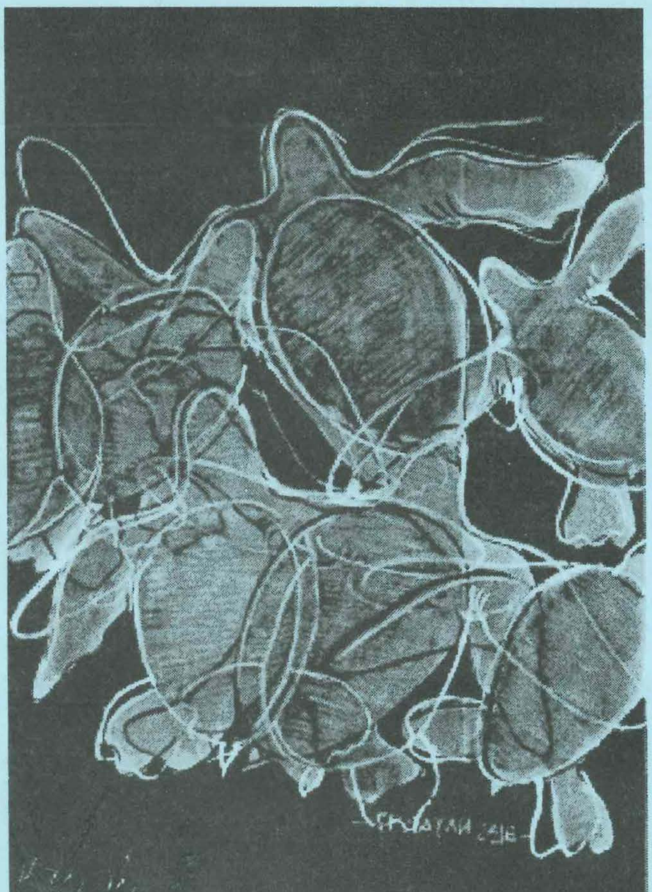
NOAA Technical Memorandum MFS-SEFSC-436

PROCEEDINGS OF THE EIGHTEENTH INTERNATIONAL SEA TURTLE SYMPOSIUM



3 - 7 March, 1998
Mazatlán, Sinaloa
México

Compilers

F. Alberto Abreu-Grobois
Raquel Briseño-Dueñas
René Márquez-Millán
Laura Sarti-Martínez

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
June 2000

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U. S. DEPARTMENT OF COMMERCE
William M. Daley, Secretary

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
D. James Baker, Administrator

NATIONAL MARINE FISHERIES SERVICE
Penelope D. Dalton, Assistant Administrator for Fisheries

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PREFACE

For the first time in its history, the International Symposium on Sea Turtle Biology and Conservation migrated to a site outside of the United States. Thus the Eighteenth edition was hosted by the Mazatlán Research Unit of the Instituto de Ciencias del Mar y Limnología of the Mexican National Autonomous University (UNAM) in Mazatlán, Sinaloa (Mexico) where it was held from 3-7, March, 1998.

Above all, our symposium is prominent for its dynamism and enthusiasm in bringing together specialists from the world´s sea turtle populations. In an effort to extend this philosophy, and fully aware of how fast the interest in sea turtles has grown, the organizers paid special attention to bring together as many people as possible. With the tremendous efforts of the Travel Committee and coupled with a special interest by the Latin American region´s devotees, we managed to get 653 participants from 43 countries. The number of presentations increased significantly too, reaching a total of 265 papers, ranging from cutting-edge scientific reports based on highly sophisticated methods, to the experiences and successes of community-based and environmental education programs.

A priority given by this symposium was the support and encouragement for the construction of "bridges" across cultural and discipline barriers. We found success in achieving a multinational dialogue among interest groups- scientists, resource managers, decision makers, ngo's, private industry. There was a broad representation of the broad interests that stretch across these sectors, yet everyone was able to listen and offer their own best contribution towards the central theme of the Symposium: the conservation of sea turtles and the diversity of marine and coastal environments in which they develop through their complicated and protracted life cycle. Our multidisciplinary approach is highly important at the present, finding ourselves at a cross roads of significant initiatives in the international arena of environmental law, where the conservation of sea turtles has a key role to play.

Many, many people worked hard over the previous 12 months, to make the symposium a success. Our sincerest thanks to all of them:

Program committee: Laura Sarti (chair), Ana Barragán, Rod Mast, Heather Kalb, Jim Spotilla, Richard Reina, Sheryan Epperly, Anna Bass, Steve Morreale, Milani Chaloupka, Robert Van Dam, Lew Ehrhart, J. Nichols, David Godfrey, Larry Herbst, René Márquez, Jack Musick, Peter Dutton, Patricia Huerta, Arturo Juárez, Debora Garcia, Carlos Suárez, German Ramírez, Raquel Briseño, Alberto Abreu; *Registration and Secretary*: Jane Provancha (chair), Lupita Polanco; *Informatics*: Germán Ramírez, Carlos Suárez; *Cover art*: Blas Nayar; *Designs*: Germán Ramírez, Raquel Briseño, Alberto Abreu. Auction: Rod Mast; *Workshops and special meetings*: Selina Heppell; *Student prizes*: Anders Rhodin; *Resolutions committee*: Juan Carlos Cantú; *Local organizing committee*: Raquel Briseño, Jane Abreu; *Posters*: Daniel Ríos and Jeffrey Semminoff; *Travel committee*: Karen Eckert (chair), Marydele Donnelly, Brendan Godley, Annette Broderick, Jack Frazier; *Student travel:* Francisco Silva and J. Nichols; *Vendors*: Tom McFarland and J. Nichols; *Volunteer coordination*: Richard Byles; *Latin American Reunión:* Angeles Cruz Morelos; *Nominations committee*: Randall Arauz, Colleen Coogan, Laura Sarti, Donna Shaver, Frank Paladino. Once again, Ed Drane worked his usual magic with the Treasury of the Symposium

Significant financial contributions were generously provided by government agencies. SEMARNAP (Mexico´s Ministry of Environment, Natural Resources and Fisheries) through its central office, the Mazatlán Regional Fisheries Research Center (CRIP-Mazatlán) and the National Center for Education and Capacity Building for Sustainable Development (CECADESU) contributed to the logistics and covered the costs of auditoria and audiovisual equipment for the Symposium, teachers and their hotels for the Community Development and Environmental Education workshop in the 5th Latin American

Sea Turtle Specialists; DIF (Dept of Family Affairs) provided free accomodation and food for the more than 100 participants in the Latin American Reunion. In this Reunion, the British Council-Mexico sponsored the workshop on the Project Cycle. The National Chamber of the Fisheries Industry (CANAINPES) kindly sponsored the Symposium´s coffee breaks. Personnel from the local Navy (Octave Zona Naval) provided invaluable aid in transport and logistics. The Scientific Coordination Office from UNAM (CIC-UNAM) and the Latin American Biology Network (RELAB) also provided funding. Our most sincere recognition to all of them

In the name of this Symposium´s compilers, I would like to also express our gratitude to Wayne Witzell, Technical Editor for his guidance and insights and to Jack Frazier for his help in translating and correcting the English of contributions from some non-native English speakers. Many thanks to Angel Fiscal and Tere Martin who helped with the typing in the last, last corrections and editions for these Proceedings.

To all, from around the world, who generously helped make the 18th Symposium a huge success, shared their experiences and listened to ours, our deepest gratitude!

F. Alberto Abreu-Grobois
Eighteenth International Sea Turtle Symposium President

EIGHTEENTH INTERNATIONAL SEA TURTLE SYMPOSIUM

CONTENTS

PART I. ORAL PRESENTATIONS

I. ANATOMY AND PHYSIOLOGY

II. CONSERVATION AND MANAGEMENT.

V. METHODS IN CONSERVATION AND MANAGEMENT.

VI. MODELING AND POPULATION BIOLOGY.

VII. NESTING AND FORAGING BEHAVIOR.

VIII. NESTING BEACHES.

IX. PHYSIOLOGY AND BEHAVIOR.

PART II. POSTER PRESENTATIONS.

I. ANATOMY AND PHYSIOLOGY.

II. CONSERVATION AND MANAGEMENT.

V. METHODS IN CONSERVATION AND MANAGEMENT.

VI. MODELING AND POPULATION BIOLOGY.

VII. NESTING AND FORAGING.

VIII. NESTING BEACHES.

COMPARATIVE STUDIES OF RETINAL DESIGN AMONG SEA TURTLES: HISTOLOGICAL AND BEHAVIORAL CORRELATES OF THE VISUAL STREAK

Lisa DeCarlo, Michael Salmon, and Jeanette Wyneken
Department of Biological Sciences, Florida Atlantic Univ, Boca Raton Fl 33431, U.S.A. LDeCarlo19@AOL.com

Sea turtles use vision in a number of important contexts such as habitatat selection, avoiding predators, and orienting toward food or mates (Granda and Maxwell, 1978). However, our understanding of relationships between eye anatomy and marine turtle ecology is rudimentary. In this study, we determine (i) if the retinal (ganglion) cell distribution differs among three marine turtles (Caretta caretta, Chelonia mydas, and Dermochelys coriacea), (ii) whether species possess behavioral reflexes consistent with one such retinal specialization (a "visual streak"), and (iii) whether the results can be related to the ecology of each species.

Retinas were obtained from fresh, natural-mortality specimens (usually, hatchlings that died in the nest). Isodensity contour maps of ganglion cells were constructed from cell counts made from whole-mounted retinas, using Nomarski Differential Interference phase contrast microscopy.

All species possessed a visual streak: a horizontal band of higher ganglion cell density across the retinal meridian. Such areas are considered regions where visual acuity is improved. Streak development varied in horizontal extent (greatest in the green turtle, least in the leatherback, and intermediate in the loggerhead), and in relative cell concentration (highest in the green turtle, lowest in the leatherback, and intermediate in the loggerhead). Leatherbacks uniquely possessed a second region of concentrated ganglion cells, located above the streak and in the rear of the retina. This region was circular in outline (a "fovea").

Green turtle and loggerhead hatchlings showed compensatory reflexes that kept their head (eye) horizontal over a wide range of body positions (+ 300 from the horizontal). The presence of such a reflex is consistent with the importance of a visual streak in perception (Hughes, 1977). No such reflex was shown by leatherback hatchlings.

A prominent visual streak is found among vertebrates (coral reef fishes, fresh-water turtles, some birds and mammals) living in visual worlds dominated by unobstructed horizons (i.e., desert, open grassland, the water's surface, and a flat ocean bottom). These have in common that the majority of important visual stimuli (such as predators, prey, or mates) appear on a horizon (Hughes 1977). Among the marine turtles, we hypothesize the following relationships between ganglion cell concentration and ecology. The green turtle may possess the best developed visual streak because it feeds in relatively shallow, clear, and brightly illuminated tropical waters with an open horizon (i.e., sea grass "meadows"). The streak might be less developed among loggerheads that feed at greater depths in cloudy, temperate waters. Because leatherbacks feed at low light intensities (often at night) and a great depths, a visual streak is probably of minimal importance. But their circular fovea might enable diving turtles to detect jellyfish that are present in the lower and anterior visual field.

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THE FLUID DYNAMIC PROCESSES REGULATING ARTERIAL BLOOD FLOW IN SEA TURTLES

Luis Gállego[1], Claudia Mendoza[1], and Francisco de Asís Silva[2]
[1]Zoology Laboratory, Department of Animal Biology, The Balearic Island University, 07071 Mallorca, Spain dbalgc0@ps.uib.es
[2]Centro de Ecología Costera, Sn. Patricio Melaque, Universidad de Guadalajara, México

Based on the dissection of the heart and the primary blood vessels from various specimens of *Caretta caretta* and *Lepidochelys olivacea* we describe two anatomical structures that allow these animals to regulate their blood flow in distinct situations of their vital activities such as superficial and deep immersions, and terrestrial movements for nesting activities.

The first of these structures, to which we give the term "spongy tissue with a tape terminus" has not been described previously in any of the literature. This structure can be found within the heart and the great vessels, yet is absent in the carotids; and permits the maintenance of a slow and constant bloodflow throughout the body even when the heart is slowly beating. In contrast, with this structure lacking in the carotid vessels, bloodflow is fast and constant, so that the encephalous receives a greater portion of oxygen in any situation.

The second structure, which we have named smooth-border diaphragm, is previously described by Sapsford (1978); although we have added some descriptive information. We have also discussed the functional role of this structure, from a point of view strictly focusing on the effects on the fluid dynamics.

REPRODUCTIVE PROBLEMS IN CAPTIVE AND WILD SEA TURTLES

David Wm. Owens
Department of Biology, Texas A&M University, College Station, TX 77843-3258, U.S.A.

Considerable progress has been realized in the past quarter century in developing an understanding of the physiology and behavior of reproduction in marine turtles. Despite some populations being heavily explioited, and most being considered endangered, fertility is high (90% or higher) in most natural populations and the sex ratios of offspring fall within what we call the 2/3rds rule. In addition, natural intersex individuals have been rarely observed in the wild. Recently however there have been reports of low fertility in clutches and some strongly skewed population sex ratios have been noted. As Spotila and Gibbons have independently suggested for chelonians, with temperature dependent sex determination, we have the potential for strongly skewed sex ratios, particularly if global warming proceeds as predicted to an increase of several degrees in the next few decades. In contrast to the wild, captive studies at Cayman Turtle Farm and elsewhere over the past 25 years have shown very low fertility with a maximum in the 20% range in the best individuals. This is despite record high fecundity (egg production) and surprisingly early maturation ages. It is theorized that the mating system of sea turtles requires an excess of reproductively competent males and that male-male competition is essential for maximal fertility. If global warming continues, it is proposed that several resulting and interrelated problems may become more evident in the next century. These problems are sex ratios skewed towards female, loss of male producing higher latitude (cooler) nesting beaches, inadequate numbers of wild male breeders and increased infertile intersex individuals. In a worst case scenario, this Reproductive Dysfunction Syndrome (RDS), now common in captive animals, could result in the eventual extinction of all sea turtles.

DEVELOPMENT AND EVALUATION OF A SEXING TECHNIQUE FOR HATCHLING SEA TURTLES

Thane Wibbels and Robert LeBoeuf
Department of Biology, Department of Physiology and Biophysics University of Alabama at Birmingham biof009@uabdpo.dpo.uab.edu

A variety of past studies have shown that sea turtles possess temperature- dependent sex determination. As such, the resulting sex ratios are of conservational, evolutionary and ecological interest. Unfortunately, sexing hatchling turtles is not a simple task. The purpose of the current study was to develop a sexing technique based on the presence of a sex-specific hormone, mullerian inhibiting hormone (MIH). In vertebrates, both male and female embryos develop mullerian ducts which form the oviducts in females.

Male vertebrates produce MIH and this hormone stimulates the degeneration of the mullerian ducts. We have recently developed an assay for MIH in turtles.

To generate this assay, we cloned a full length cDNA for turtle MIH. The turtle MIH clone was then inserted in an expression vector system to produce turtle MIH protein. This protein was then used to identify MIH antisera.

The antisera and MIH protein were used to develop an ELISA assay for turtle MIH. We are now utilizing hundreds of blood samples collected over the past two years to validate this system for sexing hatchlings.

SEA TURTLE LOCOMOTION

Jeanette Wyneken
Department of Biological Sciences, Florida Atlantic University, 777 Glades Road, Boca Raton, FL U.S.A. 33431 0991
jwyneken@fau.edu

Sea turtles are magnificent swimming machines that possess design features which allow them to exploit, spatially, the marine environment. They possess characteristics that make them unique among turtles such as flippers, streamlining, and fore limb propulsion. While there are many aspects to the study of chelonian locomotion, much of my focus is upon the flippers and their use because they define sea turtles structurally and ecologically.

Structures such as flippers have an evolutionary history that constrains design options. The flipper is built on the basic design of a foot that itself had an earlier function in a particular context (as a typical tetrapod leg). In sea turtles the foot has been transformed into a flipper that is sandwiched between two shells. The resulting structure that interacts with the environment is a compromise of design requirements, remodeling possibilities, and conflicting functions.

The flipper as a locomotor adaptation is a highly successful design that has arisen, independently, in several secondarily aquatic vertebrates. Flipper internal design differs among secondarily aquatic vertebrates but it is similar within marine turtles. All species have semirigid fore flippers with hypertrophied, flattened, and elongated phalanges.

All marine turtles begin life as terrestrial animals, become aquatic specialists, then again become terrestrial as nesting adults. The terrestrial locomotion of sea turtles is modified by their body and limb morphology. There are two different crawling gaits used by sea turtles on land: alternate limb crawling and crutching (Wyneken, 1996). Alternate limb crawling is used by hatchlings cheloniids and adult *Caretta, Eretmochelys, Lepidochelys*, and sometimes *Natator*. It is a gait in which diagonally opposite limbs move together and superficially resembles a primitive tetrapod crawling pattern (but in the absence of axial bending).

Crutching is a gait in which the fore and hind limbs move together. It's a gait used by hatchling and adult *Dermochelys*, adult *Chelonia*, and sometimes *Natator*. Crutching is unlike the primitive tetrapod locomotor form and as such it represents a novel motor pattern. Crutching probably is an example of another locomotor experiment within the marine turtles, and can neither be described as better or worse than crawling by the use of alternate limbs (Wyneken, 1996).

Once in the water, the flippers serve as wings and oars. The principal gait used by hatchlings during their offshore migration, as well as by sublittoral juveniles and subadults, is the powerstroke. It is a very efficient mode of swimming that derives thrusts during both protraction (from lift) and retraction (from drag forces) of the limb. As such, it is ideal for prolonged swimming journeys, such as those undertaken during migration (Massare, 1994).

Pelagic stage cheloniids (post-hatchlings and some juveniles) frequently utilize dog-paddling and rear flipper kicking. These gaits are used at the surface and differ fundamentally from powerstroking in how thrust in generated. Drag forces are used in these paddling gaits. Thrust is produced during retraction of the limbs and protraction acts as a recovery stroke.

Locomotor activity patterns change during ontogeny and correspond with migratory and ecological shifts. Typically cheloniids change their swimming behavior and habitats several times in their lives. Dermochelids, which change little in ecology during ontogeny, appear to show little if any change in their aquatic locomotor patterns (Wyneken, 1996).

The flipper design is a very successful one for highly migratory animals because it allows the use of fore flipper propulsion (Massare, 1994). It is because of flippers that sea turtles were able exploit many oceanic niches. The highly efficient powerstroke which combines both lift- and drag-based thrust, enables efficient migration. Yet in spite of the success and importance of the flipper, its design is not ideal. Pure lift-based thrusting might arguably be even more efficient but is not possible with the limb operating from inside the rib cage. Also, flippers are constrained in design and function by the requirements of nesting and crawling on land. Nevertheless, flippers enable efficient locomotion in water, opening a variety of niches for sea turtle adaptive radiation. Flippers have enabled efficient swimming and have opened the door for these animals to display complex life histories with wide-ranging dispersal stages that exploit spatially disjunct feeding areas and breeding areas.

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MANAGEMENT, CONSERVATION, AND SUSTAINED USE OF OLIVE RIDLEY SEA TURTLE EGGS (*LEPIDOCHELYS OLIVACEA*) IN THE OSTIONAL WILDLIFE REFUGE, COSTA RICA: AN 11 YEAR REVIEW

Jorge Ballestero[1], Randall M. Arauz[2], and Raúl Rojas[3]
[1]Asociación de Desarrollo Integral de Ostional, Santa Cruz, Guanacaste. rarauz@cariari.ucr.ac.cr
[2]Earth Island Institute, Sea Turtle Restoration Project, Costa Rica Office, Apdo 1203-1100 Tibás, San José, Costa Rica.
[3]Estación Biológica Las Cruces, San Vito. Organization for Tropical Studies, Costa Rica.

INTRODUCTION

One of the most outstanding events in nature is the massive nesting of olive ridley sea turtles in the Ostional Wildlife Refuge, where tens of thousands, and even hundreds of thousands of nesting females, congregate and nest in a massive and synchronous fashion, known as the"arribada". The community of Ostional is allowed to harvest a certain portion of the sea turtle eggs under a Management Plan approved by the competent authorities. This Management Plan was designed and based upon the best scientific evidence available at the time (Cornelius *et al.*, 1992), which suggested that the harvesting of a certain portion of eggs would not impact hatching success rates nor net neonate production, while it does improve the economic situation of the community of Ostional, a strong incentive to the responsible management of the resource. The project is also considered a contribution to the struggle against the illegal harvest of sea turtles eggs from other beaches and that are sold in the cantinas of the Capital. The social economic success of this project is a well accepted fact by the local community, the authorities and sea turtle conservationist community in general. In fact, this unique project is considered a world model, and currently our neighbors from Nicaragua and Panama are interested in carrying out community exchange programs in order to foster and implement similar programs.

However, after 11 years of controlled harvest, a general concern exists among local authorities and the international scientific community regarding the biological implications of this legal egg harvest and the impact on the nesting population, especially considering the lack of technical reports and scientific publications since the legal harvestwas approved in 1987. It is generally accepted that the harvest of olive ridley sea turtle eggs is permissible if the adult population is stable and enough eggs are protected to ensure a healthy production of hatchlings (Heppel, 1997; Pritchard, 1997). However, and after 11 years of records, we still don't have records to definitely determine if the adult population is stable or not, nor if current harvest rates impact healthy neonate production.

METHODOLOGY

The present document is the first attempt to compile existing data regarding the size and frequency of the arribadas, hatching success, the percentage of egg extraction carried out by the Ostional Development Association since 1987, and determine if the harvest of eggs has impacted the nesting population. This review was submitted to the authorities of INCOPESCA and the Ministry of the Environment in December of 1997.

RESULTS

Because existing data is fragmented, we decided to study the total number of females that nested during the dry season arribadas (January to May), the rainy season arribadas (June to December) and yearly total, separately (Figure 1).

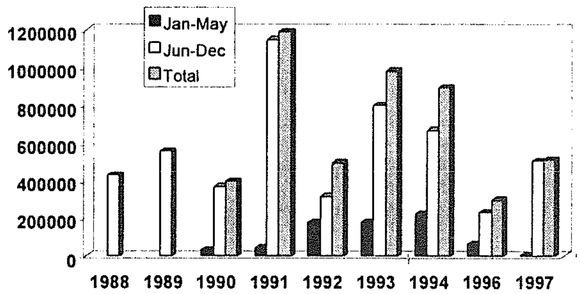

Figure 1. Total number of olive ridley sea turtle nests laid from January to May, June to December, and yearly total, in the Ostional Wildlife Refuge, Costa Rica

It becomes obvious that the dimensions of the arribada are quite greater during the rainy season than during the dry. Also, as may be observed from the yearly total counts, fluctuations occur from one year to the next, even by a factor of 4X. In an effort to determine if the population in Ostional has a tendency to increase or decrease, we applied a linear regression to the yearly totals, resulting in the following equation:

$$Y = -40467.833(X) + 0.813455*10^8$$

estimated standard error = 351692.961

The slope is negative, however, the correlation coefficient $r^2 = 0.095$ indicates that the variations in the data are too great, and thus we cannot affirm that the population is decreasing ($p = 0.499$, $t = 0.729$, $gl = 6$).

According to an ANOVA analysis, F-ratio = 0.522, $p = 0.502$, $gl = 5$, because of which it is also concluded that there is no regression relation between time and the number of nesting turtles.

Table 1 is a compilation of data regarding the yearly number of nests laid, of arribadas, and the estimated extraction rates. In general, arribadas occur on a monthly basis.

Table 1. Olive ridley sea turtle nests laid per year, # of arribadas, average standard deviation, and maximun and minimun harvest of turtle eggs, during the dry season (January to May) and rainy season (June to December) arribadas, in the Ostional Wildlife Refuge,

January - May	# of nests	# of arribadas	Average harvest	SD	Max	Min
1990	31704	5	36%	2.52	39.2	32.1
1991	40798	3	28.16	6.7	37	20.5
1992	180637	5	16.92	1.37	18.4	14.9
1993	180562	4	10.65	4.8	18.8	5.1
1994	224498	4	6.7	3.8	11.25	no data
1996	65348	4	20.59	8.92	33.9	11.01
1997	7721	2	38,6	2.14	36.9	3.2
June - December						
1988	428368	6	14.78	12.36	31.5	1.8
1989	555892	8	no data	no data	no data	no data
1990	367028	9	8	13.7	38.6	6.9
1991	1147969	13	5.4	8.9	37	1.8
1993	800685	7	6.3	2.11	11	4.2
1994	671092	6	8.11	3.04	14.9	6.3
1996	232318	5	20.9	12.1	39.4	6.08
1997	504661	10	12.72	13.85	37	3.8

However, during the dry season, it is not uncommon for the turtles to skip an arribada or even two or three. On the other hand, during the rainy season, when nesting turtles are far more abundant, up to two arribadas may occur per month. Extraction rates also vary greatly, depending on the size of the arribada. During the dry season arribadas the percentage of extraction ranges from 6.7% to 38.6%, whereas during the rainy season arribadas extraction ranges from 5.4% to 20%.

CONCLUSION AND DISCUSSSION

The Ostional nesting population of olive ridley sea turtles varies within normal parameters, and there is no statistical evidence to suggest that the number of nesting adults is increasing or decreasing. In other words, we could say that current egg harvest levels do not negatively impact hatchling production. However, certain flaws have been detected in the counting methodology which tend to underestimate the nesting population, because of which the data presented here is not absolutely reliable.

For instance, in order to count turtles during an arribada we have used the Cornelius Robinson Formula of 1985. Counts are carried out every two hours in three quadrants along the 880 meters of the main nesting beach. This formula works fine as long as the turtles nest within these 880 meters. However, sometimes the focal point of the arribada may shift a couple hundred meters, either to the north or to the south, in spite of which the counts are still done in only the 800 meters where the turtles are supposed to nest, causing an obvious underestimation.

Furthermore, the Ostional Wildlife Refuge includes more than 8 kilometers of available nesting habitat, and sometimes the focal point of the arribada may shift north or south up to 3 or 4 kilometers. For instance, in November of 1997 the turtles nested as far south as the mouth of the Nosara River. In other occasions, the focal point of the arribada is known to have shifted to the north, in a locality called El Rayo. This behavior has been recorded since 1989, and when this occurs, the turtles simply have not been counted. As a result, certain years (such as 1997), do not have one or even two arribadas included in the total yearly count. Thus, it is necessary to improve the counting methodology in order to effectively estimate the nesting population when the focal point of the arribada shifts.

