and the aPTT data (intrinsic) demonstrate that all of the sea turtle species possess an extrinsic but no functional intrinsic coagulation pathway.

DISCUSSION

Hemostasis in humans occurs by overlapping and reiterative pathways. Presumably apparent duplicated pathways reinforce each other or are operative under different conditions. In some instances loss of one pathway may not greatly effect hemostasis overall. The sea turtles do not appear to possess overlapping hemostatic pathways. The implication is that as long as there is no genetic defect in any significant pathway the machinery they possess is sufficient to maintain normal hemostasis. What we have found in a limited number of experiments is that five species of sea turtles, including Leatherbacks, have only one coagulation pathway – the extrinsic pathway. There is no evidence at this time for an intrinsic coagulation pathway. These turtles also appear to have a very reactive ristocetin-induced GP Ib-vWF agglutination reaction associated with their platelets.

We have found that some turtle blood cell proteins are cross-reactive with the human platelet specific glycoprotein Ib (GP Ib) and GP IIb/IIIa by FACS analysis. In humans GP Ib is the normal receptor for vWF (Ruggeri and Wari 1993) and for alpha- thrombin (Soslau et al. 2001). GP Ib-vWF complexes play a central role in platelet adhesion to the exposed subendothelium at sites of vessel damage (Ruggeri and Ware 1993). In vitro analysis of the human GP Ib-vWF complex formation involved in platelet adhesion/agglutination can be assessed by inducing the reaction with ristocetin (Hoylaerts et al. 1995). The fact that we see ristocetin-induced agglutination of turtle platelets implies the reaction occurs at the site of the FACs detected GP Ib and that turtles possess vWF-like proteins that can complex with these GP Ib-like proteins. The implication is that the alpha- and gamma-thrombin receptors cross-talk with the vWF-ristocetin receptor by mechanism yet to be resolved. This is an important point to help determine if one or more human-like thrombin receptors are present on turtle platelets and if evolutionary correlates could be established for these proteins.

Since the preliminary coagulation studies were conducted with a single concentration (due to limited sample size) it is impossible to quantitate the contribution of the turtle factor as compared between species. Future studies would titrate the reaction mixtures. What is clear is that the lack of the intrinsic coagulation pathway, as it appears in humans, is not due to the inability of the aPTT Kit to induce a turtle factor coagulation pathway but rather the lack of factor XII and XI-like proteins. Ostrich plasma has also been reported to lack factors XII and XI, but unlike turtles, factors VII, IX and X also seem to be absent (Frost et al. 1999). Many aspects of mammalian embryos resemble primordial ancestral features, therefore, it is particularly interesting that the murine embryo lacks FXII but expresses all of the factors required for the extrinsic pathway (Ong et al. 2000). Factor XI was not analyzed. Turtle blood also contains the anticoagulants, heparin and antithrombin (Jordan 1983).

Turtles do not appear to posses one of the two overlapping coagulation pathways nor a number of the reiterative platelet responsive receptors corresponding human receptors. However, while limited in overlapping pathways, what turtles have is sufficient to rapidly develop a stable clot at the site of vessel damage. They have: (1) the vWF-GP Ib pathway to facilitate platelet adhesion to the damaged vessel wall to act as an immediate protective cell layer to limit/reduce blood loss; (2) a thrombin- and a collagen-induced platelet aggregation pathway such that collagen exposed in the subendothelium will cause the recruitment of more platelets to build up a multilayered aggregate of platelets at the damaged site-a soft clot; (3) an unusually high concentration of plasma fibrinogen that is about 10X more than found in mammals; (4) the fibrinogen receptor, GP IIb/IIIa (by FACS) which can be partially blocked by the RGDS peptide or fully blocked when added along with the peptide, GPRP, which inhibits fibrin polymerization, and finally; (5) the extrinsic coagulation pathway to form polymerizing fibrin to interact with the growing platelet aggregate to yield a stable hard clot for a rapid and efficient hemostatic process.

LITERATURE CITED

Banfield, D.K. and R.T. MacGillivray. 1992. Proa. Natl. Acad. Sci. 89:2779-2783.

Daimon, T., Y. Gotoh, and K.J. Uchida. 1987. Anat. 153:185-190.

DaMatta, R.A, L. Manhaes, E. Lassounskaia, and W. de Souza. 1999. Tissue Cell. 31:255-263.

Frost, C.L., R.J. Naude, W. Oelosfen, and B. Jacobson. 1999. 45:75-81.

Frost, C.L., R.J. Naude, W. Oelosfen, K. Muramoto, T. Naganuma and T. Ogawa. 2000. Int. J. Biochem. Cell Biol. 32:1151-1159,

Goldenberg, S.J., N.J. G.Veriabo Soslau. 2001. Thromb. Res. 103:57-61,

Gronert, K., S.M. Virk, and C.A. Herman. 1995. Biophys. Acta 1259:203-210.