Except for one hatching success study performed by Marta Arauz of the National University of Costa Rica (UNA) in 1992, no studies of this type have been carried out in Ostional since the project was officially initiated in 1987. Yearly hatching success studies are necessary to determine hatchling production, a requirement to justify the harvest of eggs. In any case, the hatching success rates determined by Arauz (1993) are comparable to the hatching success rates determined earlier to justify the creation of the Management Plan eleven years ago.

Finally, just as Cornelius *et al.* (1992) suggested, in order to implement a project of rational use of sea turtle eggs, efficient interinstitutional coordination among the administrative and operative entities of the Ostional Wildlife Refuge must exist. Unfortunately, this goal has not been achieved, and is determined to be the greatest threat to the current program.

ACKNOWLEDGEMENTS

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CONSERVATION AND MANAGEMENT OF SEA TURTLES IN MEXICO

Pablo Arenas Fuentes, Laura Sarti, and Pedro Ulloa
Dirección General de Investigación, Evaluación y Manejo de los Recursos Pesqueros. Instituto Nacional de la Pesca, Pitágoras 1320. Col. Sta. Cruz Atoyac, México D.F. 03310

Mexico is committed to the conservation of the sea turtles, since seven out of eight sea turtle species can be found in its oceans. For the conservation of these species, the Mexican Federal Government has acted in several ways. Among these, the development and reinforcement of protection activities, research of diverse aspects of their biology and ecology, which allow better management of the populations, training in protection techniques of field technicians and researchers from different agencies, research on fishing gears and turtle excluder devices, and law enforcement around management.

Both coasts present nesting and foraging areas important due to the abundance and high density of the populations. These areas are also considered important worldwide. Among those areas are the Tamaulipas beaches, where the kemp's ridley has its only nesting site in the world and the beaches of Oaxaca, where hundreds of thousands of olive ridleys nest in "arribadas". Along the Pacific coast we have important nesting areas for leatherbacks. Other beaches in Campeche, Yucatan and Quintana Roo states have important nesting areas for hawksbill, green and loggerhead turtles. Finally we can find foraging areas along the coast for species as the loggerhead and others.

CONSERVATION AND MANAGEMENT ACTIVITIES

1.-Protection of clutches, females and hatchlings in nesting beaches.

A number of field stations were established in key beaches for all the sea turtle species. The activities in these stations are: a) Relocation of clutches to protected areas; b) Tagging and collection of biological data from nesting females; c) Nesting surveys; d) Evaluation of hatchling success; e) Recruitment of hatchlings to the wild population

Currently, more than 110 field stations for protection activities exist in Mexico, and cover around 815 Km of coast in both shores.

2.- Training of field technicians.

The technicians are constantly trained in protection activities: a) Training courses on field methods for protection; b) Courses for updating of different items on sea turtle biology; c) Planning and development of workshops for standardization of methods, terms and definitions.

3.- Research.

Several research projects are focused on: a) biology of sea turtles; b) incidental capture; c) fishing gears and TED's efficiency

Some of the main subjects are: Evaluation of population status, migration and remigration patterns, reproductive biology and ecology, effects of environment on incubation and sex determination, nesting behavior.

4.- Legal aspects:

Various should be mentioned: a) Laws have been implemented concerning management and rational use. A legal fishery of olive ridleys existed until 1990. It was regulated by capture quotas exclusively for fishermen cooperatives, which met some requirements as minimum size of capture, sex ratio, areas and seasons of capture and establishment of bans. In 1990 a total a permanent ban was established. Currently the exploitation of sea turtles in Mexico is forbidden. Also, the use of turtle excluder devices on shrimp trawlers is mandatory in both coasts; b) Signature of international agreements as the Interamerican Convention for Protection and Conservation of Sea Turtles. The goal of this convention is to promote the protection, conservation and recovery of sea turtle populations and the habitats on which they depend, based on the best available scientific evidence and recognizing the environmental, socioeconomic and cultural characteristics of the parties. Mexico signs the convention and adopts the commitments, strengthening the scientific research and conservation of sea turtles, noting the possibility for future exploitation.

- Mexico promoted an effective instrument for the protection and conservation of sea turtles in the American Continent.
- Rights and obligations are acknowledged in relation to the conservation and management of the living marine resources.

5.- Involvement of the local communities in the protection activities.

It's impossible to think of a conservation program without considering the socioeconomic conditions of the communities adjacent to the nesting beaches. Therefore, education programs have been established in some areas, as well as employment of local people for protection of eggs and hatchlings.

CONSERVATION RESULTS

For more than 30 years, the Mexican Government through Instituto Nacional de la Pesca, and more recently Instituto Nacional de Ecología, has carried out conservation and protection activities in 23 major nesting beaches, and supervised the protection activities developed for other institutions. The results show recovery signs in some sea turtle populations. One of the best examples is the Kemp's ridley (*Lepidochelys kempii*) population. A sustained increase on

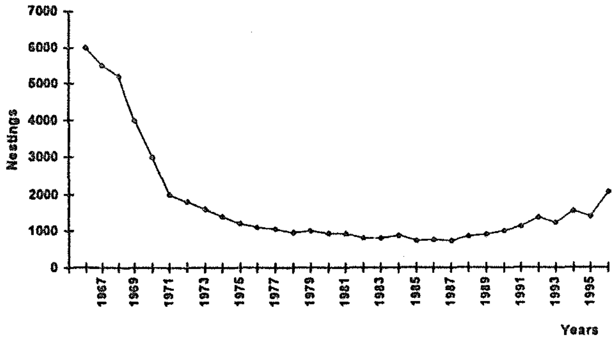

Figure 1. Kemp's ridley, Lepidochelys kempii, nests in Tamaulipas beaches

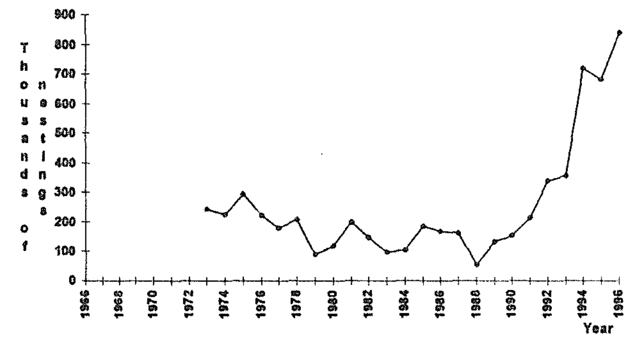

Figure 2. Olive ridley nests in La Escobilla, Oaxaca

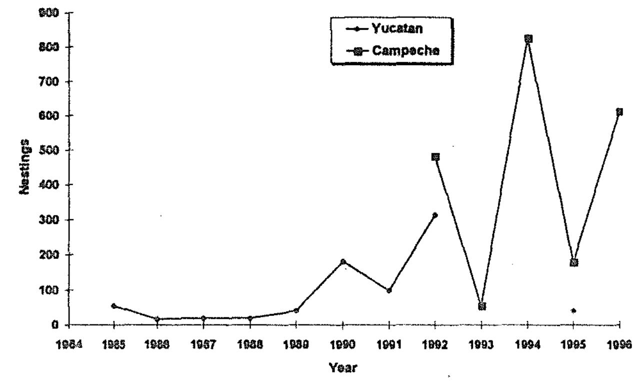

Figure 3. Green turtle nests in the Yucatan peninsula

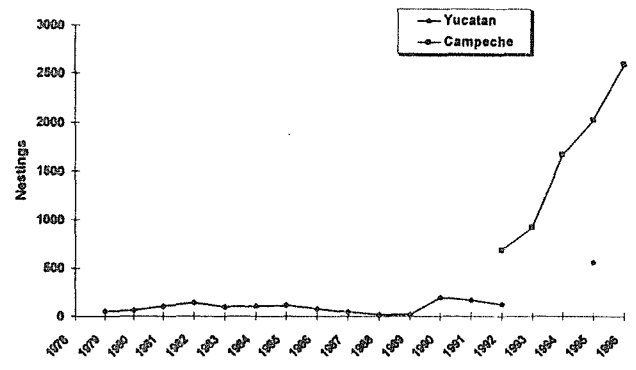

Figure 4. Hawksbill turtle nests in the Yucatan peninsula

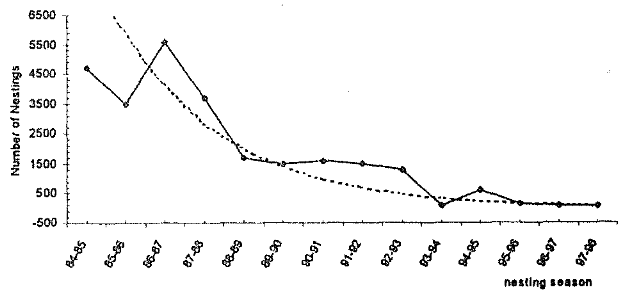

Figure 5. Decline in leatherback nesting in Mexiquillo, Michoacan

the number of nests has been reflected for the last five nesting seasons. This is the result of all conservation activities like protection of clutches and use of TED's, among others.

Other important case is the olive ridley (*Lepidochelys olivacea*) population. Their main nesting beach is "La Escobilla" in Oaxaca State. Since the total and permanent ban in 1990, the number of nestings per season in this beach has increased from 150,000 to 835,000 during the last nesting season 1996. It is considered as a recovered population.

The number of green turtle (*Chelonia mydas*) nestings in Yucatan Peninsula has increased since 1979 with a peak of 800 nests in the 1995 nesting season. The hawksbill turtle (*Eretmochelys imbricata*) shows signs of recovery. The number of nests increased from 689 in 1992 to 2,590 in 1996 in Yucatan Peninsula.

For the leatherback sea turtle (*Dermochelys coriacea*), in spite of the conservation efforts, the total nestings and the number of females show a drastic decline. Possible major causes for this dramatic fall in nestings include the heavy egg poaching before the protection activities were implemented and the bycatch in the swordfish fishery in different areas of the Pacific Ocean. The Mexican Government, worried by this situation, has improved and reinforced the program in order to maintain a monitoring capacity and strengthening recruitment by increasing hatchling production in all nesting areas.

Given the importance of Mexico as a sea turtle country, the main commitment is to accomplish the recovery of the most depleted sea turtle populations, and maintain in good conditions those that show signs of recovery at present. For this, the priority activities are:

- To continue the protection of sea turtle eggs in key beaches.
- To strengthen environmental education mainly in areas adjacent to nesting beaches with high nesting density.
- To prevent urban growth in areas surrounding major rookeries.
- Assessment and regulation of sea turtle bycatch
- To increase research on the pelagic stages of sea turtles.

MANAGEMENT PROGRAM AND TRADITIONAL CATCH PROCEDURES IN WILD

Elvira Adelaida Carillo Cárdenas
Centro de Investigaciones pesqueras, 5ta ave y 248, Santa Fé, C. de la Habana, Cuba
cubacip@ceniai.inf.cu

The hawksbill turtle management program is composed of a group of scientific and technical and organizing actions whichwarrantee the sustainable use of this source. This management is done in two main ways. Wild catch and ranching program. Wild catch give definitive data about the thrend of the population and allow the to quantify the real impact of the captures. Hawksbill turtle is in permanent close season in in all the Cuban Shelf, with the exception of two sites of traditional catch: in Crocodile Town and Nuevitas.

The mamagement program state that total traditional catch do not exceed 500 individuals of *Eretmochelys imbricata* in a year during nine month of the open season. Within this limit, both captures sites operate according to a capture plan, wich take into consideration the different oceanic conditions, fishing traditions in both zones and the anual abundance fluctuations. The management program includes from the proccesing of the capture until packing of the shell and meat distribution. To obtain such information monitoring program has been carried out wich collect the information of the size structure, ege and sex of captured population in the landing poits, and also collect information on nesting magnitude (tath is, to determine the number of nesting females, the number of nest and the size of the nesting females, among others), in a way thatwith all this information we can know how the population react on the decrement of the capture.

THE STATUS OF SEA TURTLES AND REGIONAL COORDINATION ALONG AFRICA'S ATLANTIC LITTORAL

Jacques Fretey
Fédération française des Sociétés de Sciences naturelles, Muséum national d'Histoire naturel, 57 rue Cuvier, 75231 Paris cedex 05, France. fretey@ccr.jussieu.fr

Scattered publications and reports lead us to think migratory corridors, feeding areas and excellent nesting sites for a least 5 species of sea turtles exist all along the entire Atlantic front of Africa. Leatherback nesting beaches in Gabon, for example, are probably second only to those in French Guiana. There appear to be remarkable sites for Olive Ridley (of which only small numbers still nest at their former sites in Surinam and French Guiana) in the Bijagos Archipelago (Paris and Agardy, 1993). An interesting nesting zone for Green Turtles exists on the island of Bioko in Equatorial Guinea (Castroviego *et al.*, 1994). The list goes on.

Turtles (*Caretta caretta, Dermochelys coriacea*) tagged in the Western Atlantic have been spotted several times in the East. It would be absurd to closely monitor breeding groups on one side of the ocean while remaining unaware of what's happening on the other, including massacres.

A document drawn up with the Convention of Migration Species (CMS) surveys our current knowledge of sea turtles in West Africa. The IUCN's French Committee and the CMS are sitting up the bases for Regional Coordination of sea turtles from Morocco to Namibia, along the lines of WIDECAST in the Caribbean. A first workshop was held in Gabon with representatives from 5 of the countries of the Gulf of Guinea. Further workshops are being planned for other subregions.

INE'S PROGRAM FOR SEA TURTLE CONSERVATION AND COASTAL DEVELOPMENT

Cristina García
Instituto Nacional de Ecología, SEMARNAP. México. jjperez@chajul.ine.gob.mx

The Conservation of Sea Turtles Program of the National Institute of Ecology has carried out actions of protection, the effort has not been enough, because the local population has not covered their basic requirements.

The legal frame of protection and conservation of the natural resources have been reinforced and the current politics in matter of wildlife, contemplates as basic principle for the conservation a social integrated component.

OBJECTIVES

-To protect the breeding populations of sea turtles in 13 camps and foment their self-financing.

-To develop outlines of local participation in activities of protection.

- To foment outlines of productive diversification based on the use of wildlife.

- To promote the regularization of activities of protection and conservation of the sea turtles.

FRAMEWORK

The efforts of the Program are guided toward the development of actions coordinated at state level in the matter of conservation of the wildlife.

The actions of productive diversification will be carried out through the presentation of proposals to the community, as an alternative of production and with the knowledge of the flora and fauna of the place, in order to determine the possibilities of the technically planned and regulated uses. The development and the instrumentation depends on the same community.

The activities regulations outline of the Protection and Conservation of Sea Turtles are carried out through the interest that have the diverse sectors of the society in the protection of this resource and until date they work without a normative established.

CHANGES IN THE NESTING LEVELS OF *ERETMOCHELYS IMBRICATA* IN CAMPECHE, MEXICO AFTER TWO DECADES OF PROTECTION

Vicente Guzmán-Hernández[1] and Mauricio Garduño Andrade[2]
[1] INP CRIP Carmen. Av. Héroes del 21 de Abril s/n Playa Norte. Campeche, México. cripc@internetc.net.mx
[2] INP CRIP Yucalpetén. A. P. 73 Progreso, Yucatán, México. C. P. 97320.

INTRODUCTION

Declines of several species of marine turtles have been extensively documented: *Eretmochelys imbricata* in Seychelles Islands (Mortimer, 1984); *Chelonia mydas* in Southeastern Asia (Mortimer 1991a,b); *Dermochelys coriacea* in Asia and America (Spotila *et al.*, 1995), and in Pacific Mexico (Sarti *et al.*, 1996); and *Lepidochelys kempii* in Tamaulipas (Márquez, 1994). Major common factors for the decline are the excessive captures of adults at sea and nesting beaches, egg poaching; with th eaddition of the contamination of key habitats due to pesticides and other anthropogenic residuals, and critical habitat damage or loss.

The hawksbill sea turtle (*Eretmochelys imbricata*) in the Greater Caribbean is no exception; Meylan (1997) concluded that of the populations found in 35 geopolitical units in the Caribbean, 23 have declined. In contrast however, a population that has registered important increments is the one nesting the Peninsula of Yucatan, where some of the most important nesting sites for *Eretmochelys imbricata* in the Caribbean (Garduño *et al.*, 1997) are found. Over the last two decades extensive protection and monitoring has been taking place on the beaches in Campeche, Mexico (Guzmán, 1997). Over this period, the fluctuations in the nestings indicate at least 3 modal points with subsecuent declines in periods of 11 years ocurring over a number of hawksbill nesting beaches in the Yucatan Peninsula (Garduño *et al.*, 1997). In this work we discuss the apparent recovery and analyze some of the hypothesis that could explain the phenomenon involved.

PROBABLE CAUSES

Márquez (1994) mentions that the changes in the abundance and density in some particular life stages of species could be explained by phenomena like emigration, immigration, mortality, recruitment, reproductive and feeding behavior . The fluctuations observed in numbers of nestings (Figure 1) could be explained by the following hypotheses:

I Effects of migration, with a net displecement of the nesters to other nesting zones

II Displacement to other zones because of feeding preferences.

III Mortality of recruits (due to historical capture), as described by Mortimer (1995), whereby the changes in the recruitment will only be detected after a period of time equivalent to the time to maturity- certainly a number of decades for many of the sea turtle species.

IV A combination of the above but which could include environmental variations affecting the reproductive conduct with consequential recurrent changes in the reproductive behavior of the population.

RESULTS AND DISCUSION

Former exploitation

The populations of marine turtles in the Campeche coast were subject to exploitation since Mayan times. Hoever, as for other species, in the period between the 50´s and 60´s the harvests exploited the resource beyond their capacity to recuperate (see Table 1; Solorzano, 1963, Ramos Padilla, 1974, Márquez, 1976). Groombridge and Luxmoore (1989) mention that after the 60´s most of the tortoiseshell production in the Caribbean came from the coasts of the Yucatan Peninsula.

Conservation

In order to counteract the overexploitation, the Federal Government implemented the first bans and, in addtion the Instituto Nacional de la Pesca (Fisheries Ministry) established protection and research programs for marine turtles in Isla Aguada, Campeche in 1977. In 1986, the Ecology Ministry (INE) established a second concservation camp in Chenkan, Campeche; later, in 1992 with the support from various Government agencies´and ONG's, 6 camps became operational. By 1993 eight protection camps operated along the Campeche coast, covering an area of approximately 150 km. of beach, that represents the 95% of the nesting zones. On July 1990 the total ban on the taking of sea turtles or their products was established in Mexico; together in 1992 with the obligatory use of the TED's in all the fishing shrimps trawlers of the

Table 1. Capture and protection levels 1950´s to 1990´s in Campeche

HISTORICAL PERIOD	INTENSITY OF CAPTURE		LEVEL OF PROTECTION	
	MATURE FEMALES	EGGS	EFFORT	COVERAGE
50's	moderate	moderate?	NONE	NONE
60's	commercial exploitation	excessive	NONE	NONE
70-76	over explotation	over explotation	Ban entered in 1971	NONE
77-86	illegal exploitation	60-40%	60%	50%
87-91	< 5%	< 30%	70%	70%
92-97	< 1%	< 95%	95%	95%

Gulf of Mexico.

Current Tendencies

According to Guzmán *et al.* (1993), if the changes in the nesting behavior were due to migratory net displacement between nesting beaches, we could track the displacements through the tagging of mature females. In Isla Aguada, Campeche only about 4% of females leave their main nesting beach. However, all of thesee have been recaptured within a 40 km radius of the initial tagging site (Guzmán, 1997b).

From the several hundred turtles tagged in Campeche, we recover between 30% and 60% every year. However, although we cannot be sure if some of our tagged turtles are recovered in other parts of the Peninsula, there is no evidence that Campeche females nest in other distant or inaccesible beaches inside the Peninsula. Furthermore, if these occurred, the variations which would be provoked would be massive and would influence the amounts of nests registered annually.

Far-ranging movements within the reproductive season, have been documented by Byles and Swimmer (1994), who tagged mature females with satellite transmitters in Chenkan, Campeche and in "El Cuyo", Yucatán. Their results indicate a limited displacement inside Bank of Campeche from at least for the first months.

Based on direct observations of the foraging grounds in the Campeche Bank that it is capable of providing enough feed for the local population, and this is why they remain inside these limits, most of the time.

As for juveniles; we recently recaptured a juvenile turtle in Campeche that had been tagged in Rio Lagartos, Yucatán after travelling approximately 250 kms Garduño, (pers. com.) There have been other recaptures- 4 juvenile tagged and free in Veracruz, 2 of them in Tabasco and other 2 in Campeche (Gonzalez-Diaz Mirón, pers. com.).

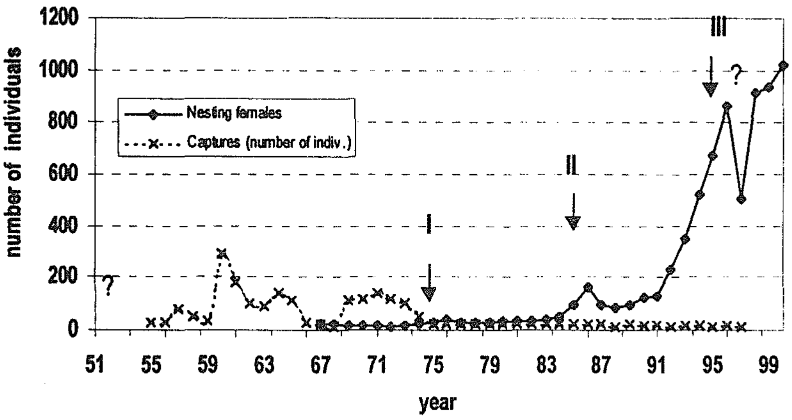

Figure 1.- Fluctuation in nestings for Eretmochelys imbricata in Campeche, Mexico 1950-1997

Currently we conclude that if migrations are not the cause of the observed increases in nestings in the Campeche beaches, then the major explanation is an increased recruitment into the mature population, possibly augmented by significant decreases in the mortality of juveniles in the area. This is supported by the following observations:

- The tortoiseshell trade has diminished in the region partly due to it being substituted by synthetic materials.
- Surveillance and law-enforcement have increased during the last years.
- The generations born after the 70's don't have the habit of turtle eggs consumption.
- Many of the local fishermen have become involved in the conservation programs.
- The protection programs in the beaches have significantly incresed the recrutiment of hatchlings into the population. It could be that, prior to 1977 there were enough local poachers that most of the nests of the already depressed populations were probably overharvested, while afterwards the effects of the uninterrupted protection of nests and turtles during 21 years reversed the trend. Under this scenario we would be observing the incoropration of those cohorts into the nestinig population, assuming an age of maturity occcurring between the 16 and 22 years.

ACKNOWLEDGMENTS

To all the people that work and worked in the turtles camps from the beginning of the protection program, as well as to the institutions that have supported this regional program. The success in the recovery of the populations is due to the opportune gathering of nests and to the night staying of the personnel of camps in the beach, that discourages to the fishermen of carrying out illicit with the turtles and their eggs.

A special recognition to the Instituto Nacional de la Pesca; to the Instituto Nacional de Ecologia, Federal Offices of SEMARNAP in Sabancuy, Champotón, Seybaplaya and Isla Arenas; to the SEMARNyD, Quelonios A. C., Marea Azul A. C., and to the H. Ayuntamiento of Champotón. M.S. Ma. Concepción Rosano Hernández helped with the English translation. Finally, we thank the Red Latinoamericana de Biologia (RELAB) for providing travel funds for the first author and DIF for accomodation and subsistence during the Symposium.

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BUCK ISLAND REEF NATIONAL MONUMENT HAWKSBILL NESTING BEACH STUDY- *COULD CONSERVATION BE WORKING ?*

Zandy Hillis-Starr[1] and Brendalee Phillips[2]

[1] National Park Service, Resource Management, Buck Island Reef National Monument, Danish Customs House, Kings Wharf #100, Christiansted, Virgin Islands 00820-4611, U.S.A. CHRI.Interpretation@nps.gov

[2] U. S. G. S, Biological Resource Division, Buck Island Reef National Monument, Danish Customs House, Kings Wharf #100, Christiansted, Virgin Islands 00820-4611, U.S.A.

Sea turtle conservation at Buck Island Reef National Monument (BUIS), which is administered by the National Park Service (NPS), encompasses the protection and management of the nesting habitat, adult female sea turtles nesting at Buck Island, their eggs, and resulting hatchlings. Two federal mandates have guided the conservation of sea turtles at Buck Island. The Endangered Species Act in 1973, which stated that federal agencies shall seek to conserve endangered species (USFWS 1989), and the National Marine Fisheries Service/US Fish and Wildlife Service Hawksbill Recovery Plan which stated the need for long-term protection of important tinue providing a safe area for sea turtles to nest and from which hatchlings can leave the beaches to join the rest of the Caribbean population of hawksbill turtles to maintain the diversity necessary for the species to survive.

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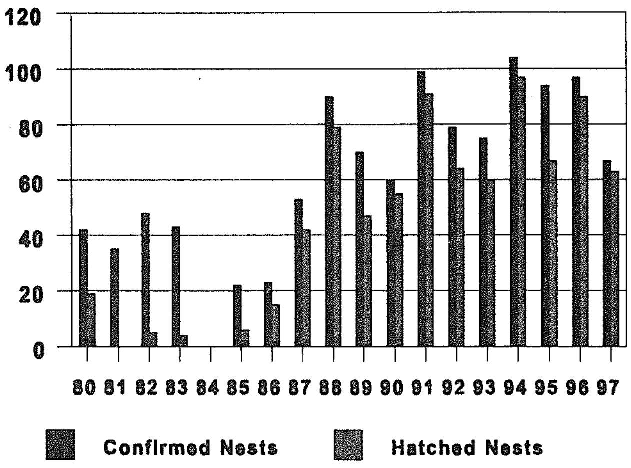

Figure 1.- BUIS Hawksbill nests per study year

nesting beaches, the need to minimize threats from illegal exploitation, and the need to increase hatch and emergence success of nests. Buck Island Reef National Monument was identified in that document as an index beach to be monitored for the recovery status of hawksbill sea turtles, *Eretmochelys imbricata* (NMF, S 1993). When BUIS initiated conservation efforts for sea turtles, the three main objectives were to: 1) balance preservation, conservation, and recreation, 2) eliminate poaching of both adult females and their nests, and 3) control predation on nests and hatchlings.

In the 1980's, NPS instituted regulations to safe guard sea turtle nesting yet not significantly limit or restrict visitor activities. These regulations included beach closure from sunset to sunrise, minimization of light and noise levels from vessels anchored offshore, no on shore anchoring, beach umbrellas, poles, or digging above high water mark, and no dogs are ever allowed on the beach. These regulations have been presented to the public through multi-media community outreach programs and are usually well received.

Outcomes of sea turtle nesting activities during the 70's and 80's indicated that nearly 100% of all nests were lost to the combination of predation and\or poaching (Figure 1). BUIS established law enforcement patrols in 1975 to provide both visitor and natural resource protection. Early morning ranger patrols were significant deterrents to many illegal activities and drastically reduced poaching on adult female sea turtles and their nests. The elimination of poaching was the first step, the next step was control of the exotic predator, the mongoose (*Herpestes auropunctatus*), which had effectively reduced sea turtle hatch success to zero. In the 1960's, NPS conducted an aerial dispersal of poison bait; the results were difficult to detect. In 1982 and '83 NPS, along with the Virgin Islands Fish and Wildlife Service, undertook an island wide trapping program which resulted in eliminating 90 % of the mongoose population by 1986. Since 1988 only one live mongoose has been sighted on BUIS, and in 1994, the skeleton of a mongoose was found lying over a hawksbill nest. The trapping program significantly reduced the impacts from mongoose. Prior to 1986 there was less than 31% emergence success of hawksbill nests at BUIS (Zullo, 1986); after 1986, the emergence success increased more than 100 % to 67.4%, even when the impacts of several hurricanes are included (Figure 2). BUIS is not predator free yet, beginning in the 1990s the exotic tree rat, *Rattus rattus*, became a new threat to sea turtle nests and hatchlings. This threat has been temporarily mitigated by nest relocation and trapping conducted during the nightly sea turtle research program, nevertheless, the rat problem is escalating and BUIS is initiating a rat control program.

In 1980, in conjunction with conservation regulations, predator control, and public education, BUIS rangers were trained to conduct sea turtle monitoring and began weekly nesting beach patrols. Rangers collected nesting data, recorded poaching and predation events, and monitored hatch success. In 1987, BUIS expanded its' sea turtle conservation program and began nightly monitoring of the sea turtle nesting beaches during peak hawksbill nesting season. The primary objectives of the expanded sea turtle program were to monitor the population status of nesting females through saturation tagging, protect nests and eggs, and record hatch success. By 1993 saturation tagging of the existing nesting population had been reached and an increased number of first time nesting turtles or "new recruits" to the population were observed (Figure 3). It's been 22 years since poaching of nesting adults and nests was stopped and 13 years since mongoose predation took nearly 100 % of the nests. If hawksbill sea turtles do reach maturity sometime between 15 - 25 years of age (Limpus 1992), then Buck Island Reef NM may be seeing an increase in the number of new recruits to the nesting population as a direct result of these conservation efforts.

We've eliminated poaching, reduced predation, educated visitors, monitored the beaches and protected the nesting adults, but sometimes, no matter how hard you try, something comes along and complicates things. On September 17-18, 1989, Hurricane Hugo hit St. Croix and Buck Island Reef National Monument. The storm stripped all vegetative cover from the beach forest nesting habitat, left tons of

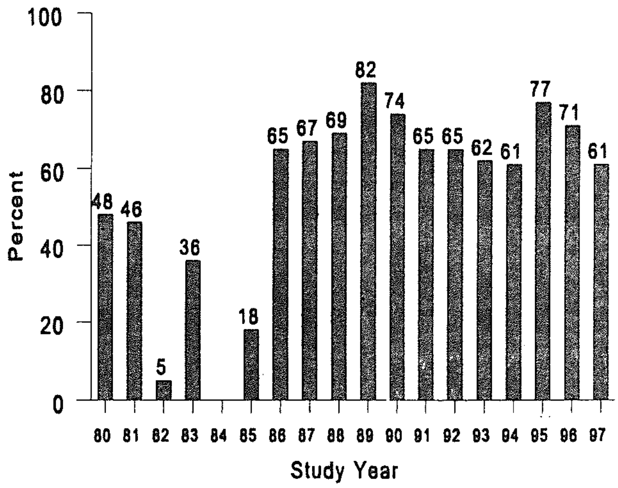

Figure 2.- % Emergence success of Hawksbill nests at BUIS 1980-1997

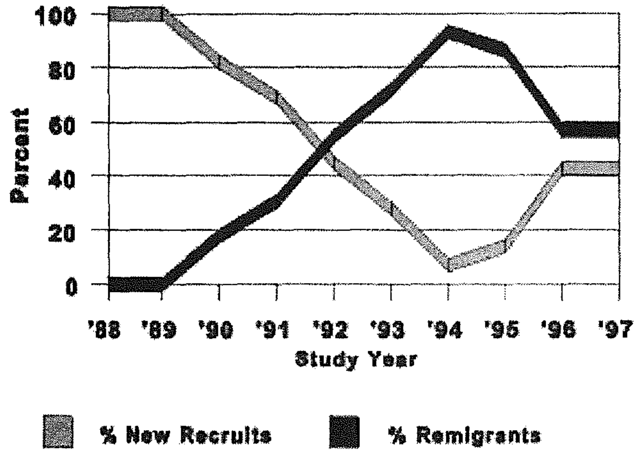

Figure 3.- BUIS Hawksbill New Recruits vs. Remigrants

downed trees and debris blocking the nesting beaches, and created one meter high berms preventing access to major nesting areas. BUIS lost 19 nests to Hurricane Hugo (Hillis, 1990) and 27 nests to the combination of Hurricanes Luis and Marilyn in 1995 (Hillis and Phillips, 1996). To prevent these kinds of losses from happening again, hurricane beach protocols were instituted. To reduce nest loss, all nests laid during the nocturnal research program that are threatened by predation, visitor impacts, or erosion, are relocated to a "safer" section of the beach. The following protocols were established: a nest is relocated if it is laid in 1) an area in which seasonal erosion is known to occur within 60 days from the time the nest is laid (the average incubation period for BUIS' hawksbill nests); 2) a "known" hurricane erosion zone (areas that were eroded during hurricanes Hugo, Luis, and Marilyn; 3) a high visitor use area (picnic areas with high density foot traffic and exotic fire ant populations; 4) high density rat areas (rats learn where a nest is, and will raid the nest until all eggs are consumed; 5) an unshaded, dark soil area, where full exposure to the sun may raise nest temperatures to lethal levels. To increase hatch success some heroic measures have been taken including, clearing large rafts of fallen trees and root tangles some blocking over 30 feet of shoreline; reduction of meter high storm berms to allow turtles access to major nesting areas; relocation of nests out of storm erosion zones to either natural or artificially shaded areas.

Beginning in 1994, it was apparent that the loss of vegetation due to Hurricane Hugo in 1989 was reducing hawksbill emergence success (Figure 2). An alarming number of nests laid in areas of the beach forest in dark soil had high numbers of full-term unpipped embryos. We suspected these nests were reaching lethal temperatures during the latter part of incubation. In 1994, in cooperation with Dr. Thane Wibbels, University of Alabama at Birmingham, BUIS began monitoring nesting beach temperature on all four nesting beaches, both in the ground (ambient) and in incubating nests. We found that the temperatures in the unshaded nests with dark soil were warmer than shaded nests by 2.1 degrees Celsius. In 1996, BUIS conducted a paired nest temperature study to determine if artificially shading the nests might increase hatch success (only nests already being relocated were included). The findings were significant; hatch success in unshaded nests was 55%, and 71% in artificially shaded nests (Fortuna and Hillis, 1996). The study was repeated in 1997 and nests that had to be relocated were moved to sites with more natural shade or they were artificially shaded. Again, the hatch success of unshaded nests was lower, 53%, than the naturally and artificially shaded nests which was significantly better, 70%. Over all, the results are encouraging and BUIS will continue following these nest relocation protocols until the beach forest vegetation recovers.

As a direct result of the nesting beach protection through ranger patrols, enforcement of the conservation laws, education, and research/monitoring, there has been an increase in the number of nests hatching from Buck Island over the last 10 years. Before 1985, BUIS had almost zero emergence success, due to poaching or predation. Between 1986 and 1997, even with hurricane impacts, BUIS produced an average of 8000 hatchlings per nesting season (Figure 4). Between 1990 and 1997, when nest relocation protocols were in practice, a total of 115 nests were relocated. The average emergence success for those years was 55%, resulting in a total of more than 9000 hatchlings produced from those relocated nests alone, which otherwise could have been lost to erosion, predation, or inadvertent visitor impacts.

Hawksbill sea turtle recovery cannot be accomplished by one act alone, nor can it succeed in the isolation of one nesting beach. Just as sea turtle conservation at Buck Island has been multilayered, finding ways to improve the survival of the sea turtles within its boundaries, so must the effort be multi-year. BUIS made the commitment to sea turtle conservation knowing it was a long-term venture — all of which has lead to a secure nesting beach, an increased number of nests surviving to term, improved hatch success, and many more hatchlings leaving the beach that will hopefully return to Buck Island Reef NM someday as adults to nest. We also know we must go beyond the park boundaries and coordinate with all agencies responsible for sea turtle conservation. Hawksbill turtles are migratory animals and must have protection during all phases of their life and in all places they may journey. Buck Island Reef National Monument will con-

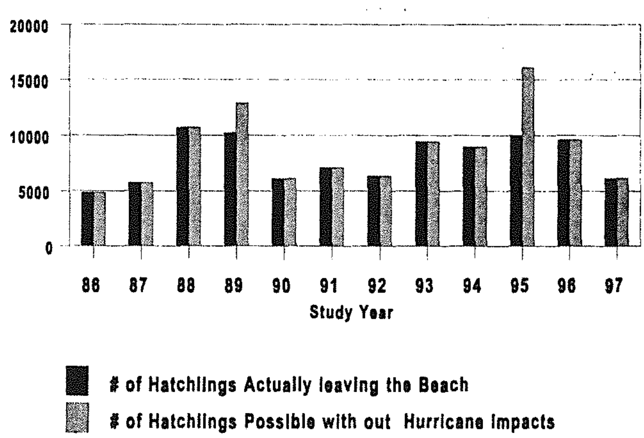

Figure 4.- Number of Hawksbill Hachlings per year at BUIS

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THE SEA TURTLES OF KEFALONIA- A STEP TOWARDS SUSTAINABILITY

Jonathan D. R. Houghton and Kim T. Hudson
Kefalonian Marine Turtle Project. 'Heronfield', Main Road, Shorwell, Isle of Wight, PO30 3JL, U.K.
deerhud@enterprise.net

Kefalonia is the largest of the Ionian Islands situated to the west of mainland Greece, just north of Zakynthos. Each year, between the months of June and August, Loggerhead turtles (*Caretta caretta*) nest along the island's southern and western shores. Nesting activity has been recorded on thirteen beaches, the most important of which is Mounda Beach on the southeastern tip with 139 females tagged to date.

It is undeniable that when compared to major Mediterranean rookeries (*e.g.*, Laganas Bay on Zakynthos with an average of 1000 nests per year) that the population associated with Kefalonia is modest. However, in terms of biology, the rookery itself displays a number of important characteristics that may help to increase our knowledge of the Mediterranean loggerhead population as a whole. These are listed below:

(1) Long Term Population Monitoring - The fourteen year data set collected on Kefalonia, combined with the modest size of the population, makes it one of the longest studies in the Mediterranean and suitable for use as a pilot programme.

(2) Intermittent Emergence - The pattern of emergence by hatchlings has been shown to be highly intermittent with observations this season of up to twenty days sporadic activity from a single nest.

(3) Low Predation - Between the years of 1994-1997 there have been no accounts of either nest depredation, or hatchling predation on Mounda Beach. This ensures that virtually every nest laid develops to completion, and all successfully emerged hatchlings reach the sea allowing good potential recruitment into future nesting populations.

(4) Beach Infidelity - One of the most interesting findings over the past couple of years has been the discovery that turtles tagged elsewhere in the Mediterranean, predominantly Zakynthos and the Peloponese coast, have been seen to nest on Mounda beach. This opens up some interesting of marine turtles as a valuable natural asset. This was complimented by a 'turtle evening' held for the local community and members of the local administration, which focused predominantly upon the idea of sustainable development.

Strong links have also been established with tour operators around the island. Our fortnightly publication, 'Turtle Update' enabled tour representatives to keep their clients up to date with turtle related matters. Additionally, 'Turtle talks' are given on a weekly basis in a number of resorts around the island, covering sea turtle biology and conservation strategies, thus directly imparting information to tourists on how they can help. This year the talks were held on a bilingual basis, which served to generate a lot of interest amongst visiting Greek tourists.

Continuing on the theme of awareness, the Katelios environmental information kiosk opened in 1997. This served to disseminate information in a multitude of languages on environmental matters in general, and sea turtles in particular. This proved highly effective and complimented the series of public information talks.

Various contacts have been made with a number of conservation organisations based on the island with the aim of increasing cooperation in matters of marine conservation. Additionally, the KMTP and Katelios Group were invited by the Natural History Museum of Kefalonia and Ithaca to assist with the development of their marine turtle display.

Significant progress has also been made in the political arena. Since 1996, the KMTP and the Katelios Group have established good communication links with a number of heads of community, local government and other officials. This set up has proved extremely fruitful as it has allowed us to receive constructive feedback from communities whilst allowing us to bring matters relating to sea turtles onto the local political agenda. This work has culminated in the submission of an application to the Prefectorate of Kefalonia questions regarding the genetic isolation of the Kefalonian population and nesting beach infidelity. More importantly, in the event that other sites around the Mediterranean become unsuitable for nesting, Mounda Beach may serve as a refuge for turtles displaced from these areas.

(5) Foraging Grounds - Two foraging grounds have been identified in the vicinity of Mounda Beach. Of most interest, with respect to these, is the observation of sea turtles tagged outside Greece *e.g.*, Malta. This finding has broad ranging conservational implications both for Kefalonia, and the Mediterranean in general.

Over the past decade, tourism on Kefalonia has increased steadily leading to the impingement into many areas critical for the survival of *Caretta caretta*. To date, the disturbance to the nesting population has been minimal, but as development increases it is only a matter of time before its effects become evident. Despite a denial by the Greek Delegate to the BERN Convention in Strasbourg, development has commenced on Mounda Beach posing a number of disturbance related problems. As a result of this, the local communities, under the initiative of The Katelios Group for the Research and Protection of Marine and terrestrial life have formed a partnership with The Kefalonian Marine Turtle Project (KMTP), to promote the concept of sustainable development in environmentally sensitive areas.

Figure 1 outlines how a sustainable management plan for the sea turtles of Kefalonia and their environment might be developed. A framework for discussion needs to be established to allow all those with an inherent interest in Mounda beach, and other important sites to air their views in a constructive manner. It is hoped to achieve this via continued co-operation with the local communities, developers, research projects, NGOs, Greek Tourist Board, international tour operators and respective Governmental bodies.

To put this plan into action, the KMTP and Katelios group have taken various steps at local, tourist and Governmental levels emphasising the need to reconsile the conflicting interests of turtles and tourism. The results of these activities are beginning to show, particularly at a local level. One of the best examples of this is the education programme. Over the past few years preliminary visits to local schools around Kefalonia have been met with a warm response. As such, during 1997 a more extensive series of activities was set up to approach children between the ages of seven and eighteen in schools in the vicinity of important nesting sites. Additionally a series of beach games, based upon various stages of the sea turtle life cycle and the associated food web, were held for local and visiting children in nearby resorts. Finally, the KMTP and Katelios Group are designing an educational pack based on the life cycle of the loggerhead turtle (*Caretta caretta*), which will hopefully be piloted in both English and Greek schools in 1998. A lot of interest has been generated in the local community to assist in the scientific program run by the project. It is hoped that school parties will also join in the work next year to gain a greater insight in to the problems faced by the turtles.

Further work with the local communities resulted in the devotion of the Katelios festival to local marine life with special attention to *Caretta caretta*. This was a significant step forward and served to demonstrate the greater acceptance

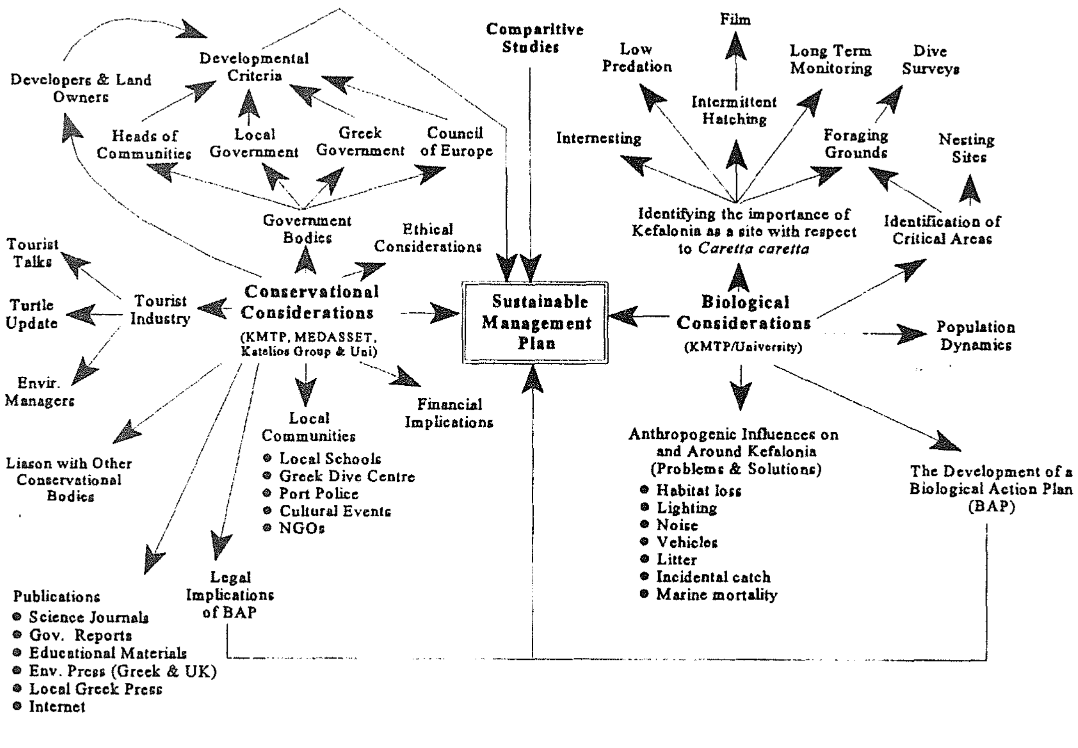

Figure 1: Outline of how a sustainable development plan might be developed for the sea turtles of Kefalonia and their environment. It is based upon an holistic approach and incorporates parties ranging from school children to universities, holiday companies to the Council of Europe.

requesting the introduction of additional environmental regulations with respect to future and present developments in the vicinity of sea turtle nesting grounds. This concentrated on the issues of artificial lighting, waste disposal, noise reduction and direct human disturbance. This application was approved by the Anti Normarchise (Deputy Head of the island) who then further submitted the application the Building Planning Office of Kefalonia and subsequently to the Greek Ministry of Planning, Environmental and Public Works. In the event that this document is passed at this level, then the island of Kefalonia will have taken a significant step towards a sustainable future.

At a higher level, annual reports are submitted to the Greek Government and with the help of the Mediterranean Society to Save the Sea Turtles (MEDASSET), it has been possible to submit documents to the Council of Europe, 15th, 16th and 17th Convention on the Conservation of European Wildlife and Natural Habitats [BERN Convention].

FINAL COMMENT - A STEP TOWARDS SUSTAINABILITY

Far too often we see the effects of excluding local opinion when Governmental intervention is put into action. For sustainability to become a reality it is important that firm foundations are laid in the local communities. After all, they are the owners of the land and it is their needs that must be acknowledged if any plan is to be successful. Through the continuation of the work outlined in this document, it is hoped that a balance may eventually be found that allows healthy economic development, without the degradation of important natural assets such as the sea turtles and their environment.

ACKNOWLEDGEMENTS

The KMTP would like to extend their thanks to the Overseas Student Travel Fund for their assistance with travelling expenses from the U.K.; participation of JH was made possible by support of funds donated the Symposium by the David and Lucile Packard Foundation.

THE CONVENTION ON MIGRATORY SPECIES AND MARINE TURTLE CONSERVATION

Douglas J. Hykle
UNEP/CMS Secretariat, Martin-Luther-King-Str. 8, D-53175 Bonn, GERMANY. dhykle@cms.unep.de

The Convention on Migratory Species (CMS or Bonn Convention) is a global intergovernmental treaty concerned exclusively with the conservation of migratory species and the habitats on which they depend. Its taxonomic coverage is diverse, encompassing marine turtles, migratory birds, as well as marine and terrestrial mammals. Its membership currently stands at over 50 contracting Parties worldwide. The Convention's activities are focused on two lists of species. Animals listed in Appendix I are considered endangered and are afforded strict protection. A much larger number of species listed in Appendix II warrant the development of specialized conservation agreement among Range States. Marine turtles benefit from listing in both CMS appendices, and are receiving increased attention under the Convention. So far, this has taken the form of sponsorship of regional workshops and strategic planning sessions, and financing of other important conservation initiatives.

UNIVERSITY PROJECT ON STUDY OF CUBAN SEA TURTLES

María Elena Ibarra Martín[1], Georgina Espinosa López[2], Félix Moncada Gavilán[3], Jorge Angulo Valdés[1], Gonzalo Nodarse Andreu[3], Gloria Hernández Aguilera[2], and Johan Pacheco Roberto[4]
[1] Centro de Investigaciones Marinas, Universidad de la Habana, Cuba. anaicr@correo.co.cu
[2] Dpto. de Bioquímica, Facultad de Biología, Universidad de la Habana, Cuba
[3] Centro de Investigaciones Pesqueras, Ministerio de la Industria Pesquera, Cuba
[4] Delegación CITMA, Pinar del Río, Cuba

INTRODUCTION

Sea turtles are well represented in the diverse Cuban fauna and throughout history have been an important source of revenues for coastal communities. Currently, this "primitive" group has gained scientific and economical importance in many countries all over the world.

The indiscriminate overexploitation, its poorly understood biology, and other indirect causes, such as habitat destruction, have provoked the depletion of many sea turtle populations (Carr, 1952; King, 1995; Ross, 1995). This situation has become a key point of discussion for the scientific community. As a result, many countries and international organizations have enacted regulations and have implemented new conservationist strategies to protect such a unique living form. At the same time, CITES has included sea turtles under the appendix 1 of its regulation.

Four species of sea turtles have been reported for the Cuban archipelago. They are the hawksbill turtle *Eretmochelys imbricata*, the green turtle *Chelonia mydas*, the loggerhead turtle *Caretta caretta*, and the leatherback turtle

Dermochelys coriacea being the last one rarely observed.

Before the latest 80´s much of the work done in Cuba, regarding sea turtles, was related to harvesting and ranching. During the 90´s the Ministry of Fishery started a National Research Program on Mark-recapture of *E. imbricata*. Within this national program, topics such as: migrations (Moncada, 1992, 1994, 1996, 1998) and (Moncada *et al.*, 1995), reproductive behavior (Moncada *et al.*, 1987), feeding preferences (Anderes and Uchida, 1994), ecological distribution (Pérez *et al.*, 1994), controlled nursery (Nodarse, 1994), sexual maturity (Moncada and Nodarse, 1994 and Sanz, personal communication), and population genetic (Espinosa *et al.*, 1996 and in press) have been addressed. Even though, most of these works have not been published, results have been presented and discussed in several international workshops.

Most of the previous work was carried out within fishery areas until 1994 when all but two of the sites were closed to fishing becoming authentic areas for scientific studies. Among sites the Cayería de las Doce Leguas and Playa el Guanal are those from many of the studies have been done.

Having into account that the Western part of the country (Pinar del Río province) has rarely been studied, that it is easy to get there by road, and that *C. caretta* and *C. mydas* have been reported to nest in that area, it is this institution's interest to develop this project.

OBJECTIVES

1. To determine nesting areas, to characterize nests and nesting animals.
2. To promote conservation and sustainable use of sea turtles in university students and local communities.

SPECIFIC OBJECTIVES

1. To determine the main nesting areas in the western part of the Cuban archipelago and to assess the suitability of establish Turtle Camps down there.
2. To gather morphometric data from nesting animals and eggs, and to determine abiotic factors, such as temperature and humidity.
3. To estimate the genetic diversity of sea turtle populations that nest in the area.
4. To improve conservationist and environmental thoughts in university students.
5. To develop and improve environmental education in local communities.

METHODOLOGY

Study area:

In 1987 UNESCO declared the Península de Guanahacabibes as a Biosphere Reserve. This area is located at the most western part of the Cuban archipelago and encompass 1, 015 Km^2. Its south coast stretches from about 75 to 80 Km and includes rocky shore and sandy beaches suitable for nesting. On the marine side occurs coral reefs and seagrass beds being the last ones important feeding and growing areas for sea turtles.

The study will be carried out in two well known beaches from the south coast of Península de Guanahacabibes. They are Playa Antonio and Caleta del Piojo which extend from about 150 to 200 m.

No turtle camp has ever been implemented in these beaches before. Nonetheless, some work on harvesting and ranching have been done by local people (Fico Valera y Cardona, personal communications).

Research design and work plan:

1. *Preliminary visits*: These visits will be carried out in order to get a general idea about the study area, to determine the beginning of the nesting season, to identify sea turtle species, to determine turtle camp's sites, and to interview local inhabitants. (3 months)

2. *Seminars*: Having known the study area's features lectures and seminars will be given to university students to let them know the kind of work to do. (36 months)

3. *Educational activities in rural areas*: Lectures will be offered to teachers of rural schools and small student-groups will be created to facilitated the understanding and comprehension of protection and sustainable use of marine turtles and other species. A publication, made by students from the Faculty of Biology of the University of Havana, will be delivered among local population to teach and encourage them the gathering of scientific data from sea turtles. (36 months)

4. *Sampling visits*: Couples of students will do nocturnal walks, along the selected beaches, to get morphometric data and diverse information from nesting turtles. (27 months)

5. *Getting of morphological and ecological data*: The following data will be collected

Morphological: Weight, Caparace length., Tail length., Nail length.