Hill, D.J. and A.F. Rowley. 1996. Br. J. Haemotol. 92:200-211.

Hoylaerts, M.F., K. Nuyts, K. Peerlinck, H. Deckmyn, and J. Vermylen. 1995. Biochem. J. 306:453-463.

Jordan, R.E. 1983. Arch. Biochem. Biophy. 227:587-595.

Morgan, D.A., R. Class, G. Soslau, and I. Bodsky. 1997. Exptl. Hematol. 25:1378-1385.

O'Toole, E.T., R.R. Hantgan, J.C. Lewis. 1994. Exptl. Mol. Path. 61:175-190.

Ruggeri, Z. and J. Ware. 1993. vonWillibrand factor. FASEB J 7:308-316.

Soslau, G., S.J. Goldenberg and R. Class. 2001a. R. FASEB J. 15, A896.

Soslau, G., R. Class, D.A. Morgan, C. Foster, S.T. Lord, P. Marchese and Z.M. Ruggeri. 2001b. J. Biol. Chem. 276:21173-21183.

Spotila, J.R., A.E. Dunham, A.C. Steyeremark, P.T. Plotkin and F.V. Paladino. 1996. Chelonian Conserv. Biol. 2:209-222.

Stiller, R.A., F.A. Belamarich, and D. Shepro. 1975.. Am. J. Physiol. 229:206-210.

Ong, K., W. Horsfall, E.M. Conway, and A.C. Schuh. 2000. Thromb. Haemost. 84:1023-1030.

Cytokine mediated proliferation of sea turtle peripheral blood cells in suspension cultures

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INTRODUCTION

Cell cultures have been established from samples derived from several different turtle tissues (Lu et al. 1999). However, no such reports have been published for cells derived from turtle blood. There are also no reported attempts of maintaining turtle blood cells for prolonged periods in vitro while the one reported attempt with chicken blood cells was unsuccessful (Da Matta et al. 1999). This group found that thrombocytes died after 24 hours. We report new information on the potential of circulating turtle blood: (1) to survive for at least three weeks in culture and retain cell-specific functions and morphology; (2) to respond to cytokines specific for human hematopoiesis; (3) to be induced into proliferation with the generation of newly synthesized proteins; and (4) to identify proteins conserved during evolution as reflected by the cross-reactivity of monoclonal antibodies against human proteins with sea turtle proteins Our approach to the study of sea turtle hematopoiesis using reagents generated against human cells, nevertheless, will permit the generation of species-specific reagents that are currently not available.

METHODS

Specimen collection and processing. Heparinized blood was obtained from the sinus cavity in the neck region of five species of sea turtles and stored at ambient temperature until received in the laboratory 24 hours after collection. Blood smears were made after removing 0.1mL of whole blood. Specimens were then centrifuged for 5 min at 1500 rpm, the plasma removed and the cell mass diluted with NaCl in preparation for density centrifugation. Aliquots of 35mL of diluted blood were layered over 15 mL of Ficoll-Hypaque (Pharmacia), centrifuged for 30 min at 480xg and cells at the blood:Ficoll interface were removed. After washing in NaCl, the cells were resuspended in nutrient medium RPMI (CellGro) containing a final concentration of 10% fetal calf serum (FCS.

Cell Culture. Cells in nutrient medium were placed into 6-well culture plates (Nunc) at a total vol of 8mL with and without cytokine (R*and*D Research Systems) supplements as follows: 25ng/mL stem cell factor (SCF), 5ng/mL granulocyte-macrophage colony-stimulating factor (GM-CSF) and interleukin 3 (IL3), 20ng/mL thrombopoietin (TPO), and 4u/mL erythropoietin (EPO). Cells were incubated at 37°C in 5% CO_2 and a humidified atmosphere. At selected time intervals, cells were removed for cell counts by trypan exclusion and cytocentrifuge (Shandon Cytospin) preparations that were subsequently stained with a hematological differential Wright-Giemsa stain (Sigma) or fixed in cold methanol for 20 min and stored at -20o C until used.

Immunofluoroscopy. Methanol-fixed cells were hydrated in phosphate buffered saline (PBS) 5 minutes prior to the addition of 10uL of primary antibody followed by a 20 min incubation at 37°. After a PBS wash for 10 min, the cells were incubated as described with 10uL of a FITC labeled anti-mouse antibody and washed prior to examination using a Zeiss immunofluorescence microscope.

Flow cytometry. Cells were washed in PBS and pellets resuspended in 1mL of PBS at ambient temperature and incubated with 20 uL of FITC-conjugated antibody for 40 min at 4oC. Cells were washed, resuspended in 1 mL of count solution and analyzed for fluorescence in a FACSort flow cytometer (Becton Dickinson).