Ecological: Beach slope, . Distance from the nest to the mean tide line, . Kind of vegetation surrounding the nest, . Type of sand, Other data of interest. .

Along morphological and ecological data small samples of skin and muscle will be also taken, from every turtle, and conserved in alcohol 95 % for DNA analysis. (36 months)

6. *DNA variation analysis*: Amplifications from DNA extracts will be done using the Polymerase Chain Reaction methodology (PCR). This PCR-products will be digested using different restriction endonuclease. It will allow the estimation of haplotype and nucleotide diversity. It will also permit to calculate differentiation index among populations, and the contribution of different nesting colonies to Cuban feeding grounds. All this analysis will contribute to a better management of sea turtle populations. (30 months)

EXPECTED RESULTS

Expected results will be in accordance to the activities carry out by professors and students during the study.

1. To identify all sea turtle species that nest in the area and to assess the size of their populations.
2. To estimate the size composition of the nesting fe-

males and to get morphometric measurement from them.
3. To assess the nesting succeed through nests and eggs counting, and elapsed time before egg hatching.
4. To determine sex proportion in juveniles.
5. Genetic characterization of the populations.
6. To improve environmental education work with local communities.
7. Results derived from this project will be published in Revista de Investigaciones Marinas, might be used for teaching purposes at the University of Havana, and would be presented in national and international workshops.

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MIYAPUNU AND TOLNGU: SEA TURTLE CONSERVATION IN NORTH-EAST ARNHEMLAND, AUSTRALIA

Rod Kennet
Faculty of Science, Northern Territory University, Darwin, Northern Territory Australia. rkennett@banda.ntu.edu.au

The Yolngu people have occupied north-east Arnhemland in the Northern Territory of Australia for some 50 000 years. Today they maintain strong cultural, spiritual and economic ties to their country. Miyapunu (sea turtles) and their eggs are an important traditional resource and the sustainable management of sea turtles is a priority. Their land management agency, Dhimurru Land Management Aboriginal Corporation, in cooperation with the Parks and Wildlife Commission of the NT and the Northern Land Council, oversees land and resource management in the region. The project combines traditional and contemporary Aboriginal knowldedge with non-Aboriginal (balanda) data and research methods to improve our current poor understanding of sea turtle distribution and ecology in the region, and to estimate the extent and composition of the harvest of sea turtle and eggs. It explores ways of gaining the support and involvement of Yolngu, who are essential to the data collection process, and ultimately to the successful implementation of any management recommendations. An overview of the project including future directions, and some preliminary data on the egg and turtle harvest will be presented.

THE RIDLEY SEA TURTLE POPULATIONS IN MEXICO

René Márquez Millán
Instituto Nacional de la Pesca, CRIP-Manzanillo, México. rmarquez@bay.net.mx

The sea turtles have some biological characteristics that are important for their administration as a resource: their distribution is tropical and subtropical, they have high fecundity but also high mortality by predation, have slow growth rates and in our latitude, depending on the species, the age to maturity is reached commonly between one and two decades. Also some turtles like *Chelonia* sp. and *Eretmochelys* sp. have the property of being successfully captive-reared and one of the most important facts is that they can be easily captured direct and indirectly.

In México their capture increased rapidly in the 60's, from 2 to 14.5 thousand tons (1963 to 1968), then some populations were considerably depleted and a total ban was proclaimed in 1972-1973. After the ban, the fishery was reorganized and the protection of the nesting beaches was increased. Since poaching of eggs and adults continued in most beaches, more populations were decimated and several of the more important nesting beaches were lost. There are 11 kinds of sea turtles, 10 can be found in Mexico and 9 of them nest in our beaches, in the next order of abundance: *Lepidochelys olivacea*, *Chelonia m. mydas*, *Caretta c. caretta*, *Chelonia agassizii*, *Lepidochelys kempii*, *Dermochelys c. schlegeli*, *Eretmochelys i. imbricata*, *Eretmochelys i. bissa* and *Dermochelys c. coriacea*, only *Caretta c. gigas* doesn't nest in our beaches, nor does so in the western American coasts.

After decades of beach protection, in México two populations have shown positive trends, one of them is the "olive ridley" (*L. olivacea*), that nests in Oaxaca state and nowadays is the more abundant sea turtle, with over 800,000 nests per year (considering only one beach, "La Escobilla) and the other is the Kemp's ridley (*L. kempii*) the most endangered species, with a few more than 2,000 nets per year. Each of our other sea turtles usually have no more than 5,000 nests per year, but ortunately, at least other two, *C. m. mydas* and *E. i. imbricata* also show positive trends of abundance.

According to the diversity and abundance of sea turtles it is possible that at the present México is one of the more important countries, since both the government and the society are compelled to solve in a near future the relationship between turtles and man.

COMMON SENSE CONSERVATION

Rod Mast
R.MAST@conservation.org

In considering the objectives, strategies and methods we employ for achieving the goals of marine turtle conservation worldwide, it is useful to look at biodiversity conservation in general, what has worked and what has not in recent times. An overview of some of the successes and failures and the lessons they can teach us, can help turtle conservationists and managers to better determine what are the common sense approaches that will lead most rapidly and efficiently to their goal. Standard biodiversity priority-setting models like those used for tropical forests, when adapted and applied to marine turtles, can serve as useful guides to those investing in the conservation of turtles and their habitats. Similarly, a glimpse at some past successes in wildlife management (*in situ* and *ex situ*) can provide answers about the directions we take as managers and researchers of marine turtle species and populations. The author will propose some over-arching principles for effective marine turtle conservation and management.

RESEARCH UPDATE ON THE CUBAN HAWKSBILL TURTLE PROGRAM

Charlie Manolis[1], Elvira Carrillo C.[2], Grahame J. W. Webb[1], Hiroko Koike[4], Rogelio Diaz F.[3], Felix Moncada G.[2], Alexis Meneses P.[2], Gonzalo Nodarse A.[2], Georgina Espinosa L.[3], and Bryan Baker[1]
[1]Wildlife Management International, PO Box 530, Sanderson, N. T. 0812, Australia. cmanolis@wmi.com.au
[2]Ministerio de la Industria Pesquera, Cuidad de la Habana, Cuba
[3]Facultad de Biologia, Universidad de la Habana, Cuidad de la Habana, Cuba
[4]Graduate School of Social and Cultural Studies, Kyushu University, Kukuoka, Japan

INTRODUCTION

Hawksbill Turtle shell has been produced by Cuba since the 1500's, and until the cessation of international trade (in 1992), it was one of the main suppliers of *Eretmochelys imbricata* shell from the Caribbean region. In 1968, Cuba's sea turtle fishery was organized into a more formal, managed fishery, organized within four defined harvest zones (Zones A-D). In 1983 the Cuban Ministry of Fishing Industries instigated a more scientific approach to the fishery, and more detailed data (size, reproductive status, stomach contents, etc.) were collected on *E. imbricata* taken within each of the fishing zones. In 1990, the fishery was voluntarily phased down, so that fishing effort could be diverted to other export fisheries, and in 1994 the taking of *E. imbricata* was restricted to two traditional harvest sites [Isle of Pines (Zone B; southwest); Nuevitas (Zone D; northeast)] (ROC 1997a; Carrillo *et al.*, 1997a).

In 1997, Cuba submitted a proposal to the 10th Conference of Parties to CITES to transfer *E. imbricata* in Cuban waters from Appendix I to Appendix II (ROC 1997a). The proposal presented a variety of detailed data to support Cuba's case. Additional data collected after submission of the proposal were distributed at the CITES meeting in June 1997 (ROC, 1997b), and this Symposium provides an opportunity to provide a further update on key research programs currently underway in Cuba.

One of the key concerns raised about Cuba's proposal to CITES was the extent to which harvests in Cuba may affect the status of *E. imbricata* elsewhere, and vice versa. As definitive data on rates of immigration and emigration for sea turtles are not available, this issue was, and remains, difficult to resolve. There was a misconception that a "closed" population was being advocated by Cuba. There is no "closed" population of sea turtles anywhere, and Cuba has maintained that it does not have a closed population of *E. imbricata* (ROC, 1997a, b). Rather, Cuba has consistently rejected the notion that all *E. imbricata* move randomly throughout the Caribbean region, and that to accept such a theory on the basis of speculation would be irresponsible based on the evidence to date.

REPRODUCTIVE DATA

Examination of over 8700 *E. imbricata* taken during the harvest period (1983-1995; Carrillo *et al.*, 1997b) yielded extensive data on reproduction (Moncada *et al,*. 1997b). (Data collection has been maintained at the traditional harvest sites). General patterns of reproduction of *E. imbricata* in Cuba were apparent, but more importantly, these data provided insights into reproduction within the different fisheries zones.

Although proportions of female *E. imbricata* containing follicles were similar in different fishing zones, lower proportions of females caught in Zones B, C and D were found to contain shelled eggs (2.9%, 6.3%, 1.6% respectively), compared with Zone A (10.6%) (Moncada *et al.*, 1997b), the main nesting area in Cuba. These data suggest that a significant proportion of females with enlarged follicles in Zones B, C and D move out of their capture zone to nest. This was not the case with females in Zone A, where the data were consistent with turtles caught there actually nesting there.

The main period of reproductive activity (August-December) is also the time when fewer turtles containing eggs are caught in Zone D, consistent with movement of turtles to Zone A. Based on these reproductive data, it was estimated that some 65% of reproductively active *E. imbricata* were in Zone A. Zone-specific harvest data between 1983 and 1990 (before harvests were scaled down) indicated that Zones A and D accounted for 64% of the total Cuban harvest (Carrillo *et al.*, 1997b).

TAGGING STUDIES

Eretmochelys imbricata have been tagged in a number of countries in the Caribbean (*e.g.* Antigua, Costa Rica, Mexico, Virgin Islands, Bahamas, Puerto Rico), and until recently only two (both from Mexico) had been recovered in Cuba, in the western part of the country. Tags from an *E. imbricata* marked in the Bahamas is reported to have been recovered in Cuba (Zone D) in August 1997 (Bjorndal and Bolten, 1998). There are no records of tags from *E. imbricata* marked in Cuba being recovered in any other country - all have been recovered in Cuban waters.

In contrast, harvesting in Nicaragua has led to the recovery of tags from *E. imbricata* originally tagged in Costa Rica, the Virgin Islands and Puerto Rico. *Chelonia mydas* and *Caretta caretta* tagged in Cuba have been recovered in various countries throughout the Caribbean, and vice versa (Moncada *et al.*, 1997a). Notwithstanding the lower numbers of *E. imbricata* tagged, the results for *E. imbricata* are different from other species, and are more consistent with spheres of movement rather than random movement.

Tag recoveries from *E. imbricata* tagged on the northern coast (Zone D) suggested movement in an easterly direction, with some animals rounding the eastern tip of Cuba (Moncada *et al.*, 1997a). In contrast, tag recoveries in Doce Leguas (Zone A; southeast) were indicative of a higher degree of residency. As a tagging program was only recently initiated at the Isle of Pines (Zone B), no comparable data are available from there.

MITOCHONDRIAL DNA

To date, the Cuban study has resulted in the analysis of 529 samples (nesting and foraging) from Mexico (126), Puerto Rico (74) and Cuba (279), and additional samples are currently being analyzed. However, although mt-DNA studies are a very powerful tool, caution must be exercised when interpreting the results from such studies (*e.g.* Mrosovsky, 1997). That foraging populations contain a wider range of haplotypes than those hatched in nearby beaches is true, but the degree to which mt-DNA results can be used to establish current rates of immigration and emigration for marine turtles is unclear (Bowen and Bass, 1997). The approach taken by Cuba is to treat such results cautiously, and to continue to expand their database.

Notwithstanding that sampling biases can be significant (ROC, 1997b), data from Cuba indicate that a high proportion of *E. imbricata* in 3 foraging zones (Zones A, B, D) shared nesting haplotypes from one zone (Zone A). Some 86% of turtles foraging in Zone A shared the same haplotypes as nesting samples from that zone. High proportions of foraging animals in the two other zones (65% and 66% in Zones B and D respectively) also shared the same nesting haplotypes. Likewise, using data from Mexico and Puerto Rico, 71% and 76% of turtles in foraging areas shared haplotypes in nearby nesting areas (ROC, 1997b).

SATELLITE TRACKING

Satellite tracking of *E. imbricata* was recently initiated at the two traditional harvest sites in Cuba (see ROC, 1997a, b). Initial results from Nuevitas, on the northern coast indicated movement of 4 *E. imbricata* in an easterly direction, in inshore waters along the coast. These data were consistent with the pattern of tag recoveries from *E. imbricata* tagged at this site (Moncada, 1994; Moncada *et al.*, 1997a). Turtle fishermen with over 25 years of experience in this area have consistently stated that turtles are always caught on the western side of their nets, and when released on the other (eastern) side, are never recaught in the nets.

Results from the second traditional harvest site at Cocodrilos, on the southern coast of the Isle of Pines, in early 1997, consisted on one *E. imbricata* which stayed in the area of release for 75 days before transmissions ceased. Another turtle swam from the Isle of Pines to Cayman Brac (Cayman Islands), and soon after returned to Cuban waters (ROC 1997b) before transmissions ceased. Further work in late 1997, with 3 *E. imbricata* at the Isle of Pines, resulted in greater movement. One individual swam into Jamaican waters, before proceeding in an easterly direction until it reached the eastern Caribbean (area near Monsterrat, Guadeloupe, Antigua). The second turtle headed in a southerly direction, passing to the east of the Cayman Islands, and proceeding to shallow waters off the coast of Honduras and Nicaragua; it later changed direction, moving east to Colombia. Transmissions subsequently ceased for both of these animals. The third individual moved in a northwesterly direction before moving south to shallow waters off Campeche Bank, Yucatan, Mexico. Readings are still being recorded for this turtle.

The lack of readings when animals reach shallow waters remains a concern, and damage to the transmitter aerials as animals swim in coral reefs may be the cause of sudden cessation of readings from some of the transmitters. Previous studies with *E. imbricata* have demonstrated this problem. Nonetheless, the study will continue, and the next stage will involve transmitters being placed on *E. imbricata* in nesting and foraging zones in Cuba, and perhaps in collaboration with other countries in the Caribbean, with *E. imbricata* in their waters.

CONCLUSIONS

Cuba has long been a major supplier of *E. imbricata* shell and Japan the main buyer, until trade ceased in 1992. Anecdotal evidence from Japanese artisans with a long history of working with *E. imbricata* shell ("bekko") suggests differences between shell from different areas. For example, they have been able to distinguish Cuban shell from that derived in other parts of the Caribbean, and have long valued it above that from countries such as Panama, Nicaragua and Mexico. Color, pattern and the workability of the shell have been identified as key differences.

Through studies with tagging, mitochondrial DNA and satellite tracking, Cuba continues to address the question of the extent to which *E. imbricata* move in and out of Cuban waters. Satellite tracking has provided some valuable data, but no definitive rates of immigration or emigration can be quantified from the limited data collected so far. The cost of carrying out satellite telemetry means that this aspect of the program will proceed cautiously, steadily providing new data.

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SEA TURTLE RECOVERY ACTION PLAN FOR KENYA

Jane R. Mbendo[1], George M. Wamukoya[2], and Felix P. Kaloki[3]

[1] Fisheries Department, P. O. Box 90423, Mombasa, Kenya. 104721.3234@compuserve.com

[2] Kipini Community Conservation Centre, P. O. Box 1209, Mombasa, Kenya

[3] Kindemothilfe Africa, P. O. Box 39531, Nairobi, Kenya

INTRODUCTION

Sea turtles continue to play an important role in the cultural and socio-economic development of the coastal communities of Kenya. The historic cultural act of capturing sea turtles by use of the sucker fish (remora) links these people, society, environment and biota. It is a means through which knowledge of the sea and marine life is passed on, technological patterns maintained and, sea and resource procurement skills socially rewarded.

The green turtle (*Chelonia mydas*) is an important source of protein and is significant as an item of social exchange. The hawksbill turtle (*Eretmochelys imbricata*) provides tortoiseshell and scutes sold for commercial gain. Turtle oil, considered medicinal is used in the treatment of asthma, ear infections and paralysis. Once obtained turtle meat is shared among kinsmen and villagers at different levels increasing in symbolic value at every level. Evidence of declining harvests of sea turtles can be attributed to depleted stocks and presence of legislation. The most significant threat to sea turtle survival in Kenya, however, is incidental capture in set gill nets and trawfl nets. Emphasis has to be laid upon both protection of turtles and their eggs, protection of important feeding and nesting habitats and enforcement mechanisms.

Current local legislation in the form of the Fisheries Act, Cap 378 and the Wildlife Conservation and Management Act, Cap 376, has proved inadequate in providing for the recovery of sea turtles. This legislation does not provide for the recovery of habitats critical to sea turtles and enforcement efforts are hampered as several enforcement agencies are charged with this responsibility, creating obvious jurisdiction overlap. There is also lack of capacity in the form of personnel and equipment. Most of the turtle nesting areas are remote therefore encouraging the illegal transactions of turtle products to continue unnoticed since surveillance is also wanting. Local community participation seems to be the only plausible way to control illegal exploitation and conservation of sea turtles and their habitats.

The Kenya sea turtle conservation committee has maintained education and awareness. Under the same committee, funds are being generated to support the community reward scheme for local fishermen who participate in turtle nest protection and also for compensation of nets destroyed in the event of incidental capture. Through grassroots actions, multimedia campaigns, hands-on conservation projects, environmental education and prosecution KESCOM has persisted with efforts towards recovery of sea turtle stocks.

There is need for monitoring programs to establish population trends and also evaluate the success of conservation efforts, thus necessitating the selection of index beaches for comprehensive studies. The area between Kipini and Ras Biongwe within the Tana River delta is the most important nesting beach for turtles in Kenya.

The migratory nature of sea turtles calls for regional co-operation. For any effective management to be achieved there must be National, Regional and international initiatives. The Kenya sea turtle recovery action plan seeks to provide policy makers and the public with detailed information necessary to make informed decisions regarding the conservation and recovery of depleted sea turtle populations in Kenya. Specific objectives include: to provide, the most current and comprehensive information on the distribution and status of sea turtles in Kenya, to indicate gaps in present knowledge, to review the national and international legal responsibilities of the government toward sea turtles, to discuss contemporary threats to continued survival of sea turtles in Kenya and to make recommendations for their sustainable conservation and management.

STATUS, DISTRIBUTION AND THREATS

The sea turtle species occurring in Kenya's waters include: the green turtle (*Chelonia mydas*), loggerhead (*Caretta caretta*), olive ridley (*Lepidochelys olivacea*), leatherback (*Dermochelys coriacea*), and hawksbill (*Eretmochelys imbricata*). Of these, the green turtle and hawksbill which appear to be evenly distributed, nest along the entire coastline, the green turtle being most common. Nothing is known of the pelagic distribution or extent and abundance of the olive ridley, loggerhead and leatherback turtles, although olive ridley have been reported to be localised in Ungwana Bay (Frazier, 1975). There is also inadequate indigenous knowledge of the loggerhead and leatherback turtles making it difficult to determine their distribution. Hughes (1971) reported that loggerheads nesting in Natal, South Africa and marked with metal tags have been captured in Malindi at the Kenya coast, thus confirming their use of Kenya's waters.

An obvious decline in the number of nesting females has been documented (Olendo, 1993). The older fishermen further reveal that most of the sea turtles presently encountered during fishing expeditions are smaller in size. They also indicate that there has been a rapid and drastic decline in turtle numbers and nests along the Kenyan coast in the past two decades, although a large number of pelagic turtles is reported. This implies that there are two different populations along the coast consisting of a migratory population and the resident population. It is not known, however whether the sea turtle population along the coast is stable or declining, though there is evidence that some nesting populations have been virtually exterminated (Wamukoya *et al.*, 1995). Noticeable is the sporadic nesting pattern typical today along the coast.

The threats faced by sea turtles in Kenya include: destruction and modification of habitat, trawling activities and sedimentation in Ungwana bay which cause a change in the structure of the sea bed and characteristics of the outlying waters and elimination of species habitats, thereby affecting the functioning of the entire ecosystem. Sea grass beds are known to be showing signs of stress in some areas due to sedimentation, sewage and other effluents. Dynamite fishing, use of spear guns, beach seining and use of poisons/ chemicals results in damage of benthic communities. Sand mining affects turtle nesting beaches. Coastal development triggered by the tourism industry is a critical threat as economic benefits precede conservation. Over-exploitation from traditional practice both for subsistence and commercial purposes is exacerbated by the recent political unrest in neighbouring Somalia as a spill-over of refugees (Kayamas) increase the pressure on turtles. Ineffective law enforcement has led to poaching of eggs, turtle meat and oil which are sold in the remote areas of Mtondani and Tenewi.

MITIGATION MEASURES

For an effective recovery programme, protection of marine and terrestrial habitats is critical. The integrity of sandy beaches is also essential. Protection and sustainable use of these habitats requires conscious planning. It is recommended that proper land use planning for the coastal zone and development mechanisms to foster successful implementation of the same, at local level be put in place. Environment impact assessments need to be made mandatory for all coastal projects. This should be a holistic, interdisciplinary approach that considers impacts from both natural and anthropogenic effects.

Surveillance and enforcement capabilities by the departments concerned need to be strengthened. There is need to determine incidental catch and promote the use of turtle excluder devices. The technology transfer has been done and the experimental phase of implementation is in progress on three shrimp trawlers in Ungwana Bay. Also regulation of set nets and drift nets is essential coupled with the use of closed seasons. Sewage disposal systems have to be put in place. Annual beach clean-up exercises are carried out to clear the beaches of marine debris especially plastics usually ingested by leatherback turtles. An oil spill contingency plan with appropriate equipment and capability to handle up to tier 2 spills is in place.

Supplementing reduced populations through management techniques has involved: protection of eggs by transplanting nests and relocating to safer identical areas. Community participation has been fostered for the success of collaborative management. The success of co-management depends on whether these areas can provide benefits sufficient for the local communities to participate in conservation. Their cultural and economic interests must be seen to be served. Suitable mechanisms for conflict resolution are necessary. An approach of facilitating and supporting income generating activities for the local people is also being employed. Long term data for monitoring programmes has to be accrued and techniques standardised so that scientific understanding of the trends in sea turtle populations can be achieved. Public education and awareness need to be carried out so that the recommendations in the action plan are articulated effectively with a view of enlisting public support. Gaps in legislation ought to be identified and augmented whilst new regulations are proposed. Networking and information exchange are to be co-ordinated within the Western Indian Ocean marine turtle strategy.

KIPINI COMMUNITY CONSERVATION CENTRE

The area which is situated at the Tana River delta is a unique ecosystem encompassing a large number of habitats. The most critical, however, are: coastal ecosystems such as estuaries, wetlands and mangrove forests; Mtondani and Tenewi marine turtle nesting beaches; Ziwayuu/Tenewi marine turtle and dugong feeding habitats; sand dune ecosystem; and marine and fresh water fisheries resources. The need for proactive intervention against the resulting anthropogenic environmental degradation in Kipini led to the formation of the community conservation group in 1996, whose aims broadly address sustainable development and natural resource management, while enhancing local community participation through capacity building and incentives. The centre has a main focus on conservation of ecological processes and threatened species particularly marine turtles and dugongs and their habitats by managing human activities. Secondly, determining levels of resource use that are sustainable and to encourage all user groups to keep within those limits. Finally, to encourage fair and equitable sharing of the benefits of effective management and conservation.

CONCLUSIONS

In a bid to manage the most important habitats for the continued sustainability of the sea turtle population in Kenya, it is important to recognise the need to manage the Tana River delta as a whole ecosystem in its entirety, rather than focusing on a single resource, as the dynamism of the whole ecosystem is significant to the survival of sea turtles. The conceptual framework has to include ecosystem functions, human uses, and the interplay of the two. Traditional conservation methods should be blended well with modern scientific approaches in planning for sustainable development. Inevitably all stakeholders are required to participate so as to provide an opportunity for local communities and developers to synchronise their activities.

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SEA TURTLES IN THE REPUBLIC OF SEYCHELLES: AN EMERGING CONSERVATION SUCCESS STORY

Jeanne A. Mortimer[1 and 2]
[1]Department of Zoology, University of Florida, Gainesville, Florida 32611 U.S.A. jmort@compuserve.com
[2]Division of Conservation, Ministry of Environment, Victoria, Mahe, Republic of Seychelles

The Seychelles Islands, located in the Indian Ocean north east of Madagascar, were uninhabited when they were discovered by Europeans in 1609. From the time the islands were settled in 1770, marine turtles featured prominently in the economy of the Seychelles. Historically, raw shell from hawksbills (*Eretmochelys imbricata*) and dried calipee from green turtles (*Chelonia mydas*) (used by Europeans for turtle soup) were exported, and green turtle meat formed a staple in the local diet. This led to a serious decline in the turtle populations. Over time, the attitudes of both the Government and the general public towards turtles have changed significantly. Following is a description of some of the events that led to these changes as seen from the perspective of the author who has done sea turtle conservation work in Seychelles for more than six years—including three years during 1981-1984, several shorter visits in the late 1980's and early 1990's, and 2.5 years from 1995-1998.

In the early 1980's (and before) Seychelles had primarily a rural economy. Most Seychellois were oriented toward the direct utilization of natural resources. Because of the historic economic and cultural importance of turtles, Seychellois took particular pride in their tradition of turtle exploitation. On the inhabited islands, most female hawksbills emerging onto the nesting beach were killed for their shell which was either exported to Japan or used in the local tourist curio trade. Both fresh and salted green turtle meat was readily available, and although the law protected nesting female green turtles, in fact, its enforcement was difficult. But even in that society, and even among poor illiterate people, there were special individuals who could appreciate turtles for their intrinsic value as beautiful, living animals.

Unfortunately, in virtually all societies, people have viewed marine turtles as valuable primarily because they could be cut into pieces and their parts utilized directly or sold to generate income. This attitude in itself is not problematic except where such utilization becomes unsustainable in the long term (as is often the case). As conservationists, we need to find ways for people to generate income from sea turtles in a manner that will not destroy the populations. In recent years, in some parts of the world, sea turtles have taken on new value as a tourist attraction.

RECENT EVENTS

In Seychelles, the patterns of overharvest documented between 1981 and 1984 (Mortimer, 1984) continued relatively unchanged until about 1989 when Seychelles developed a National Environmental Management Plan (EMPS) and put in a bid for a multimillion dollar grant from the Global Environment Facility (GEF) to fund implementation of the plan. Critics both inside and outside the country questioned the commitment of Seychelles to environmental protection, given the unsustainably high levels of sea turtle exploitation taking place. After discussion and debate the Seychelles Government determined to make policy changes.

In 1993, the Government implemented the *Hawksbill Artisan Compensation and Retraining Programme* through which the artisans reached a consensus between themselves and the Government to: 1) give up their businesses as turtle shell artisans in exchange for financial compensation; and 2) sell their stocks of raw shell to the Government. These stocks of raw shell have been maintained by the Government in a sealed container. The program, which cost US$ 250, 000 (50% paid by the Global Environment Facility and 50% by the Government of Seychelles), has been highly successful. All the artisans are now employed in alternative occupations, and domestic trade in hawksbill shell products is no longer apparent. In 1994, having protected the curio artisans from economic hardship, the Government passed a law offering complete legal protection for sea turtles.

Sea turtle conservation in Seychelles also got a boost from the fact that during much of the past decade the Seychelles economy has been strong, and become largely a service economy based on tourism—tourism being the primary source of foreign exchange for the country. The Seychelles Government has come to appreciate that foreign tourists are attracted to Seychelles because of her beautiful environment, and that steps must be taken to preserve this beauty. Seychellois have also come to the (perhaps surprising) realization that Europeans love to see live sea turtles. In Seychelles, tourists can encounter sea turtles on the nesting beaches and also while snorkeling on the coral reefs in the vicinity of the tourist centers.

In mid-1997, both the Division of Conservation and the Ministry of Tourism and Transport expressed concern that dormant gill nets (a recently introduced fishing technique) were killing too many sea turtles and other forms of marine life. The Government responded by banning the use of such nets in near shore waters.

To be truly effective, such favorable national policies and Government commitment needed to be accompanied by a change in public attitudes at the grass roots level. This need was addressed by the *EMPS Project J1: Seychelles Turtle and Tortoise Conservation*, coordinated by the author between 1995 and 1998. The J1 Project implemented a wide range of activities relating to sea turtles, including: 1) institutional strengthening; 2) training of conservation personnel; 3) monitoring of the status and biology of nesting and foraging turtle populations; 4) identification of critical nesting and foraging habitats; 5) assessment of human impacts; 6) review of national legislation and policies pertaining to turtles; 7) collaboration with the Ministry of Education to sensitize school children; and 8) awareness campaigns directed at the general public. This paper will describe some of the strategies we used to enhance public awareness about the endangered status of sea turtles in the Seychelles.

STRATEGIES TO ENHANCE PUBLIC AWARENESS

The population of Seychelles comprises some 70, 000 people, primarily of African origin, whose first language is Seychellois Kreol. All the Seychelles media (including local TV, radio, and the press) respond positively to requests by the Ministry of Environment to cover almost any newsworthy event relating to turtles. But, our most powerful public awareness tool has probably been television. Almost every Seychellois family has a color TV, despite the fact that television has been a feature of Seychelles only since the mid-1980's, and until very recently had but a single station (SBC). The management of the Seychelles Broadcasting Company (SBC) strongly promotes environmental awareness. SBC regularly imports nature programs in both French and English from overseas sources. Perhaps more important, however, SBC produces their own shows in the local language (Seychellois Kreol) to highlight local environmental problems.

During the past two years SBC has featured sea turtle issues in the following programs in the Kreol language: 1) an hour-long documentary about sea turtles in Seychelles; 2) several "Magazine Shows" that incorporated 10-15 minute features about local turtle issues; 3) an hour long round table discussion about turtle issues; and 4) on the very popular nightly news program in Kreol, on more than a dozen occasions over the past two years. The news has reported on: the discovery of carcasses of illegally slaughtered turtles; stranded turtles that drowned in gill nets; workshops or seminars highlighting turtle biology or conservation; the intention of law enforcement officers to aggressively prosecute offences involving turtles; and actual arrests or prosecution of such cases.

In the presentation of information through the media we try to appeal to the sensibilities of the local culture through the following strategies:

1) Language. Although most Seychellois speak English, we usually present information in the local language, Seychellois Kreol.
2) Economic justification. We explain that live turtles in their natural state make a good tourist attraction that can be used to generate income for the Seychelles. We feature the turtle tourism pilot project at Bird Island as an example of a successful program in which tourists assist the island management to monitor the nesting population. Interviews with tourists demonstrate how much they enjoy the experience.
3) Appeal to national pride. We try to create an awareness of how the turtle resources of Seychelles are unique:
    a) Seychelles hosts some of the largest popula-

tions of hawksbills remaining in the world. Although these populations are vastly depleted from previous levels, many hawksbill populations in other countries are on the verge of complete extinction.

b) Only in Seychelles do hawksbills nest primarily in the daytime in significant numbers (another reason why they make a good tourist attraction).

4) Explain clearly why turtles need protection. Without an understanding of how the long age to maturity (which may be 30-40 years in some turtle populations) complicates successful management of a population, the casual observer may find it hard to believe that sea turtles are really in need of protection. Two approaches have proved successful:

a) The use of diagrams (Figure 1) to illustrate how damage caused by overharvest is masked by the long age to maturity. And to show that the damage may only become apparent after it is already too late to save the population. Mortimer (1995) explains the use of these diagrams.

b) Ensure that people understand the difference between the life cycles of sea turtles and those of the domestic animals with which they are more familiar. A good approach is to ask people to compare turtles to domestic pigs. After ascertaining that pigs usually take 6-8 months to reach maturity, the next step is to ask people to imagine how they would manage a pig farm if the pigs took 30 to 40 years to reach sexual maturity and if in the process most of the piglets did not survive to reach adulthood.

5) Maintain a dialogue with the turtle hunters. Since 1981, the author has cultivated the friendship and cooperation of men who made their living hunting turtles. These men often possess a great knowledge of turtle natural history and can also offer insights about the importance of the resource to the society as well as about the methodologies of exploitation. One such individual, who had been a close friend of the author since 1981, was employed on a full time basis as Project Assistant for the *EMPS Project J1*. He is one of the best turtle hunters in the country having literally killed thousands of turtles during his lifetime, and is highly respected by his peers. He now genuinely believes that the turtle populations have declined and are in need of protection, and he is willing to appear on TV and say so.

As a result of all the publicity, we have noticed heightened public awareness and participation. Coastal inhabitants regularly report sightings of nesting turtles to the Division of Conservation. They also call the police to report incidents of poaching. In the past year, some half dozen cases have been prosecuted as a result. Young people are enthusiastic about live sea turtles as can be seen in art exhibitions, poetry competitions and general classroom discussion. We have seen in Seychelles that a strong public awareness campaign is critical to the implementation of any good sea turtle management plan. Some of the strategies we have used in Seychelles can be and should be part of sea turtle management programs elsewhere in the world.

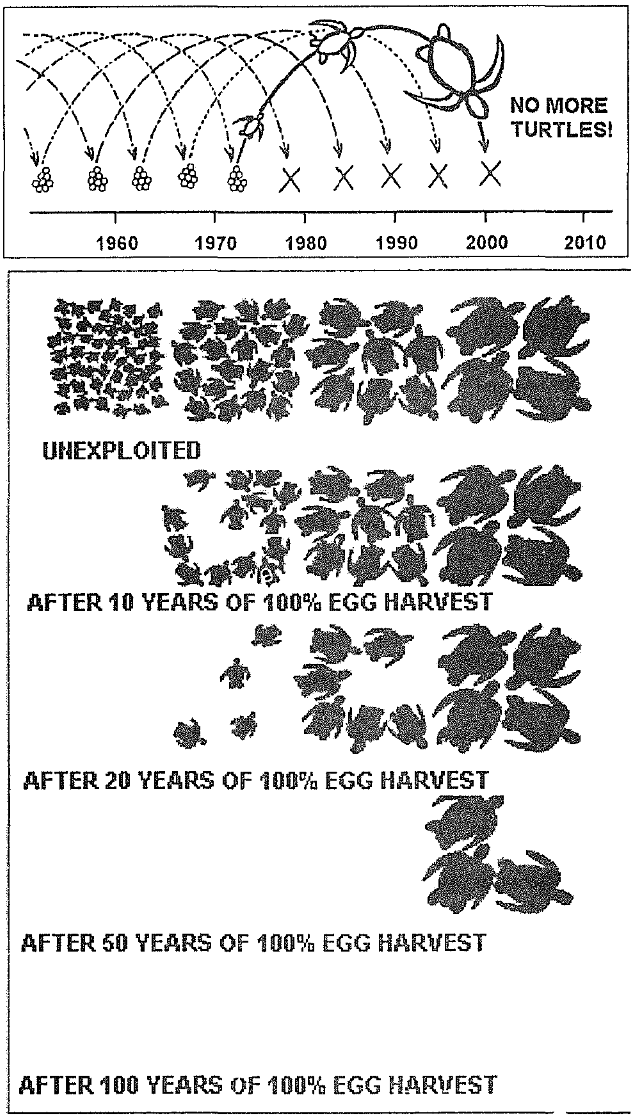

Figure 1. Diagrams illustrating how:
a) Slaughtering nesting females on the nesting beach can destroy a turtle population, even before a decline in the numbers of nesting females becomes apparent on the breeding beach; and
b) Overharvest of eggs will destroy a turtle population from the bottom up, even before the numbers of nesting females decline significantly at the breeding beach. For further explanation of diagrams see Mortimer (1995).

ACKNOWLEDGMENTS

The *EMPS Project J1: Seychelles Turtle and Tortoise Conservation* was conducted with funding from both the GEF (administered by the World Bank) and the Government of Seychelles. The success of the public awareness campaign would not have been possible without the hard work, collaboration and support of individuals from the Ministry of Environment (and especially the Division of Conservation and the Environmental Education section), Seychelles Broadcasting Company, and the local newspapers. I thank David Godfrey (CCC) for his helpful suggestions regarding this presentation.

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TWENTY FIVE YEARS NESTING OF OLIVE RIDLEY SEA TURTLE *LEPIDOCHELYS OLIVACEA* IN ESCOBILLA BEACH, OAXACA, MEXICO

Cuauhtémoc Peñaflores Salazar[1], Javier Vasconcelos Pérez[1], Ernesto Albavera Padilla[1], and René Márquez Millán[2]
[1]Instituto Nacional de la Pesca, Centro Mexicano de la Tortuga. P. O. Box 16, Puerto Angel 70902, Oaxaca, México cmtpenaf@angel.umar.mx
[2]Instituto Nacional de la Pesca, Centro Regional de Investigaciones Pesqueras. Playa Ventanas s/n, P. O. Box 591, Manzanillo 28200, Colima, México

INTRODUCTION

The olive ridley turtle in Mexico has a singular importance since it has constituted the historical support to the use of the turtle as resource. In the coast of Oaxaca, where their nesting is massive in two main beaches, La Escobilla and Morro Ayuta, their capture reached so high levels that it came to consider like an over-exploited population (Márquez *et. al,*. 1990). The above-mentioned was one of the circumstances that moved the Mexican Government to promote the decree of total ban for all species and subspecies of sea turtles in Mexican waters (Official Newspaper May 31st 1990) together with other actions in the search for recovery their populations.

Several authors have given definitions for *arribazón* and, with words more or words less, all give the idea of a natural phenomenon consistent in the massive arrival of marine turtles to the beach in order to deposit their eggs. They mentioned that it is a form of highly organized as evolutive result and not like a fortuitous phenomenon, that helps them in order to protect of predators (Pritchard, 1965), or like the typical form of massive, synchronized and day aggregation in order to could nest (Hildebrand, 1963 and Casas, 1978). Márquez in 1990 describes the *arribazón* like the emergency of nesting females to a small fringe of sandy beach and that it could last several hours or days. There might be more definitions, but the phenomenon continues reserving us big incognito on the factor or factors that discharge it and it makes possible that it happens.

WORK AREA

La Escobilla beach is in the Western end of a long beach of approximately 22 kilometers. The nesting zone has a longitude of 8 km. Traversal there are three fringes: the first is the zone that is narrow with an inclination approached of 30 degrees and it stays humid; the second is a platform of superficial dry sand with a width of up to 40 m. This is the area that most of the turtles use in order to deposit their eggs and the third zone, the most distant of the sea, it is covered with cringing vegetation and grasses (Warring *et al.*, 1992).

OBJECTIVE

To do a retrospective analysis of the nesting of turtle olive ridley in La Escobilla Beach, Oaxaca, during the period 1973 to 1997.

METHOD

In order to esteem the number of nesting during the *arribazones* it was applied the proposed method by Márquez and Van Dissel (1982), which is based in the number of females in beach every hour, differentiating them for activity in sampling areas previously established, it is obtained the nesting females esteemed of which sampling area, and the results are extrapolated for the whole *arribazón* zone.

With data obtained in the period 1973 to 1997 (Peñaflores *et al*, 1988) we made the pursuit of the number of *arribazones* and their annual frequency; it was defined the olive ridley turtle reproductive season. In accordance with bibliographical references was agreed to consider an average of 100 eggs by nest. During the periods when the hatchlings goal the surface was considered the amount produced in each *arribazón* using traps placement in sampling zones (10 meters); the breeding captured in the traps were counted and released immediately and this number was extrapolated (Guerrero *et al.*, 1992); this value is named *released hatchlings*. For several factors we consider around the 30 percent of the eggs deposited produce breeding that reach the sea (Márquez, 1992). It is considered that the sexual maturation happens between 8 to 10 years of age and that 3 percent of the number of hatchlings recruit to the reproductive population (Márquez, 1982), also each female nests on the average 1.6 times by season (Márquez, internal report 1983). Based on this we calculated the number of nesting females for each season. During commercial capture between 1980 and 1990 in San Agustinillo, Oaxaca, the sexual ratio was obtained.

RESULTS AND DISCUSSION

The number of *arribazones* for season fluctuate from 2 to 13 with average of 5, but if we differentiated the period of study in two stages: a) with legal capture (1973-1989) and b) without legal capture (1990- 1997). The averages show a remarkable difference one to another, for the first one is 3.6 while for the second is 8.6 *arribazones* by season (Figure 1). A change in the average period between *arribazones* also is observed, because in the first stage the average was 28 days (Márquez, 1976), and the second show a 17.4 days average; at the same time the increasing of reproductive season is observed from 6 months before the ban (June to December) to 11 months at the present time (May to March); the nesting top stays between August and October.

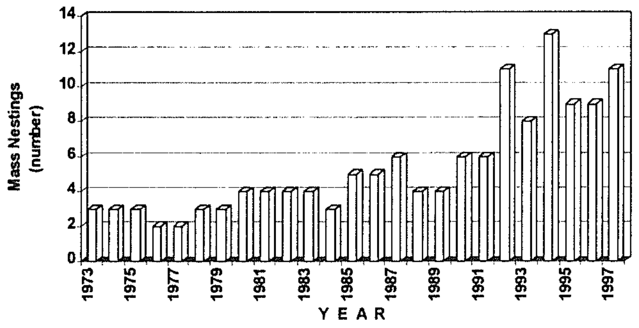

Figure 1. - Arribazones of olive ridley Lepidochelys olivacea in Escobilla beach during 1973 to 1997

With the nesting data we calculated have been released 169 million hatchlings of olive ridley approximately in the period of this work. The year with lowest hatchling production was 1975, while 1997-1998 is that of highest number of hatchlings produced. The annual average was about 7 million (Figure 2). In a sampling of 288.479 adult individuals (done during the period between 1980 and 1990), 85.5% were females and 14.5% males, with a ratio of 6:1 was obtained (Figure 3).

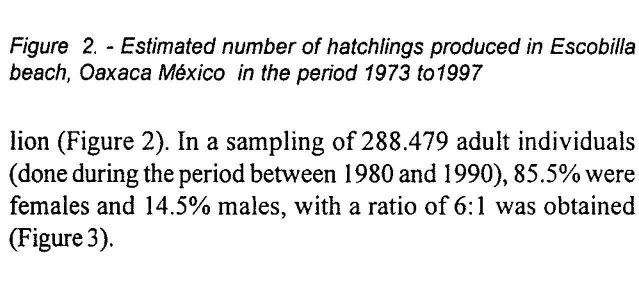

Figure 2. - Estimated number of hatchlings produced in Escobilla beach, Oaxaca México in the period 1973 to1997

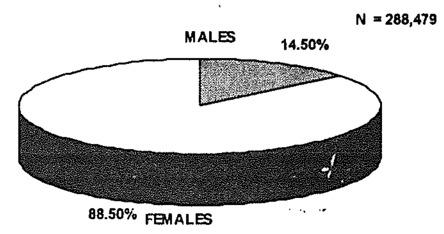

Figure 3. - Sex ratio of olive ridley in commercial catch in San Agustinillo, Oax.

CONCLUSIONS

- For the number of nesting females, La Escobilla beach is one of the most important in all the world.
- The forbidden in the commercial capture for olive ridley sea turtle has permitted recruitment and permanence to the reproductive population from hatchlings born in previous years.
- The trend to the increment in number of nesting fe1males permit to suppose the existence of several reproductive groups.
- In the current conditions it is very probable that the value of 1.6 times of nesting by season has modified having an increment.
- Due the overlapping for the increment in the number of nesting, as well as of *arribazones*, between them, with the rising destruction of eggs, which gives the phenomenon an aspect of waste of organic matter, is important to consider the possibility of the sustainable use of that protein. At the present time vultures, dogs and crabs take advantage of this protein.

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CONSERVATION AND MANAGEMENT OF THE OLIVE RIDLEY ON THE MADRAS COAST IN SOUTH INDIA

Kartik Shanker
Centre for Ecological Sciences, Indian Institute of Science, Bangalore 560012, India. kartik@ces.iisc.ernet.in

The Olive Ridleys that nest on the Madras coast appear to be on the decline, as do other populations on Indian coasts. While Whitaker estimated 100 nests/km/season in 1973, estimates ranged from 5-20 nests/km/season from 1988-1996. Nesting declined to 2-3 nests/km in 1997 and 1998. The main causes for the decline are the direct and indirect effects of urbanization. While poaching may have been prevalent prior to urbanization, it seems to have increased dramatically since. Public beaches and residential areas (which have expanded south along the coast about 1 km per year) are brightly lit. Habitat degradation has occurred due to sand mining and encroachment. Further, due to the decline in traditional fishing as a livelihood, because of pollution and competition from motorized trawlers, turtles have lost a protector (traditional fisherfolk worship turtles) and gained an enemy (opportunistic poaching by younger fishermen).

Various groups have been involved in sea turtle conservation on the Madras coast since 1973. The Students Sea Turtle Conservation Network (SSTCN) designed a cost-effective hatchery in 1988 (study area and methods are described in Shanker, 1994). Between 1988 and 1997, we collected 700 nests and released about 55, 000 hatchlings. The mortality of hatchlings (largely dead in pipped eggs) was high (20 to 30%) during 1988-91. Survival of hatchlings was inversely correlated with clutch size from 1989-1991 and with environmental temperatures in 1989-90. Low Survival in the hatchery was overcome by lowering nest density from 2 to 1 nest/m^2 in 1991-92, so that hatchling survival increased from 48 % in 1990-91 to 84 % in 1991-92.

Urbanization and fishing communities both continue to pose threats to nesting turtles, and coastal residents need to be mobilized to provide protection for the turtles. Earlier traditions can be revived in the fishing communities; this can be reinforced in various ways by the adjoining urban community which has the requisite financial resources. In this manner, those immediately in contact with the turtles can ensure their sustained protection on this and other inhabited coasts.

ACKNOWLEDGEMENTS

Members of the SSTCN over the past ten years are commended for their conservation efforts on the Madras coast. I thank the Ministry of Environment and Forests and the Tamil Nadu Forest Department, Government of India, for supporting our work and the organizers of the Symposium and The David and Lucile Packard Foundation for travel assistance.

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AGREEMENT FOR THE CONSERVATION OF SEA TURTLES ON THE CARIBBEAN COAST OF PANAMA, COSTA RICA AND NICARAGUA

Lucinda K. Taft[1], Chris Wold[2], Thomas T. Ankersen[3], Lizbeth Espinoza[4], Mario Boza[1 and 5], Anne Meylan[6], and Peter Meylan[7]
[1]Caribbean Conservation Corporation
[2]Center for International Environmental Law, Northwestern School of Law of Lewis Clark Law College
[3]Center for Governmental Responsibility, University of Florida College of Law
[4]Centro de Derecho Ambiental y Recursos Naturales, San Jose, Costa Rica
[5]Wildlife Conservation Society
[6]State of Florida Department of Environmental Protection, St. Petersburg, FL, U.S.A.
[7]Eckerd College, St. Petersburg, FL, U.S.A. ccc@cccturtle.org

A draft "Agreement for the Conservation of Sea Turtles on the Caribbean Coast of Panama, Costa Rica and Nicaragua" has been prepared to provide a framework for a coordinated and systematic multinational approach to the conservation of sea turtles. It is based on the premise that these nations share the responsibility for certain sea turtle populations that cannot be managed independently. Trilateral negotiations for the adoption of this unique agreement commenced in December 1997 in San José, Costa Rica. The Agreement calls for the Parties to establish a regional system of protected habitats based upon the biological requirements of sea turtles specific to these three countries, including nesting beaches and marine habitats. Parties together decide on a regional basis which marine and terrestrial habitats to protect. Implementation and enforcement duties are assigned to a Sea Turtle Conservation Advisory Committee, a nine-member committee of governmental officials, non-governmental organizations, representatives of the private sector, local people, and scientists. The Agreement prohibits many activities until the Parties demonstrate that they are sustainable or do not harm sea turtles. In order to maintain its focus on regional habitat protection and management, the agreement defers to the Inter-American Convention and CITES with respect to issues concerning turtle excluder devices (TEDs) and international trade. Additionally, the Agreement is expected to serve as a sub-regional mechanism for implementation of the recently concluded Inter-American Convention for the Protection and Conservation of Sea Turtles.

ILLEGAL HARVEST OF NESTING GREEN TURTLES *CHELONIA MYDAS* IN TORTUGUERO NATIONAL PARK, COSTA RICA

Sebastian Troëng and Thomas A. Rankin González
Caribbean Conservation Corporation, Apartado Postal 246-2050, San Pedro, Costa Rica. basse@hotmail.com

INTRODUCTION

Tortuguero National Park (TNP), situated on the Caribbean coast of Costa Rica, hosts the largest green turtle rookery in western Caribbean (Carr *et al.*, 1978). Tagging and monitoring of the nesting population was initiated in 1955 by the late Dr. Archie Carr and has since been conducted every green turtle nesting season (Carr 1956). A major issue in the early days of the green turtle monitoring program was the harvest of green turtle females from the beach (Carr 1969). Nesting turtles were turned and slaughtered mainly for their calipee which was exported to Europe and U.S.A. to be used as the main ingredient in turtle soup (Parsons 1962). Better protection for nesting females was provided in 1970 when 18 miles of the Tortuguero nesting beach became part of Costa Rica's first national park. Park rangers and Caribbean Conservation Corporation researchers and volunteers patrolling the nesting beach have since contributed to limit the illegal take of females from the nesting beach.

However, Costa Rican authorities currently allow a green turtle fishery. Permits are issued to fishermen in Limón, 55 km south of TNP, allowing a total annual catch of 1, 800 green turtles. The permits only allow fishermen to catch turtles in the sea and not within protected areas. Green turtles are caught entirely for the domestic Costa Rican meat market and consumption is mainly limited to Limón. The legal quota system is not strictly enforced which makes it easy for opportunistic fishermen to exceed their quota and sell green turtles caught on nesting beaches and in protected areas. Inadequate beach patrols by park rangers caused by lack of funding for Tortuguero Conservation Area (ACTo) have also contributed to an increase in illegal harvest of female turtles from the nesting beach in TNP.

A study was carried out during Caribbean Conservation Corporation's 1997 Green Turtle Program with the objective to quantify the illegal harvest of green turtles from the nesting beach in Tortuguero.

METHODOLOGY

The study period extended from 6 July to 26 September 1997. Track surveys were conducted weekly to determine the level of nesting and the number of turtles illegally harvested from the beach. The study area includes three beach sections. A total of twelve track surveys were conducted from Tortuguero rivermouth to 8 km south of the rivermouth (=beach section A). Eleven track surveys were conducted from 8 km south of Tortuguero rivermouth to Jalova lagoon (=beach section B=22 km), the most inaccessible beach section. Also, three track surveys were conducted from Parismina rivermouth to 8 km south of the rivermouth (=beach section C), outside of TNP. Green turtles nest only sparsely on this stretch of beach (<4 nests/night) but reports of extensive illegal harvest in this area rendered surveys necessary.

Track surveys were conducted in the early morning and only tracks from the previous night were recorded. The number of illegally harvested green turtles was determined by recording the drag marks from flipped-over turtles. Drag marks often covered each other. In such cases, the track surveyor would estimate the total number of turtles taken by poachers.

RESULTS

Ample evidence of illegal harvest was found during the course of the study (Figure 1). Relatively low levels of illegal harvest (0-3 females/night) occurred in beach sections A and C, throughout the study period. A large part of this harvest is likely to be for local consumption in Tortuguero and Parismina villages. However, turtles found flipped-over but alive in the morning indicate that part of this harvest was for commercial purposes.