Isotope labeling of proteins. Cells from cytokine supplemented cultures were incubated with 10 uCi of 35 S-methionine/cytosine for 24 hr at 37° C. Cell lysates were electrophoresed on a 15% PAGE gel and exposed overnight on film.

Electron microscopy. Cells were pelleted in a microcentrifuge tube and overlayed with 2% glutaraldehyde, post-fixed with OsO_4 and embedded in epon. Ultra-thin sections were stained with uranyl acetate and lead citrate.

RESULTS AND DISCUSSION

Blood smears from five different species of sea turtles showed well-identified eosinophils and mononuclear cells. Nucleated platelets with morphology resembling mononuclear cells usually appeared in clusters. Most interesting, however, was the heterogeneity of the erythrocytes. Cells with a more immature nucleus and dense nuclear membrane were not uncommon. A few cells appeared lighter in cytoplasm staining, more irregular in shape and usually full of vacuoles. Another interesting feature observed using the fluorescent microscope was a single cytoplasmic inclusion body in each erythrocyte. These structures were not detected in the routine hematological staining. Most likely the intense hemoglobin colorization masked these structures.

Even though human embryonic, fetal and adult globin chains were not detected in blood smear erythrocytes, embryonic globin was strongly positive in the cytoplasm as well as the nuclei of some cultured erythrocytes independent of the presence of cytokines. Globin chains detected by a monoclonal antibody against human embryonic epsilon were located in the nucleus of both positively stained cells and detected also in the cytoplasm of some cells.

Cells with basophilic cytoplasm reflecting immaturity and increased protein synthesis were observed only in cytokine supplemented cultures. Activated lymphocytes as the source of mitotic cells were ruled out by flow cytometry. Eosinophils were actively proliferating. A cell in prophase appeared to have an intact nuclear membrane. This phenomenon was observed several times even though the nuclear membrane usually dissolves when a cell undergoes mitosis. The chromosomes in telephase have migrated to opposite sides of the cell prior to cytokinesis.

Cell cycle analysis showed 8.5% of the cells were proliferating. The mitotic cells were actively synthesizing new proteins. Cytokine driven cells after 17 days in culture were labeled with 35S -methionine and cell extracts run on an electrophoresis gel. A wide range of labeled proteins was observed

P-selectin was present in the nucleus of control platelets after 17 days of culture without cytokines. Nuclear localization of this cell adhesion molecule was lost when cells were cultured with cytokines. Only membrane/surface p-selectin was observed. This cytokine effect in mobilizing proteins from the nucleus to the cell surface will be of interest in future studies.

The ultrastructure of sea turtle platelets was visualized by electron microscopy. Even though the platelets at Day 6 of culture retain the capacity to aggregate, these cells were devoid of mitochondria, endoplasmic reticulum, Golgi and other organelles common to most cells with an active metabolic status, regardless of species.

The response of turtle cells to human cytokines and the sustained biological properties of platelets identify the suspension culture system as a powerful tool for an in-depth study of sea turtle hematopoiesis.

LITERATURE CITED

Lu Y., V.R. Nerurkar, A. Aguirre. T.M. Work, G.H. Balazs, and R. Yanagihara. 1999. Establishment and characterization of 13 cell lines from a green turtle (*Chelonia* mydas) with fibropapillomas. In Vitro Cell Dev. Biol. Anim. 37:389-393.

DaMatta R.A, l. Manhaes, e. Lassounskaia, and W. de Souza. 1999. Chicken thrombocytes in culture: lymphocyte-conditioned medium delays apoptosis. Tissue Cell 31:255-263.

Bacteremia in free-ranging Hawaiian green turtles with Fibropapillomatosis

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Past studies of free-ranging green turtles with fibropapillomatosis have shown that animals become immunosuppressed with increasing severity of disease. Additionally, pilot studies have revealed that some animals that strand with severe FP also have circulating bacteria in their blood stream (bacteremia). To test the hypothesis that in addition to being immunosuppressed, turtles with FP are also bacteremic. We captured free-ranging green turtles from the Kona coast, Hawaii where FP is absent and from Kaneohe Bay, Oahu where FP is endemic. Each turtle was given an FP severity score ranging from 0 (non-tumored) to 3 (severely tumored). A fifth category included turtles that were stranded on land. We found that percent of turtles with blood cultures positive for bacteria increased with severity of FP and that the majority of bacteria cultured were Vibrio sp. These data continue to support the hypothesis that immunosuppression is a sequela to FP rather than a pre-requisite and that debilitated turtles offer a permissive environment for bacterial growth in their blood.