Only live turtles are bought for slaughter in Limón, to ensure that the turtles are freshly caught. No illegal harvest was observed in beach section B during the first part of the study period. However, extensive illegal harvest began in beach section B in late August. Large-scale illegal harvest

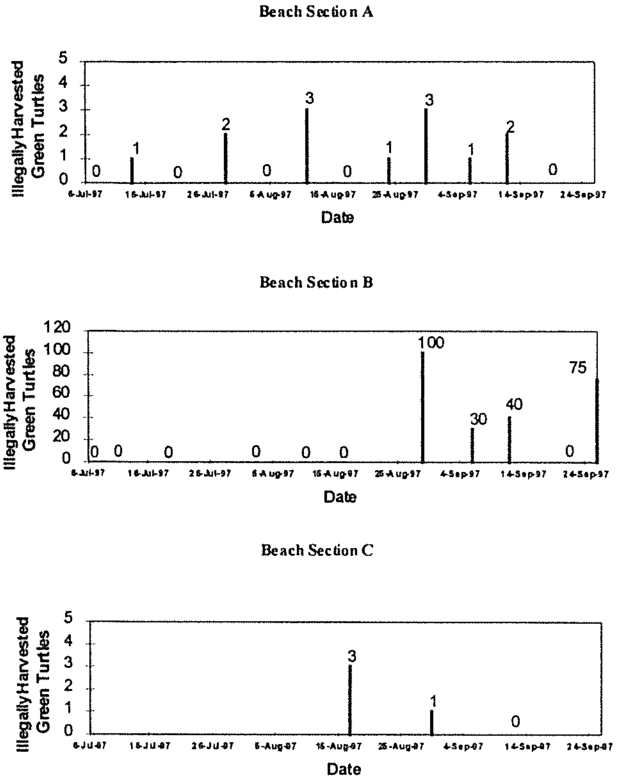

Figure 1. Illegal harvest of green turtles in: a) Beach Section A, b) Beach Section B, and c) Beach Section C.

bean Conservation Corporation staff encountered poachers and flipped-over turtles in a remote part of beach section B. The start of the intense illegal harvest coincided with the onset of calm seas that allowed boats from Limón to approach the beach at night.

The limiting factor for the illegal harvest in beach section B during the second part of the study period was the capacity of the poachers' boats to carry turtles. This was confirmed one morning when the track surveyor encountered 15 turtles still flipped-over on the beach. The turtles were most likely left by poachers who had filled their boat to the brim and would return to collect the turtles after they had off-loaded their first shipment

To estimate the total illegal harvest, we assume a constant harvest regime in beach section A and C, and two harvest regimes, 6 July-26 August and 27 August-26 September, in beach section B.

A total of 1, 720 (90% C. I. =601-2, 939) green turtles were illegally harvested from the nesting beach (sections A, B, and C) during the study period (Table 1).

DISCUSSION

The estimate of the illegal harvest presented here should be considered conservative for two reasons. Firstly, only drag marks visible on the beach in the morning were recorded. Drag marks from turtles turned over close to the water's edge had by then already been erased by waves. Secondly, the study period did not encompass the entire green turtle nesting season (late June-late October 1997). Illegal harvest was observed before 6 July and after 26 September in conjunction with other monitoring activities.

The full effects of the illegal harvest on the nesting population are not known. However, consequences may be serious given the long time green turtles take to become sexually mature and the sensitivity of sea turtle populations to exploitation of adult females. It should be added that the population of green turtles that nest at Tortuguero is also heavily exploited in the main feeding pastures in Nicaragua. Lagueux (1998) estimates that at least 10, 166 green turtles were harvested in Nicaragua in 1996.

The illegal harvest in Costa Rica is made possible by lack of enforcement of the legal quota system and lack of enforcement of protected area legislation. Caribbean Conservation Corporation and other Costa Rican conservation organizations therefore urge the newly elected Government of Costa Rica to address the problem by:

A) increasing the number of beach patrols by Tortuguero Conservation Area (ACTo) staff;

and either:

B) enforcing the legislation that controls the sale of turtle products, particularly in Limón;

or:

C) ending the legal harvest since the quota system renders the enforcement of legislation controlling turtle trade difficult.

ACKNOWLEDGMENTS

This study was entirely funded and conducted by Caribbean Conservation Corporation as part of the 1997 Green Turtle Program.

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Table 1. Illegal harvest of green turtles in Tortuguero, Costa Rica, 6 July-26 September 1997.

Section	Period	Nightly harvest ± C.L.	*Extrapolated to entire study period* Total Harvest	C.I.
A	6 July-26 Sept	1.08±0.60	89.9	48-133
B	6 July-26 Aug	0	0	0
B	27 Aug-26 Sept	49±37.3	1519	549-2,489
C	6 July-26 Sept	1.33±2.58	110.7	4-317
TOTAL	**6 July-26 Sept**	**N/A**	**1,720**	**601-2,939**

ROLES OF SEA TURTLES IN MARINE ECOSYSTEMS: NUTRITIONAL ECOLOGY AND PRODUCTIVITY

Karen A. Bjorndal
Archie Carr Center for Sea Turtle Research, University of Florida, Gainesville, FL 32611, U.S.A. kab@zoo.ufl.edu

The roles of sea turtles in the structure and function of ecosystems have been largely unstudied. An understanding of their capacity to affect ecosystem structure and function can be viewed as the ultimate integration of our knowledge of sea turtle biology. In addition, such studies have important implications for the management and conservation of sea turtles. Under the pressure of increased demand, priority for access to conservation resources is shifting to those species that have critical roles in the functioning of ecosystems. Are sea turtle species central to and essential for healthy ecosystem processes, or are they relict species whose passing would have little effect on ecosystem function? To address this question, many studies must be conducted, most of which have a nutritional basis: the roles of sea turtles as predators and prey, as competitors with other species, and as conduits for substantial nutrient and energy flows within and between ecosystems. Another critical area for research is the mechanisms that regulate productivity (growth and reproduction) of sea turtle populations. Many of these mechanisms have a nutritional basis as well.

GREEN TURTLES IN THREE DEVELOPMENTAL HABITATS OF THE FLORIDA ATLANTIC COAST: POPULATION STRUCTURE, FIBROPAPILLOMATOSIS AND POST-JUVENILE MIGRATORY DESTINATIONS

Llewellyn M. Ehrhart, William E. Redfoot, and Dean A. Bagley
Department of Biology University of Central Florida P.O. Box 162368Orlando, FL 32816-2368, U.S.A. lehrhart@pegasus.cc.ucf.edu

Green turtle populations are under study in three developmental habitats, each with distinctive biotic and abiotic characteristics, on Florida's Atlantic coast. These include the Indian River Lagoon (a shallow estuary), nearshore worm-rock reefs and a Trident submarine turning basin. The lagoon and reef populations are morphometrically similar but strikingly different in the prevalence of fibropapillomatosis (GTFP). Trident Basin turtles are significantly smaller (SCL) than those of the lagoon and reef, and free of GTFP. A limited number of international tag recoveries now suggests the western Caribbean coast, and possibly Cuba, as the post-juvenile migratory destination of Indian River green turtles.

ECOLOGY AND POPULATION BIOLOGY OF HAWKSBILL TURTLES AT A CARIBBEAN FEEDING GROUND

Yolanda M. León[1] and Carlos E. Diez[2]
[1] Grupo Jaragua, Inc., Santo Domingo, República Dominicana. cediez@caribe.net
[2] Departamento de Recursos Naturales y Ambientales, San Juan, Puerto Rico

INTRODUCTION

Beginning in the summer of 1996 and throughout 1997 an intensive tagging program of hawksbill turtles and in-the-water surveys were conducted on the South-west coast of the Dominican Republic, specifically in the area of Jaragua National Park. The objective was to study on a long-term basis certain aspects of the ecology and population biology of this endangered species in a feeding area.

METHODS

In-the-water surveys were conducted to find and hand-capture turtles following methods developed by Diez and van Dam (unpublished) at depths of 15 m or less. A benthic classification of the study area was performed using natural color aerial photographs (vuelo INFRATUR, 1993). Stomach lavage was conducted as described in Balazs (1980). The latitude and longitude of all captured turtles were obtained using a GPS receiver. Straight carapace measurements, from notch to tip (SCL N-T) were taken for all captured turtles using tree calipers. The sex of the animals was determined by testosterone level analysis in blood serum at Dr. David Owens' Laboratory (Texas A&M University).

RESULTS

All hawksbills captured (n = 234) were found in low-relief, sparse hard bottom and coral reef habitats of eastern Jaragua National Park and Cabo Rojo. Diet preferences differed from other studies in the Caribbean (Meylan, 1988; van Dam and Diez, 1996; Anderes and Uchida, 1994), the preferred food item being *Ricordea florida* (*Cnidaria: Corallimorpha*). Captured turtles had a size range (SCL N-T) of 19.7-69.7cm. The majority of the turtles (87%) were juveniles between 20 and 40 cm SCL N-T. Sex ratio was biased towards females (68 %, n = 146). Recaptured turtles (n = 25; time interval between captures = 45-571/days, average 182 days, S. D. = 146.17) showed limited displacement from the first capture site (range = 10.0-870.0 m, average = 276.25, S. D. 242.16) during the study period. Annualized growth rates were very variable among individuals and localities (range 0.52-9.52 cm year^{-1}, average = 5.58, S. D. = 2.93).

ACKNOWLEDGMENTS

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THE FEEDING ECOLOGY OF JUVENILE GREEN TURTLES UTILIZING THE TRIDENT BASIN, PORT CANAVERAL, FLORIDA AS DEVELOPMENTAL HABITAT

William E. Redfoot and Llewellyn M. Ehrhart
Department of Biology, University of Central Florida,Orlando, Florida 32816, U.S.A. bredfoot@gdi.net

The Trident Basin, a man-made embayment lined with rock rip-rap, supports an unusual population of juvenile green turtles-none of the captured individuals have exceeded 50 cm SCL. The combined results of the analysis of 136 samples of food items obtained from these animals revealed that 87.3 % of the food items were algae species found in the algal mat growing on the rip-rap. Animal tissue made up 4.4 % of the food items, unidentifiable materials 4.0 %, angiosperm stems and leaves 3.6 %, and plastic 0.7%. The limited biomass of the algal mat might explain the unusual population structure. Only two other reported populations of juvenile green turtles in the southeastern U.S. have a similar population structure; both utilize rock rip-rap habitats.

HAWKSBILL TURTLES IN THE CARIBBEAN: THE MONA PERSPECTIVE

Robert P. van Dam and Carlos E. Diez
Negociado de Pesca y Vida Silvestre Departamento de Recursos Naturales y Ambientales San Juan, Puerto Rico rvandam@compuserve.com

Since 1992 we have been conducting intensive studies (both in the water and on the nesting beach) with hawksbill turtles at Mona Island, Puerto Rico. This work is yielding new insight into basic turtle biology, such as recruitment, abundance, genetic makeup, diet, growth rate, behaviors, and reproduction. The implications and limitations of these findings for other hawksbill turtle populations are discussed.

HABITATS AND BAD HABITS OF YOUNG LOGGERHEAD TURTLES IN THE OPEN OCEAN

Blair E. Witherington
Florida Department of Environmental Protection, Marine Research Institute, 9700 South A1A, Melbourne Beach, Florida 32951 U.S.A. spinnaker@prodigy.net

This study seeks to provide additional information on the pelagic ecology of neonate sea turtles found in the Atlantic Ocean near the western Florida Current off Florida. Post-hatchling loggerheads (*Caretta caretta*), at sizes of 41-78 mm straight carapace-length, are commonly found in this area and have been reported on elsewhere (Witherington, 1994). Elements of this study include a description of the oceanographic features where post-hatchling loggerhead turtles are found, an analysis of post-hatchling catch-per-unit-effort (CPUE), a comparison of items recently eaten by post-hatchling loggerhead turtles to items collected from the surrounding water, and a description of the prevalence of plastics and tar in the mouths, esophagi, and stomachs of captured post-hatchling loggerheads.

STUDY AREA/PERIOD

Eighteen trips were made to a region of the Atlantic, east of Cape Canaveral, Florida, near the 40 fathom contour at approximately 28.5 N and 80.0 W. The region is approximately 25-40 nautical miles east of the Florida coast near the western wall of the Florida Current. Trips were made during the period of hatchling emergence activity on nearby nesting beaches and spanned the period of 22 July through 1 October 1997.

HABITAT

Habitat was surveyed on board the R/V Excellent Fishe II, a 6.5 m cuddy cabin with a 150 hp outboard motor. Within the study area, lines of debris were targeted that indicated regions of surface-water downwelling. These areas of potential neonate sea turtle habitat were characterized by taking measurements of position (latitude and longitude), water-surface temperature, conductivity, and current speed and direction at points located 0. 1 nautical mile on either side of the debris line. Temperature and conductivity were measured with a YSI model 30 meter and current measurements were made by tracking a current drogue with a Garman global positioning receiver. Additional notes were made describing density of *Sargassum* and other debris, width of the debris line, orientation of the debris line relative to wind direction, and weather and sea conditions.

Three types of debris lines were surveyed and were found to contain neonate turtles. The first habitat type included oceanic fronts which were evident as shear boundaries between water masses having different temperature, conductivity, and current characteristics. A second habitat type included slicks, which are produced by the downwelling above and behind the crests of large, slow-moving, thermocline waves and are evident as lines of foam and debris adjacent to or within an area of calm surface water. A third habitat type included windrows, which are produced by wind-generated Langmuir circulation cells and are evident as closely aligned rows of debris that are oriented parallel with wind direction. These habitat types were not mutually exclusive. For instance, fronts and slicks that contained turtles commonly broke up into windrows when the wind became greater than 10-15 knots.

CATCH-PER-UNIT-EFFORT

Timed searches for neonate turtles were made as the research vessel moved at idle speed (approximately 2.5 knots) through the center of a debris line. After turtles were observed, an attempt was made to capture them using a dip net or similar device. Some turtles were observed and identified to species and size class but not captured.

A total of 293 post-hatchling loggerhads were observed during timed searches (n=24.0 search-hours). No neonate green turtles (*Chelonia mydas*) were observed, which is surprising given that 1-5% of all hatchlings leaving east-coast Florida beaches are green turtles. Mean CPUE divided among six bi-weekly periods between 15 July and 15 October ranged from 31.4 turtles/hour (in early August) to 0.0 turtles/hour (in early October). The mean CPUE for the study period was 12.4 turtles/hour.

FORAGING HABITS

Sixty-six post-hatchling loggerheads were captured in a way that allowed the simultaneous collection of the floating material surrounding them (referred to as "outside samples"). The device used for this was a funnel net which consisted of a funnel of 500 micron stainless steel mesh connected to a 300 micron mesh removable sample bag. The net sampled an approximately 30 cm radius around the captured turtle. Each turtle captured in this way received a gastric lavage in order to flush a sample of recently eaten items from its stomach and esophagus (referred to as "inside samples"). The material collected from around each turtle and the sample of flushed items from the lavage were bagged and iced for later identifications on shore.

The mean wet-weight of the surrounding material from 66 post-hatchling captures was 79. 6 g (0.0-490. 1 g, SD=117.7 g). All but one of the 66 turtles had measurable amounts of material nearby and measurable lavage samples were obtained from all but one turtle.

After weighing, large samples (such as most of the outside samples) were first reduced in size by randomly dividing them and discarding portions selected by coin toss. Samples were cut until they fit easily onto a 8.4 cm^2 grid (6 x 6) of filter paper. After samples were drained on the filter paper, a clear acrylic plate with a 6 x 6 grid etched into it, was placed over the sample on the filter paper. One centimeter posts supporting the acrylic plate kept the plate from crushing the sample. The sample was then placed on the stage of a binocular dissecting microscope with a 10 x 10 square graticule in one eyepiece. The sample was surveyed by matching the outer margin of the graticule grid to each of the 36 squares of an etched acrylic plate overlying the sample. Descriptions of items to the lowest possible taxon were made for four graticule intercept-points at each of the 36 overlying grid squares. In smaller samples (such as in all of the inside samples) the entire contents of the sample was surveyed and all graticule intercept points were examined.

Table 1. Availability of items recovered from the water surrounding 66 post-hatchling loggerhead turtles (outside samples) and from gastric lavage samples from the same group of turtles (inside samples). Availability is represented as the proportion of identifications made at surveyed grid-intercept-points (see text).

	% of Intercept Points	
	Outside Samples (N=3479)	Inside Samples (N=1006)
Plants		
Sea Grasses	15.4	4.9
Sargassum	35.7	8.1
Other Algae	8.8	7.4
Sargassum Community Endemics		
Hydroids	21.7	26.3
Copepods	0.1	5.3
Spirorbis	2.1	0.4
Membranipora	8.5	2.1
Fishes, Crabs, Shrimp	1.4	0.5
Flying Insects	0.7	1.0
Pelagic Animals	0.0	18.1
Other Material	5.7	25.8

Identifications at 3479 intercept points were recorded for outside samples and identifications at 1006 intercept points were recorded for inside samples. Plant material was more frequent in outside samples (60.3%) than it was in the inside samples (22.5%) and animal material was more frequent in the inside samples (70.9%) than in the outside samples (35.5%). Much of the remaining material was anthropogenic in origin (plastics and tar; 4.1% in outside samples and 5.1% in inside samples).

Most of the material collected in the outside and inside samples could be placed into five principal categories (Table 1). Plants included sea grasses (mostly *Syringodium*), *Sargassum* (mostly *Sargassum fluitans*), and algae other than *Sargassum* (principally the blue green alga, *Rivularia*). A second category included animals endemic to the *Sargassum* community such as hydroids (principally thecate hydroids), copepods (principally harpacticoid), *Sprorbis* (a tube polychaete), *Membranipora* (a bryozoan), fishes, crabs (principally *Portunus*), and shrimps (principally *Latreutes*). A third category included flying insects. A fourth included pelagic animals not closely associated with the *Sargassum* community such as *Janthina* and *Creseis* (planktonic shelled-gastropods), *Porpita* (a siphonophore), *Halobates* (a pelagic hemipteran), and *Pelagia* (a medusa). A fifth category included less common items, anthropogenic debris, and unidentified material. A t-test for dependent samples run on transformed proportions (y_t=arcsin$\sqrt{y}$) revealed that inside samples were different from outside samples for each of the item groups in Table 1 (alpha=0.05).

The comparison of inside and outside samples indicated that post-hatchling loggerheads have a preference for animal material over plant material. Some animal food items apparently preferred and/or easily obtainable by post-hatchlings included hydroids, copepods, and pelagic animals not commonly associated with the *Sargassum* community. Animals apparently not preferred and/or not easily obtainable included *Sprorbis*, *Membranipora*, and the group comprising fishes, crabs, and shrimp.

PREVALENCE OF PLASTIC AND TAR

Turtles from which gastric lavage samples were taken were also examined for the presence of tar in the oral cavity. Tar-like material adhering to the jaws of sampled turtles was removed with a wooden toothpick and tested for solubility in dichloromethane (DCM). Dark, tacky, and DCM-soluble material was categorized as tar. Data on the prevalence of tar and plastic in the 66 post-hatchling loggerheads were grouped with data obtained from post-hatchling loggerheads captured in 1993. Of the 168 turtles in the two-year sample, 46% had tar present in lavage samples and/or in oral-cavity samples and 15% had plastic present in these samples.

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SKELETOCHRONOLOGICAL AGE ESTIMATES OF GREEN SEA TURTLES LIVING IN A FLORIDA DEVELOPMENTAL HABITAT

George R. Zug[1] and Richard E. Glor[2]
[1]Department of Vertebrate Zoology, National Museum of Natural History, Smithsonian Institution, Washington, DC, 20560, U.S.A. zug.gorge@nmnh.si.edu
[2]Department of Zoology, Cornell University, Ithaca, NY, 14853, U.S.A.

Juvenile *Caretta caretta* (44-92 cm SCL) and *Chelonia mydas* (30-75 cm SCL) occur year around in the Indian River Lagoon system of eastern Florida. An extraordinary cold snap in December 1989 cause a major cold-stunning event in the lagoon. Over 150 seaturtles were rescued and their rehabilitation attempted. About one third of the *C. mydas* did not survive the cold-shock; these turtles offered an opportunity to use skeletochronology to estimate their ages and examine the age structure of *C. mydas* in this developmental habitat. The sample contains individuals ranging from 28-74 cm SCL with estimated ages of 3-14 yr. The age estimates suggest the following hypothetical life cycle for Florida-Atlantic *Chelonia mydas*. The pelagic phase lasts a minimum of 3 years, although 5 to 7 years is the most likely common duration. The juveniles then return to coastal water (nearshore and estuarine habitats) and join foraging assemblages in developmental habitats. Individuals remain in these developmental habitats for 6-10 years, although likely not at the same locality, and depart these habitats for subadult-adult feeding grounds somewhere in the Caribbean at ages of 12-14 yr and at 60-75 cm SCL.

ORIGINS OF JUVENILE GREEN TURTLES FROM AN EAST CENTRAL FLORIDA DEVELOPMENTAL HABITAT AS DETERMINED BY mtDNA ANALYSIS

Dean A. Bagley[1], Anna L. Bass[2], Steven A. Johnson[3], Llewellyn M. Ehrhart[1], and Brian W. Bowen[2 and 4]
[1] Dept. of Biology, University of Central Florida, P. O. Box 162368, Orlando, FL 32816. dab15782@pegasus.cc.ucf.edu
[2] Dept. of Fisheries and Aquatic Sciences, University of Florida, 7922 NW 71st Street, Gainesville, FL 32653
[3] Dept. of Wildlife Ecology and Conservation, University of Florida, 303 Newins-Ziegler Hall, Gainesville, FL 32611
[4] Archie Carr Center for Sea Turtle Research, 223 Bartram Hall, University of Florida, Gainesville, FL 32611

The developmental habitats of the east central coast of Florida are utilized year round by juvenile green turtles and have been under intensive study by the U. C. F. Marine Turtle Research group since the mid 1970s. Netting work began on the Sabellariid worm-rock reefs in Indian River County in 1989 and initial results were presented at the 10th Annual Workshop (Guseman and Ehrhart, 1990). The Recovery Plan for the U. S. Population of Atlantic Green Turtles, *Chelonia mydas* (1991) states that "the foremost problem in management and conservation of sea turtles is the lack of basic biological information." Among other things, it requires that we determine the origin of juvenile/sub-adult turtles foraging in U. S. territorial waters.

To assess the population genetic structure in this developmental habitat, blood samples were collected from 94 juvenile green turtles (Owens and Ruiz, 1980). Whole genomic isolations were conducted using standard phenol/chloroform methodology (Hillis *et al*., 1996). A 510bp fragment of the control region located in the mitochondrial DNA genome was amplified using primers HDCM1 and LTCM1 (Allard *et al*., 1994). Control region fragments were sequenced using an automated sequencer in the DNA Sequencing Core at the University of Florida. Results were then compared with haplotypes from previously sampled green turtle rookeries (Encalada *et al*., 1996).

In terms of haplotypes alone, this study has revealed the most diverse developmental habitat of juvenile green turtles yet, with a total of 12 haplotypes. Nine matched haplotypes known from specific nesting colonies. The remaining 3 haplotypes have not been identified previously. Results of the maximum likelihood analysis UCON (Masuda *et al*., 1991) indicate that although the two main contributors, the Florida/Mexico and Costa Rican populations, make up 95% of the estimated contribution, the remaining five percent consist of contributions from several source populations as distant as the Mediterranean. These data suggest that the population of reef-dwelling juvenile green turtles in Indian River County is made up primarily of juvenile greens from Florida and Mexico beaches. The results of the ML are significantly different than what would be expected in a random mixture, indicating that Florida and Mexican juvenile green turtles may be recruiting non-randomly to Florida developmental habitats.

Each green turtle developmental habitat study to date has revealed new haplotypes—that is, haplotypes for which we have not yet discovered the corresponding rookery. If we are to fully understand green turtle life history and movements, it is of the utmost importance that we continue sampling nesting beaches in order to identify these unknown haplotypes. It is equally important that we continue sampling developmental habitats/foraging grounds for additional data. This endeavor will require the full support and cooperation of all agencies involved with permitting and funding as well as researchers with access to the animals.

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MIXED STOCK ANALYSIS OF JUVENILE HAWKSBILL FORAGING GROUNDS IN THE CARIBBEAN

Anna L. Bass
Department of Fisheries and Aquatic Sciences, University of Florida Gainesville, FL 32653, U.S.A. abass@icbr.ifas.ufl.edu

Mitochondrial DNA has proven useful for the elucidation of population structure and questions concerning the behavior of adult female hawksbills (*Eretmochelys imbricata*). In addition, a previous analysis of a juvenile foraging population at Mona Island, Puerto Rico, has provided information that more than one nesting location contributes individuals to a particular foraging site. What can the analysis of multiple disjunct foraging sites tell us about hawksbills? Investigations into the composition of juvenile foraging grounds may provide insight into migration and behavior in hawksbills in the Caribbean. Are there differences in the genetic composition of different foraging locations? This paper will discuss the findings from the previous studies. In additon, multiple foraging locations in the eastern Caribbean have been sampled and the genetic composition of these sites has been determined. The potential causes (*e.g.* management practices or biotic factors) of differneces in foraging ground composition at these locations are discussed.

POPULATION STRUCTURE, PHYLOGEOGRAPHY, AND MOLECULAR EVOLUTION

Brian Bowen[1] and Stephen Karl[2]
[1]Dept. of Fisheries and Aquatic Sciences, University of Florida, 7922 NW 71st St., Gainesville, FL 32653, U.S.A.
[2]Dept. of Biology, University of South Florida, 4202 E. Fowler Ave., Tampa, FL 33620, U.S.A. bowen@gnv.ifas.ufl.edu

Molecular genetic techniques have been applied to sea turtle biology for ten years, and substantial progress has been made on aspects of behavior, natural history, and evolution. Genetic results support the natal homing theory as a general paradigm for marine turtles, and have demonstrated the importance of continental barriers in shaping the intraspecific phylogeography of these species. Comparisons of nuclear and mitochondrial DNA illuminate aspects of reproductive biology, most especially the possibility of male-mediated gene flow between some nesting populations. DNA sequence comparisons in a phylogenetic context demonstrate an evolutionary separation of the ridley species, but do not support a species-level designation for *Chelonia agassizi*. The application of rookery-specific genetic markers for tracing the migrations of marine turtles shows much promise. It is this approach that will most effectively serve the future needs wildlife management programs, as they begin to address the aquatic components of marine turtle natural history and conservation. However, government-sponsored management programs have a history of overutilization scientific tools (such as mechanical tags) and this would be very costly in the context of molecular assays. Studies which employ genetic markers must have a clearly-defined goal and end-point, and should not be used for ongoing monitoring except under special circumstances.

GENETIC STOCK IDENTIFICATION AND DISTRIBUTION OF LEATHERBACKS IN THE PACIFIC: POTENTIAL EFFECTS ON DECLINING POPULATIONS

Peter Dutton[1], George Balazs[2], Andrew Dizon[1], and Ana Barragán[3]
[1]National Marine Fisheries Service, Southwest Fisheries Science Center, La Jolla Laboratory, P.O.Box 271, La Jolla, CA 92038, U.S.A. [2]National Marine Fisheries Service, Southwest Fisheries Science Center, Honolulu Laboratory, 2570 Dole St., Honolulu, I-H 96822-2396, U.S.A. [3]Laboratorio de Tortugas Marinas, Departamento de Biologia, Facultad de Ciencias, UNAM, Circuito Exterior, Ciudad Universitaria, Mexico D.F. 04510, MEXICO e-mail: peterd@caliban.ucsd.edu

Analyses of mitochondrial DNA (mtDNA) control region sequence variation in combination with nuclear (NucDNA) data from 6 microsatellite loci indicate that eastern and western/Indo-Pacific nesting populations are genetically distinct and suggests these regional nesting assemblages represent independent demographic units for management purposes. To date, samples have been obtained from six leatherbacks caught in the Hawaii-based pelagic longline fishery. Four had haplotypes only found in the western/Indo-Pacific populations,while two had haplotypes only found in the eastern Pacific populations, indicating that both regional stocks are affected by this fishery in the north Pacific.

Additional samples obtained from strandings off the coasts of North America and South America confirm trans-oceanic migrations by leatherbacks in the Pacific, and examination of the distribution of samples allows hypotheses to be drawn on the migratory patterns. The sudden and drastic decline of nesting populations in Mexico coincides with the growing longline and coastal gillnet fisheries around the Pacific, and this study suggests that animals from eastern Pacific stocks migrate through areas both in the north Pacific and Southeast Pacific where these fisheries operate.

TENDENCY TOWARD SINGLE PATERNITY IN LEATHERBACKS DETECTED WITH MICROSATELLITES

Peter H. Dutton[1], Elyse Bixby[1], and Scott K. Davis[2]
[1]National Marine Fisheries Service, Southwest Fisheries Science Center, La Jolla Laboratory, P. O. Box 271, La Jolla, CA 92038, U.S.A. peterd@caliban.ucsd.edu [2]Dept. Animal Sciences, Texas A&M University, College Station, TX 77843, U.S.A.

Molecular techniques provide new tools for peeking into the sex life of sea turtles. Observations on courtship and mating in leatherbacks are almost non-existent, although sea turtles are generally presumed to be promiscuous based on extensive studies of green turtles (Alvarado and Figueroa, 1991). FitzSimmons (1996) surprisingly found that multiple paternity was rare in Australian greens. Leatherback paternity studies to date have been invalid due to an insufficient number of reliable polymorphic loci. We have identified informative new microsatellite loci, and have sampled successive clutches laid by the same females over a three month period in St. Croix, U. S. Virgin Islands. A total of 6 loci were used to construct the genotypes of nesting females and their offspring. Loci were amplified by PCR using fluorescent dye-labelled primers analyzed on a 377A ABI automated sequencer with GENESCAN. Paternal genotypes were inferred by comparing the known offspring and known maternal genotypes. Using allele frequencies for the St. Croix nesting population, the probability of detecting multiple paternal alleles (d) was determined for each locus and across all loci (D) (see FitzSimmons, 1996). The probability of detecting multiple paternity was relatively low for some individual loci (DC99 and N32 in particular), combined D for all 6 loci was 99%. Analysis of data from a total of 178 hatchlings from series of 3 to 5 clutches (n=17 total) laid by each of 4 females, did not reveal any evidence of multiple paternity. Unexpected paternal alleles were detected in four cases; however, since in each case these alleles were only present at one locus, they were considered to be mutations rather than contributions by a second male. Two instances of mutation of the maternal allele were also detected in this way. Mutation rates were highest in DC2-95, one of the most polymorphic loci. The lack of multiple paternity in this study corroborates previous findings with microsatellites for green turtles in Australia (FitzSimmons, 1996), and suggests either that female leatherbacks rarely mate with multiple males (perhaps as a result of behavioral factors, like competition, or because they rarely encounter them), or that sperm competition occurs. Either scenario would require the ability to store sperm. The detection of mutation within one generation turnover emphasizes the importance of using multiple loci when attempting to detect multiple paternity with microsatellites. Samples from additional females are presently being analyzed.

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CONTRIBUTION OF A NESTING COLONY OF HAWKSBILL TURTLE *ERETMOCHELYS IMBRICATA* TO SOME FEEDING GROUNDS IN CUBAN PLATFORM

G. Espinosa[1], A. Robainas[2], G. Bordón[1], E. Garcia[2], M. Ramos[1], G. Hernández[1], and M. Rodríguez[1]
[1]Faculty of Biology, University of Havana, Cuba. anaicr@correo.co.cu [2]Marine Research Center, University of Havana, Cuba

INTRODUCTION

Mitochondrial (mt) DNA genealogies have figured prominently in genetic studies of marine turtle, in spite of typically exhibiting low rate of molecular evolution relative to many other organism groups (Bowen and Avise, 1995). Hawksbill turtles mt DNA have been useful in the definition of the distribution pattern in different geographic regions (Broderick *et al.*, 1994; Bass *et al.*, 1996 and Bowen *et al.*, 1996). In this study we used mt DNA polymorphism's to characterize Cuban hawksbill populations and to determine the contribution of different hawksbill populations in Caribbean regions to Cuban feeding grounds.

MATERIALS AND METHODS

We sampled 83 *E. imbricata* from three regions of the Cuban platform (Isla de Pinos and Nuevitas) all from feeding grounds and Cayeria de Las Doce Leguas, with 13 individuals from nesting area and 16 from feeding ones) and one from Las Coloradas, Yucatán (21 individuals from nesting colony). The sample consisted of muscle pieces fixed in 70% ethanol. Total DNA extraction was carried out according to Kocher *et al.* (1989). An approximately 400 base pair fragment located in non-coding region of mt DNA was amplified with PCR methodology (Mullis and Faloona, 1987) using TCR-5 and TCR-6 primers (Norman *et al.*, 1994). PCR products were digested with three restriction endonucleases: Dra I, Msp I and Taq I, which present polymorphic sites in the fragment. The digested products were separated in 7% polyacrilamide gel electrophoresis using TBE 1 X buffer and visualised with silver staining protocol of Ceatano-Anollés and Greshoff (1993), using Pharmacia 50 Bp estandar size. The different haplotypes detected were used to calculate the haplotype diversity (Nei, 1987). The frequencies were analyzed by a G test (Sokal and Rohlf, 1981). To estimate the contribution of each nesting area to each Cuban feeding grounds we used the unconditional Monte Carlo algorithms in the program Shadracq (Xu *et al.*, 1994).

Table 1. Three polymorphic sites, which define 6 identified PCR-RFLP mt DNA haplotypes. (A=no site, B= 1 site and C= 2 site, all according to the sequence order of polymorphic sites for haplotype A (Bass et al., *1996).*

Haplotypes (this paper)	Nucleotide in position of sequence using Bass *et al.* (1996) numbering 13	78	309	Haplotypes from Bass *et al.*, 1996.
1. BCB	G	A	C	B,C,D,F,I,J,K,L,N y Q
2. ABA	A	G	G or T	R,S,T y U
3. ACA	A	A	G or T	A,E,G,H y O
4. BBA	G	G	G ó T	
5. BBB	G	G	C	P
6. BCA	G	A	G or T	M

Table 2. Haplotype diversity (h) and frequencies at assayed hawksbill turtle colony and feeding grounds.

Location	h	Haplotype 1	2	3	4	5	6
Nesting colonies							
D. Leguas	.765	4(.30)	5(.40)		2(.15)	2(.15)	
Yucatán	.308	19(.83)				2(.10)	2(.10)
Feeding grounds							
I. de Pinos	.680	6(.50)			3(.25)	3(.25)	
D.Leguas	.860	4(.27)	3(.20)	1(.07)	4(.27)	1(.07)	2(.13)
Nuevitas	.590	13(.65)	2(.10)	1(.05)	4(.20)		
Nesting colonies							
P. Rico[1]		11(.73)		2(.13)			2(.13)
Belice[1]		12(.86)		2(.14)			

[1]Bass *et al.*, 1996

RESULTS AND DISCUSSION

The polymorphism of the three enzymes is produced by the lost of restriction site for each one of them coincident with sites 13: Msp I, 78: Dra I, and 309: Taq I. from Bass *et al.* (1996) haplotypes. These haplotypes can be compared to those of Bass *et al.*(1996). (Table 1).

The six haplotypes are distributed in the population as it is showed in Table 2. Haplotype 1 is observed in all samples included those from Puerto Rico and Belice (Bass *et al.*, 1996), anyway this haplotype can be further separated in ten different ones, after sequencing of the same fragment as demonstrated by these authors.

The haplotype frequencies from all populations showed no differences according to G test, for this reason we conclude that there is a large genetic similarity among Caribbean colonies. Bass *et al.*, 1996. Also found similar results in this area.

Haplotype diversity estimates (h) for Doce Leguas Nesting population (Table 2) is the same order of magnitude to haplotype diversity estimates for hawksbill turtle colonies in the Atlantic (overall estimates h= 0.849, Bass *et al.*, 1996). But this value is higher that the overall estimates (h=0.69) for Cuban feeding grounds. On the other hand Yucatan shows the lowest value of haplotype diversity and Puerto Rico Results the most similar area to Doce Leguas.

We demonstrated that nesting area is similar to each feeding ground of Cuban shelf, although, we use the unconditional Monte Carlo algorithm as a qualitative indicator of the contribution of some nesting colonies to the three Cuban feeding grounds. The highest contribution to Isla de Pinos and Doce Leguas feeding grounds comes from Doce Leguas nesting colony On the other hand, Belices contributes with a 61% to Nuevitas while Doce Leguas with only 39%. It is possible that in the South shelf of Cuba specifically in Doce Leguas region, where waters are shallow and warm, the animals show a highest degree of site fidelity. Similar results have been stated by Koike (1996) for Cuban and Puerto Rico populations, but Bowen *et al.* (1996) found a very low contribution of Puerto Rico nesting area to Mona Isle a Puerto Ricon feeding grounds. The fact that Belice and Yucatan, being neighbor population, have a different the contribution to distint areas is according with to Bass *et al* (1994), which conclude that there is no strong correlation between geographical distance among nesting colonies and migration rate estimates. The existence of mixed stock in the three Cuban feeding ground is according with the results of Broderick *et al.* (1994) in Australian hawksbill populations,

Table 3. Contribution of nesting colony to three feeding grounds of Cuban shelf as indicated by unconditional analysis (Xu et al., 1994). Puerto Rico and Belice data from [1]Bass et al., 1996.

Nesting colonies	Feeding grounds Isla de Pinos	Doce Leguas	Nuevitas
Doce Leguas	0.60	0.81	0.39
Yucatán	0.41	0.00	0.00
Puerto Rico[1]	0.01	0.19	0.00
Belice[1]	0.00	0.00	0.61

and of Bowen *et al.*, 1996 and Koike 1996, in Caribbean hawksbill populations.

Nevertheless the relatively small sample sizes of nesting populations examined to date, these results indicate: The high genetic variability of Doce Leguas nesting colony, the high stay of Doce Leguas nesting colony in Cuban feeding grounds and the presence of other nesting colonies from Caribbean area in Cuban feeding grounds

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A COMPUTER PROGRAM THAT USES GENETIC DATA TO INFER THE MAXIMUM LIKELIHOOD ESTIMATES OF SPERM COMPETITION AND MULTIPLE PATERNITY

Kristina L. Kichler and Mark T. Holder
The University of Texas, Department of Zoology, Austin, TX 78712 U.S.A. kichler@mail.utexas.edu

Recently developed genetic techniques have allowed researchers to examine the reproductive biology of animals in new ways. Classic paternity analysis requires genetic information about the mother, all possible fathers, and the offspring. In sea turtle biology the possible fathers are generally not sampled; so we must rely on population genetics to give us their likely genetic composition. In many cases the implications of genetic data are clear (for example FitzSimmons *et al.*, little evidence of multiple paternity despite extensive sampling of hatchlings and very polymorphic markers). When sampling of hatchlings is limited the pattern can be difficult to infer and the level of certainty is hard to measure. We have written a computer program in the language "C", that analyzes genetic data in a three parameter maximum likelihood framework. The first parameter, m, measures average female promiscuity in the population. We assumed that females can mate with either one or two males (with probabilities of 1-m or m respectively). The second parameter, r, measures the level of sperm competition. This parameter is the proportion of the eggs fertilized by one of the two males (r=0.5 indicates no sperm competition, an r of 1 or 0 is complete sperm competition). The program also considers the possibility of mutation with a parameter for the mutation rate (mu, which can be between 0 and 1). The first step is to infer the genotypes of the paternal gametes using Mendelian genetics and information from the offspring and the mother. The program calculates the probability of diploid genotypes for the two males under the assumption of Hardy Weinberg equilibrium. The probability that one would see the observed offspring data for a clutch is the probability of two males having particular diploid genotypes multiplied by the probability of a female's offspring getting the observed gametes given the males' genotypes and a pair of values for the sperm competition and multiple paternity parameters. This probability must be summed over all possible male genotypes. The likelihood of any pair of parameter values is proportional to this probability. The program's output is a function that gives a likelihood surface over the possible parameter space. This method is computationally intensive, but powerful. Using this method and the likelihood ratio test we are able to reject the hypothesis of no sperm competition and the hypothesis of no multiple mating for a data set from the Kemp's ridley sea turtle. The model and the program could be expanded to encompass the possibility of more than two fathers for a clutch, linkage disequilibrium between marker alleles.

THE INCIDENCE OF MULTIPLE PATERNITY IN LOGGERHEAD TURTLE NESTS ON MELBOURNE BEACH, FLORIDA U.S.A.

M. Katherine Moore[1 and 2] and R. Martin Ball[2]

[1]Grice Marine Biological Laboratory, University of Charleston, 205 Fort Johnson Road, Charleston, SC 29412 U.S.A. Kathy.Moore@noaa.gov

[2]National Oceanic and Atmospheric Administration, National Ocean Service, Office of Science, 219 Fort Johnson Road, Charleston, SC 29412, U.S.A.

Missing from estimates of adult population size and health of sea turtle populations are the numbers of males contributing to the next generation. Peare (1994) used genetic analysis (multi-locus minisatellite probes) to demonstrate multiple paternity in green turtle clutches at Tortuguero. Mixed reports at subsequent turtle symposia have indicated that the incidence of multiple paternity varies from species to species and perhaps location to location. This study uses microsatellites to examine the paternal contribution to loggerhead clutches laid on Melbourne Beach, FL in the summer of 1996 . Blood was collected from 150 mothers, and scute biopsies were taken from 1341 offspring from 89 clutches. Samples were collected at two locations which are approximately eight kilometers apart, one within and one just north of the Archie Carr National Wildlife Refuge. The genotypes of the mothers were ascertained at four polymorphic microsatellite loci: Cc141, Ei8 (FitzSimmons *et al.* 1995), Cc7, and Cc117 (FitzSimmons, 1997). The two most polymorphic of these loci (Cc7 and Cc141) were then selected to estimate the levels of multiple paternity in 38 clutches.

The maternal genotype frequencies were compared between collection locations and were found not to be significantly different at either locus Cc7 (p=0.63, s. e. =0.007) or Cc141 (p=0.08, s. e. =0.004). Pooled maternal allele frequencies were also found not to significantly differ from inferred paternal allele frequencies at either Cc7 (p=0.75, s. e. =0.04) or Cc141 (p=0.42, s. e. =0.006). Maternal frequencies were found to be within Hardy-Weinberg expectations for locus Cc141, with heterozygotes neither in excess (p=0.54, s. e. =0.023) nor deficient (p=0.44, s. e. =0.025). At locus Cc7, heterozygotes were not found to be in excess (p=0.99, s. e. =0.004), but heterozygotes were found to be deficient (p=0.01, s. e. =0.004). We postulate that the deficiency in heterozygotes at this locus is due to the presence of null alleles. The existence of null alleles at this locus is confirmed by the mother-offspring genotype data.

Given the allele frequency distributions in this population, the probability of detecting the second father in any hatchling that is the result of an extra-pair fertilization is 0.91 (Westneat *et al.*, 1987). Ten or more hatchlings from each clutch were analyzed to estimate the level of multiple paternity. What appear to be more than two paternal alleles were observed in eight of the 38 clutches analyzed. However, the contribution of a second father is rarely reflected at both loci, leading to the speculation that some of the "extra" alleles that were attributed to a second father may in fact be due to mutation of alleles from either parent. Offspring of questionable parentage are being analyzed at additional loci to confirm these results.

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EFFECT OF PARTIAL SHADOW IN THE INCUBATION TEMPERATURE IN KEMP'S RIDLEY (*Lepidochelys kempii*) NEST, IN THE BEACH HATCHERIES, AT RANCHO NUEVO, TAMAULIPAS, MEXICO.

Miguel Angel Carrasco[1], René Márquez[1], Juan Díaz[2], Verónica Benitez[3], Noé Villanueva[1], and María del Carmen Jiménez[1]

[1] CRIP-Manzanillo, Playa Ventanas s/n, Manzanillo, Colima, México C. P. 28200, AP. 591.tomar@bay.net.mx

[2] INP-Oficinas Centrales. Pitágoras 1320, 4to piso. Cruz Atoyac, México D. F. C. P. 03310

[3] PROFEPA. Crucero Las Brisas, s/n. Manzanillo, Colima, México, C. P. 28210

INTRODUCTION

The temperature during the incubation process has an effect over the sexual differentiation of sea turtles (Morreale *et al.*, 1982). Between 30-33°C, females are produced at a 100% rate, while for temperatures between 26-28°C 100% males are produced (Mrosovsky *et al.*, 1980).

Conservation techniques have been discussed, because the removal of the nests from their natural conditions into the incubation boxes and yards may have effect over the sex ratio (Mrosovsky *et al.*, 1980).

Studies about temperature and humidity have shown that both parameters are very important to obtain a high survival rate, and knowing the optimal incubation parameters, it can help us to improve the survival rates and to know the sex ratio.

This paper presents the temperature effect over the nests in the incubation yards under several sun radiation conditions and the objective is to evaluate its effect on the survival of the nests and over the sex ratio.

METHODOLOGY

During the 1997 nesting season of the Kemp's ridley (*Lepidochelys kempii*) in the Rancho Nuevo, Tamaulipas, Mexico beach, there were six "arribazones" that occurred with more than one hundred nests. The nests were collected in an extension of 30 km and removed to the central area, it was considered that all the nests were removed in the same safety conditions.

One of these "arribazones" was chosen to do the study with 120 nests, which were separated in two groups, the first group (A) 40 nests were shadowed with a plastic mesh, the tipe used at winter quarters for plants, while the second group (B) consisted in 67 nests and were exposed to total solar radiation.

In each group (with shadow (A) and total radiation (B)) three thermocouples selected at random were installed (one in each extreme of the fence and another in the center, to have a daily record temperature maximum and minimum).

RESULTS

Survival

The results are presented in Table I. The survival average in both groups was higher than 1997 season (68.5%) (Burchfield *et al.*, 1997). A Kruskal-Wallis test was applied, the result $F_{(1, 105)} = 4.33$ ($P<0.05$) was significantly different between the groups.

Temperature

With the covariance analysis done to learn if the temperature fluctuation was the same along all the incubation yard, results show that the temperature was similar in both groups. As a conclusion the fluctuations affected in the same way the nests in each group.

A regression analysis was done with temperature average in groups A and B and the following equation was obtained.

$$Y= (0.047)X + 28.34$$

That equation was applied in each group and their square sum of differences (SSD) was compared. As a result, in group B (Figure 2) the temperature variation was higher than in group A (Figure 1), and the SSD 121.6 in group A and 201. 1 in group B.

The temperature difference between groups A and B was 0.8°C average and the incubation time difference was 3 days, delayed in group A because of the difference in temperature.

Temperature average in each group was 30°C and 31°C and we can expect to obtain a high females number in both groups, but the group A, during the last third of incubation period had temperatures lower than 30° C and maybe the sex rate was affected.

During this work, the temperature average in both groups was optimal, and we obtained a high survival rate. However, during the last third of the incubation time, a "temperature shock" happened, the temperature fell to 25.5°C in group A and to26.7°C in group B and the embryonic development could be affected.

Table I. - Survival of nest incubation during 1997 with different intensity of sun radiation, determined with the temperature

	Survival		Temperature		Incubation Time	
	Average	S.E.	Average	S.E.	Average	S.E.
Group A	78.8	15.9	30.2	1.31	52.4	0.7
Group B	84.3	12.1	31.1	1.47	48.8	0.8

CONCLUSIONS

The use of shadow in incubation yards may help to maintain free of drastic temperature changes, however if environment temperature fall down, the dark mesh must be removed because it could decrease the temperature below the survival limit.

Maintaining temperature in spite of drastic environmental changes, can increase the probability of high survival rate.

It is necessary to consider that survival rate can be affected with extreme high and low temperatures.

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MORE ON ERROR TABOOS: COUNTING EGGS AND EGG SHELLS

Brenda J. Cruz and J. Frazier

Centro de Investigación y de Estudios Avanzados del I. P. N. Unidad Mérida, Carretera Antigua a Progreso km 6, A. P. 73 "Cordemex", Mérida C. P. 97310, Yucatán, México. bcruz@kin.cieamer.conacyt.mx

INTRODUCTION

An enormous amount of information is generated from beach protection programs, and as a rule, numerous people help collect basic data at each field site. Two simple direct counts are standard for most beach studies: right after oviposition, eggs are counted; and after hatching, nest contents are counted. Numbers derived from these counts are used for the calculation of life history parameters such as: clutch size, hatching success, fecundity and reproductive success. Unfortunately, many common research protocols and management techniques have not been evaluated. It is essential to assess the magnitude of error for basic counts, to be able to separate variance related to different observers and handling techniques from biological variability.

MATERIALS AND METHODS

The present study was carried out during the 1996 nesting season at X'Cacel, Quintana Roo, Mexico, a regionally important nesting beach for *Caretta caretta* and *Chelonia mydas*. Seven people participated in the field work. Clutches of freshly laid eggs were counted twice: on removing them from a recently made, natural egg chamber ("extraction") and as they were deposited in an artificial egg chamber ("deposition"), either in the beach or in a hatchery. Both counts were made over a period of no more than one hour. Comparisons were done between extraction and deposition counts made for the same clutch, by the same individual. Nests were excavated once hatchlings had emerged from them, and the contents were categorized and counted, as is normal practice. Egg shells and unhatched eggs were counted for each clutch: yielding a total "nest contents". Comparisons were done between counts of deposition and nest contents, made for the same clutch, by the same individual.

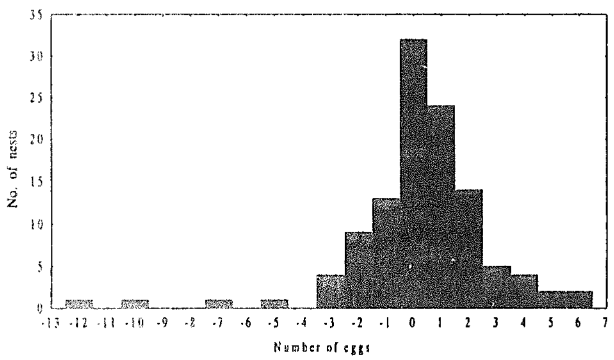

Figure 1. Distribution of differences between egg counts at extraction and deposition for the same clutch, done by Individual 1; Caretta caretta, X'Cacel, Quintana Roo, Mexico, 1996

RESULTS

Error in counting eggs

The difference between extraction and deposition for most individuals was between zero and three eggs. There were cases of much larger errors, and in one case the difference was as much as 33. The general tendency was for the extraction count to be greater than for deposition (Figure 1). This tendency was shown by all seven individuals, but the amount of error was not homogenous between people. Although all people had differences between extraction and deposition counts during the entire nesting season, there was a tendency in several individuals for this difference to decrease over time (Figure 2). Furthermore, there was a general tendency in all seven individuals for larger differences to occur in larger clutches (Figure 3).

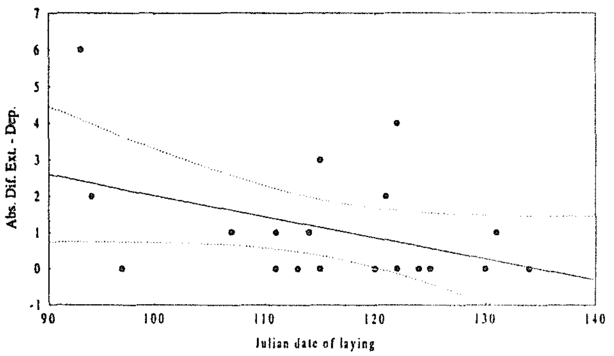

Figure 2. Relation of absolute difference between extraction and deposition counts (Abs. Dif. Ext. - Dep.) and Julian date of laying, done by Individual 2; Chelonia mydas, X'Cacel, Quintana Roo, Mexico, 1996 (y = 0.0581x + 7.8279; r = -0.3343; d. f. = 17; p = 0.162; dotted lines are 95% confidence limits).

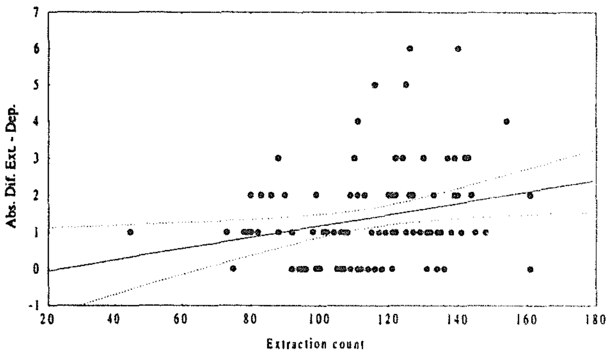

Figure 3. Relation of absolute difference between extraction and deposition counts (Abs. Dif. Ext. - Dep.) and clutch size (Extraction count), done by Individual 1; Caretta caretta, X'Cacel, Quintana Roo, Mexico, 1996 (y = 0.01537x - 0.3694; r = 0.2570; d. f. = 96; p = 0.010; dotted lines are 95% confidence limits).

Error in counting nest contents.

In general, the difference between deposition and nest contents was no more than one or two eggs, although much larger differences did occur. Counts of nest contents were usually less than for deposition (Figure 4), although there were differences in the amount of error between individuals. Because there were generally relatively few unhatched eggs, and egg shells are difficult to count because of their fragmented condition, it was assumed that most of the difference was due to underestimating the numbers of egg shells. Although this difference in counts occurred in all people throughout the season, there was a tendency for it to decrease in some individuals with time (Figure 5). In all individuals, the difference between deposition and nest contents increased with larger clutch sizes (Figure 6).

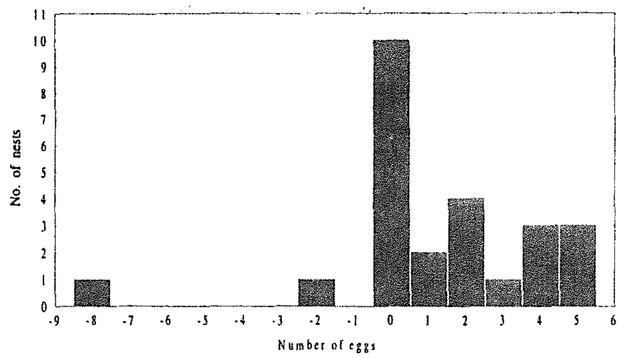

Figure 4. Distribution of differences between deposition egg counts and counts of nest contents for the same clutch, done by Individual 1; Chelonia mydas, X'Cacel, Quintana Roo, Mexico, 1996.

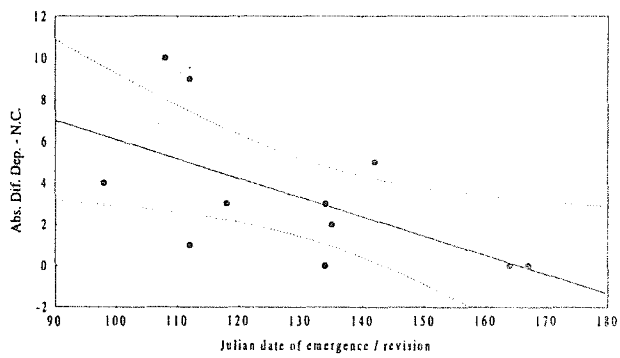

Figure 5. Relation of absolute difference between deposition count and nest contents count (Abs. Dif. Dep. - N. C.) and Julian date of emergence/revision, done by Individual 3; Caretta caretta, X'Cacel, Quintana Roo, Mexico, 1996 (y = - 0.0929x + 15.379; r = 0.6811; d. f. = 10; p = 0.015; dotted lines are 95% confidence limits).

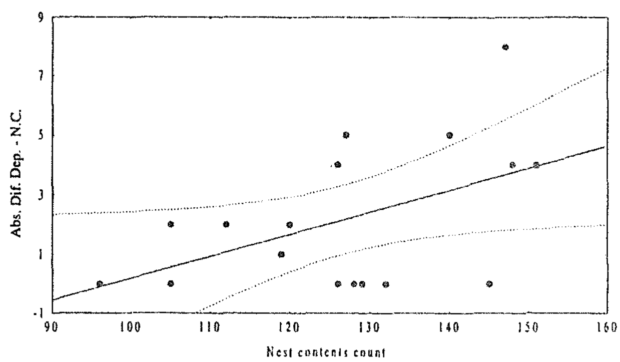

Figure 6. Relation of absolute difference between deposition count and nest contents count (Abs. Dif. Dep. - N. C.) and estimated nest contents, done by Individual 1; Chelonia mydas, X'Cacel, Quintana Roo, Mexico, 1996 (y = 0.07402x - 7.212; r = 0.4758; d. f. = 15; p = 0.054; dotted lines are 95% confidence limits).

CONCLUSIONS

All seven individuals involved in the study had errors in counts of both eggs and egg shells. In several people, there was a significant reduction in differences between types of counts as the season progressed: this suggests an effect of learning. There was also a clear relationship between magnitude of error and clutch size: the more there is to count, the greater the chance of a an error in counting. It is important to emphasize that there were a number of differences between the people working at X'Cacel in 1996. The level of error between different types of counts, as well as the relationship between counting errors and date as well as clutch size varied between people, making it difficult to derive one standard correction for everyone.

DISCUSSION AND RECOMMENDATIONS

Error must be evaluated in different methodologies used in field studies, and especially to calibrate error attributable to personal differences. This is especially important when there are various people involved in gathering the same sort of data, and even more so when their levels of experience are not comparable and change over the period of a single season. When field personnel are not constant from year to year, the complications are even greater, and this is precisely the situation when volunteers do the bulk of data gathering. Errors in simple counts of eggs and egg shells may affect the calculation of basic life history parameters such as clutch size, hatching success, fecundity, reproductive effort, hatchling recruitment and reproductive success. Without resolving these problems, large and costly field efforts may yield spurious information; and even worse biological theory and management practices could be based on equivocal data.

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METALLIC OR INTERNAL TAGS- CAN WE OMIT ANY IN RANCHO NUEVO, MEXICO?

Ma. del Carmen Jiménez Quiroz[1], René Márquez Millán[1], Noé A. Villanueva[1], Manuel Sánchez[2], Juan Díaz[2], Alma Leo Peredo[3], M. A. Carrasco[1], and Jaime Peña[4]

[1] Centro Regional de Investigación Pesquera (CRIP)Manzanillo Playa Ventanas s/n, Apdo. Postal 591, Manzanillo, Colima. México. C. P. 28200. cjimenez@bay. net. mx; tormar@bay. net. mx

[2] Instituto Nacional de la Pesca. Pitágoras 1320 Col. Sta Cruz Atoyac. el Benito Juárez, México, D. F. C. P. 03310

[3] CRIP-Tampico. Prolongación de Altamira s/n. Isleta Perez, Tampico, Tams. México

[4] Gladys Porter Zoo, 500 Ringled Street, Brownsville, Tx. U.S.A.

INTRODUCTION

The mark-recapture method has been used to estimate the population abundance and survival of many species (Saber, 1982). In Rancho Nuevo, Tamaulipas (Mexico), the most important nesting beach of Kemp's ridley (*Lepidochelys kempii*), this technique has been applied since 1966 using metallic tags, afterwards, starting from 1988 internal tags (pit-tags) has been used too. In the other hand, in 1992 the camp of Barra del Tordo/Playa Dos and Tepehuajes/ Ostionales was installed and consequently, the protection activities extended from 30 to 120 km approximately.

The objective of this work is to compare the recovery of metallic and internal tags in the nesting season between 1992 and 1996 using the registers of the three camps to evaluate the efficiency of both tags and to determinate the possibility to discard any tag.

METHODS

The information was sorted and classified following the field notes, the presence of scars, the "old tags" when the turtle was remarked and comparing the consecutive marks when the female was observed many times inside each nesting season. When there was doubts about their rank like "neophyte" or "re-emigrant", the tags were compared with the general database that include registers from 1966.

The information was organized following the number of times that each female was registered inside each season. The number of marks and recaptures were accounted with one and/or both tags. The females were classified like neophytes or re-emigrant (recaptures) in function of their characteristics of the first time when they were observed. In other hand the 1992's neophyte females were followed between 1993-1996 and the number of recaptures and remarks that they had in these years were estimated.

The mistakes were accounted to estimate the confidence of the mark-recapture registers. The database was reviewed to account the females with damaged flippers and to obtain an indicator of the impact of the external tag.

RESULTS AND DISCUSSION

1. -Mark and recapture inside each nesting season. The observed females were between the 50 and 67% of the total registers in each season and almost all were included in the mark-recapture program. The remaining percent were nest obtained after the female laid there. The external tags were

Table 1 Characteristics of the first observation ("capture") of each season. Keys: Re: re-tag of females that loss the tag; Rec: recapture of females with tag. Units :% of the total of the females observed.

Year	metallic (%)		pit tag (%)	
	Re	Rec	Re	Rec
1992	28.40	25.14	11.90	33.78
1993	28.97	23.31	9.80	32.89
1994	24.39	25.61	5.64	33.07
1995	26.38	22.50	2.13	5.03
1996	25.28	19.65	6.75	33.16

applied to approximately 100 % of the females observed inside each season, whereas the pit tag were applied to a percentage variable between 60 and 90%, except in 1995 when the use of this tags was severely limited (168 registers of pit tags).

Although a high proportion of the females was observed once inside each season, several turtles were registered more times. The probability to detect these consecutive arrivals was grater with the use of metallic tag than with the pit tag, however, the internal tag allows to detect the mistakes in the alphanumeric strings of metallic tags.

In the first observation the percent of females with metallic tag was between 19 and 25% (Table 1), whereas between 23 and 30 % were losses and they had to be remarked. In contrast, it was more frequent to detect the internal tag (32-39%) and it was not possible to put an elevated number of pit tags because there were not enough scanning devices.

The re-emigrant females were identified because they carried external tags or remaining scars. The neophyte females can be easily recognized because they lack of these characteristics. The pit tags are not useful to discern the neophytes, because it is necessary to have numerous readers devices and sometimes the observant can not find it in the flipper. Is necessary to point out that only 17 turtles of the 5138 registers of the database were marked only with pit tags. By this and the female fecundity rate, it was estimate in 1.5 nest by nesting season (Márquez *et al.*, 1989; Pritchard, 1990; Rostal *et al.*, 1992) is possible to suppose that most of females are observed and tagged at least once in each nesting season and then the use of the metallic tags allow to recognize the neophyte females with a little margin of error.

2. *-Recaptures between seasons.* It was possible to "follow" 47 tagged turtles with metallic tag and 63 with internal tag (Table 2). They are 20.3 and 27.3 % of the total 92's neophytes females. There were 20 common tags between these two groups. The females tagged with metallic tag were observed up to 4 nesting seasons (Table 2A) more, although most were seen only in 1994 and 1995. The turtles with pit tag were observed in one or two season more, specially in 1994 and 1996, however the few data obtained about this tag in 1995 must influence these results.

The 86% of the females followed with the pit tag were re-tagged with metallic tags in the next recaptures, since the 70% of the metallic tags were lost since 1992, when they were placed and the following season (Table 2B), while the turtles re-tagged with pit tag followed by metallic tag were 21% in the two seasons, however approximately in 59% of them the internal tag can not be possible to detect.

3. *-Errors.* The most common errors were the change of some characters (T by J, or 0 by D, per example), the more or less number of alphanumeric characters and when the interval between two consecutive laid close. In general, these mistakes were the 1.3% of the total registers, however in some years it was greater, like 1996 when the number registers were higher.

Table 2. Results of the following of 92's neophyte females in the lapse 1992-1996. A) External tags (N=47), B) Pit tags (N=63). Units: %

(A)

Recaptures	0	1	2	3	4
with pit tag		34.04	10.63		2.12
re-tag of pit tag		19.14	2.12		
Mistakes		4.2	0		
Without pit tag	12.76	42.6	0	2.12	
Total		100	12.8	2.12	2.12

(B)

Recaptures	1	2
with metallic tag	30.16	12.7
re-tag of metallic tag	690.84	15.9
total	100	28

4. *-Damages in the flippers.* In the database 24 turtles with some damage in the flippers were found. Most frequent injury were predator bites in the left back flipper and most females were neophytes. If suppose that the probability of survival to predator attacks is similar with independence of the flipper injured, is possible to suppose that the turtles are attacked more frequently in the back flippers and this means that the presence of tags does not increase the probability of attack. On top of this, the loss rate of this tag was high and that approximately half of the females of each season were re-emigrant and were tagged in some previous season, is possible to suppose that the injuries originated by the external tag are negligible.

CONCLUSIONS

The metallic tag simplifies the register of the consecutive arrivals of the females inside each season, the identification of the neophyte turtles and in some cases the re-tag with pit tag, however the loss of this tag between seasons is high. The damages provoked by this devices are not deeply investigated but the registers of the females with injured flippers are few in the National Institute of Fisheries (INP) database.

The recapture of internal tags between seasons was greater than the metallic, but the posterior recognition depended of the availability of readers devices and the ability of the observer. In 1995 when the readers malfunctioned at the beginning of the season the registers of these tags were scarce, however when the conditions are adequate it is possible to recognize a high number of pits and this makes easy to detect the errors in the registers of the metallic tags and follow a bigger number of turtles in the next seasons.

The use of both of these marks makes the identification of the females easy and gives two different kinds of information, so it is not adequate to omit anyone.

ACKNOWLEDGMENTS

The database used in this work was collected in the Cooperation Program Mexico-E.U.A. under the sponsorship of the US Fish and Wildlife Service, the National Marine Fisheries Service and the Secretaría del Medio Ambiente, Recursos Naturales y Pesca trough the Instituto Nacional de la Pesca. The coordinators of this Program were: Ph. D. Leslie Dierauf, Mr. Patrick Burchfield (Gladys Porter Zoo), Dr. Refugio Castro (CRIP-Tampico) and Dr. René Márquez (Coordinador del Programa Nacional de Investigación de Tortugas Marinas/ INP).

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AN ESTIMATION OF THE OVERALL NESTING ACTIVITY OF THE LOGGERHEAD TURTLE IN GREECE

Dimitris Margaritoulis
The Sea Turtle Protection Society of Greece, P. O. Box 51154, GR-14510 Kifissia, Greece. stps@compulink.gr

INTRODUCTION

Genetic studies have shown that loggerhead turtles *Caretta caretta* originating, most probably, from Florida colonized the Mediterranean Sea about 12, 000 years ago (Bowen *et al.*, 1993).

There is evidence that loggerhead stocks in the Mediterranean have been depleted due to human exploitation, restriction and degradation of nesting areas, and incidental catch. Today, loggerheads in the Mediterranean nest mainly in the eastern oceanographic basin and particularly in Greece, Turkey, Cyprus and Libya. However no overall data for each country are available in order to assess the total nesting potential in the Mediterranean.

The loggerhead in the Mediterranean is considered a threatened species under various international and national listings. In Greece, the loggerhead turtle is protected by international conventions, European Commission directives (*e.g.* the Habitats Directive where *Caretta caretta* features as a "priority" species) and national legislation. The obligation of the States to protect *Caretta caretta* habitats and especially nesting areas (by means of land use planning, management measures, etc.) requires adequate substantiation of the nesting activity not only at the area in question but also in relation to the overall nesting potential at national and Mediterranean scale.

The present paper is an attempt to produce an estimate of the overall nesting activity of the loggerhead turtle in Greece.

METHODS

The Sea Turtle Protection Society of Greece (STPS), in the context of various projects, monitors systematically loggerhead nesting areas in Greece, some of them since 1984. Furthermore, a major investigation, with the aim to discover "new nesting areas", was conducted by the STPS from 1989 until 1992. About 7, 500 km of coastline were visited, all beaches of "soft" substrate were recorded and surveys were conducted, during the nesting season, on the most promising of them. During this work, some important nesting areas were found on the island of Crete and the extent of "diffuse" nesting was estimated (Margaritoulis *et al.*, 1995).

Monitored nesting areas are precisely delimited and surveyed daily during the nesting season (from the end of May until the middle of October) with the aim to record all nests. Depending on local threats, clutches are protected, either *in situ* or by relocation to safe sites. After the emergence of hatchlings, a large number of nests are excavated in order to determine hatching success. All data are entered, locally in most cases, in computer data bases and thereafter are processed and evaluated.

In order to assess the relative significance of a nesting area and thereby co-ordinate accordingly conservation efforts, nesting beaches in Greece have been divided in three categories: areas of "major" nesting, areas of "moderate" nesting and areas of "diffuse" nesting. The selection criteria were arbitrarily set as follows: a "major" area should have an average number of nests per season (recorded over several

Table 1. The "major" nesting areas of the loggerhead turtle in Greece and their nesting potential

Nesting area	Beach length (km)	Maximum number of nests per season	Minimum number of nests per season	Average nesting density (nests/km)	Number of monitoring seasons
Laganas Bay,Zakynthos	5.5	2,018	857	235.6	14
Kyparissia Bay*	44.0	927	286	12.8	13
Rethymnon, Crete	10.8	516	316	36.6	8
Lakonikos Bay	23.5	220	107	7.3	6
Chania Bay, Crete	13.1	192	77	8.9	6
TOTAL	96.9	3,873	1,643		

* More than 83% of nests concentrate at the southernmost 10 km of Kyparissia Bay, where average nesting density reaches 47.2 nests/km/season.

seasons) of more than 100 and an average nesting density of more than 6 nests/km/season. Areas of "moderate" nesting should have an average number of nests per season between 20 and 100, irrespective of nesting density. Areas hosting less than 20 nests/season or featuring irregular nesting patterns are characterized as areas of "diffuse" nesting.

RESULTS

Considering the existing data for all nesting areas in Greece, five "major" nesting areas are recognized (Table 1). From the same table it is seen that nesting fluctuations between "good" and "bad" seasons may reach 61% (Rethymnon area). Table 2 shows areas of "moderate" nesting. Some of these areas are rather extensive (*e.g.* Ipirus coast) and more surveys are needed in order to locate possible nesting concentrations. Finally, taking into account the "diffuse" nesting (estimated at 15% on total nesting) that takes place along the 15, 000-km Greek shoreline, the overall number of loggerhead nests in Greece ranges from 5, 287 to 2, 355 (Table 3).

DISCUSSION

Existing data, most of them collected over several seasons, permit a more or less adequate estimation of the overall nesting activity of the loggerhead turtle in Greece. As most part of the Greek shoreline has been already investigated, it is unlikely that new nesting areas, with a substantial influence on the existing overall situation, will be found.

The five "major" nesting areas in Greece, totaling about 97 km in length, account for 69.8%-73.3% of the total loggerhead nesting activity (Table 3). Conservation programs are conducted by the STPS on all "major" areas, including monitoring of the turtle populations, protection of nests, public awareness activities as well as preparation and implementation of management plans. All five "major" areas have been proposed by the authorities for inclusion in the European Union's network of protected areas, known as Natura 2000, under the Habitats Directive. Especially the Bay of Laganas in Zakynthos, with its tremendous nesting potential, will soon be declared a National Marine Park.

Areas with "moderate" nesting activity account for 11.7%-15.2% of the total nesting activity in Greece (Table 3). Some of these areas (*e.g.* Kotychi lagoon, Bay of Messara) are monitored by the STPS and have also been proposed for the Natura 2000 network as they feature other important characteristics. The nesting area on the island of Kefalonia is systematically monitored by the Kefalonian Marine Turtle Project and hopefully will receive some protection by local land use planning. On the other hand, some rather extensive areas with "moderate" nesting (and subsequently with low nesting densities) are not watched over as closely as the others (*e.g.* Ipirus, Kos).

Table 2 Nesting areas in Greece with "moderate" loggerhead nesting (20<x<100 nests/season on the average)

Area	Number of nests per season
Kerkyra island (including nearby islets)	20
Ipirus coast (Preveza-Albanian border)	40
Lefkas island	50
Kefalonia island	21 - 83
Kotychi lagoon (NW Peloponnesus)	32 - 80
Yanitsena, Bouka, etc. (W Peloponnesus)	30 - 60
Romanos (SW Peloponnesus)	17 - 30
Koroni, Foinikous, etc. (S Peloponnesus)	45 - 80
Astros, Kythira, etc. (SE Peloponnesus)	20
Bay of Messara, Crete	15 - 77
Kos island	60
Rhodes island	9 - 21
TOTAL	359 - 621

1. Areas in geographical order from NW to the SE.
2. Two numbers per area refer to maximum and minimum numbers recorded over different seasons.
3. One number per area refers to estimation during one season.
4. Data for Kefalonia from Houghton et al., 1997.

In total, 76.5%-81% of the overall loggerhead nesting activity in Greece is, more or less, overseen very closely and efficiently, and specific legislation and management measures are in effect or soon to be effected. However, adequate enforcement of regulations and local participation have still a long way to go until they become fully operational.

Table 3 Estimation of total loggerhead nesting activity in Greece (nests per season)

Category of nesting	Maximum number	Minimum number
In "major" areas (>100 nests/season)	3,873	1,643
In areas with "moderate" nesting (20<x<100 nests/season)	621	359
"Diffuse" nesting (15% of total)	793	353
TOTAL	5,287	2,355

ACKNOWLEDGEMENTS

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GREEN TURTLE HATCHLING SWIMMING PERFORMANCE AND THE EFFECTS OF PROLONGED CAPTIVITY

N. J. Pilcher and S. Enderby
Institute of Biodiversity and Environmental Conservation, University Malaysia Sarawak, 94300 Kota Samarahan, Sarawak, Malaysia. nick@tualang.unimas.my

INTRODUCTION

Turtle management around the globe targets primarily the life history stages that are accessible on land due to the relative ease of dealing with nesting adults, eggs and newborn hatchlings as opposed to free swimming individuals. Many conservation sites include hatcheries in which eggs are incubated and from which hatchlings are subsequently released. Unfortunately, what is known about the short- and especially long-term effects of hatchery activities on turtles is severely lacking and it is possible that well-intentioned practices have negative effects on survival.

The actual performance of the hatchlings after they enter the sea is poorly studied due to their speed and the logistics of tracking a large number of individuals that rapidly disperse. Most of these studies have been on hatchling orientation and the dynamics of near-shore movements and predation.

This study details the swimming performance of hatchlings over time after entering the water through controlled laboratory experiments. In particular, it is concerned with the performance of hatchlings after prolonged captivity such as when they hatch and are prevented from reaching the sea by hatchery enclosures. Hatchlings were taken from a hatchery up to six hours after emergence at one-hour intervals. Swimming speed and style were monitored in a purpose-designed raceway system (affectionately dubbed "The Swimerator") that catered to the known swimming characteristics of the hatchlings, and were then correlated with flow-through water speeds.

In general it was found that swimming performance decreased with prolonged captivity, with swimming distances dropping by over 11% with six hours of detention. Average swim rates during the tests ranged from 0.463m·sec-1 to 0.751m·sec-1 (x = 0.586m·sec-1 n = 609) with distances covered ranging from 1980m·sec-1 to 2249m·sec-1 (x = 2110m, +/- 112m) during the first six hours after hatching. In addition, swimming style was found to vary with prolonged captivity which, coupled with decreased swimming distances, could have negative effects on overall hatchling dispersion patterns and survival rates.

METHODS

Swimming trials were carried out on Pulau Selingan, off Sabah, Malaysia from November 1997 to February 1998. Swimming behavior and performance were monitored in a custom-designed recirculating raceway system that catered

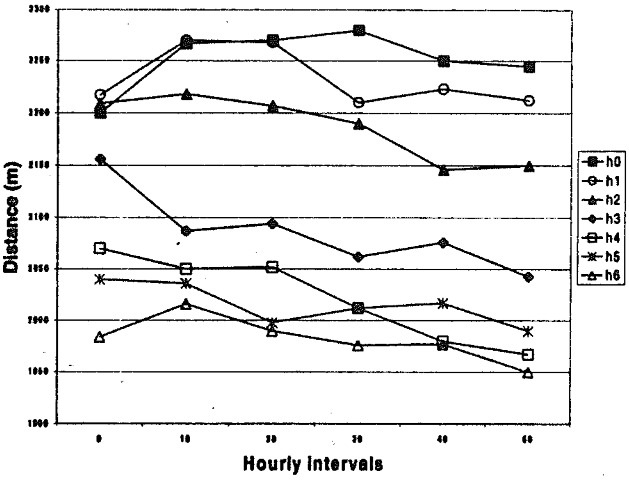

Figure 1. Estimated total swim distance at different release times (Hx) for green turtle hatchlings during their first hour in the water; mean distances are represented by the filled boxes.

to known hatchling swimming requirements. Hatchlings were not tethered in the raceway, rather, they were allowed to swim into an artificial current regulated to exactly match their swimming speed. The raceway, constructed of marine plywood, measured 220 cm X 38 cm with a depth of 40 cm and had an adjustable-height (0-4 cm) outflow area. A similar-sized tank under the raceway system acted as a reservoir for the recirculating water. The interior was painted matte black, and a single 100W light source on a dimmer was attached to the front edge, slightly above water line and behind a cloth screen, towards which the hatchlings faced. The leading half of the tank was topped with black cover to reduce outside visual stimuli. The unit was situated within a darkened shed 30m from the water line and oriented in direct line with the beach so the hatchlings would be swimming 'directly offshore' (255° magnetic compass). The combination of point-source light and tank orientation was used to keep the turtles swimming straight into the recirculating water and away from the sides of the unit. All other design features were intended to deprive the hatchlings of environmental cues, so that they would not be aware that they were not moving forward (relatively) upon swimming. Water depth averaged 15-20 cm, and flow speeds could be varied from 1 to 2.5 m·sec-1 with adjustable channel boards that narrowed or widened the water inflow cross-section. Under normal operations, the rear end of the raceway was open (rear gate height of 0 cm). When hatchling swimming speed decreased below the minimum at this setting, the gate was raised by 2 or 4 cm to create a higher water volume in the raceway (reducing overall flow-through speed while pumped volume remained equal).

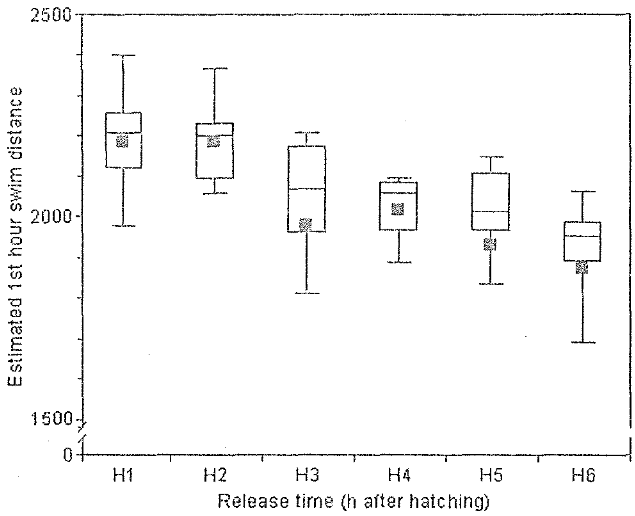

Figure 2 Average swim distances at ten-minute intervals for different green turtle hatchlings at relasetime Hx

RESULTS

Swimming speeds were determined from the matching opposing water speeds. Fastest speeds attained reached 0.751m·sec-1, the lowest were 0.463 m·sec-1 (Figure 1), while the average across all trials was 0.561m·sec-1 (0.001, P>99%). Average swimming speed was found to decrease steadily with increased retention times (r = -0.806), suggesting either a forced change in natural behaviour or utilisation of limited energy stores, or a combination of both. The trend in swimming speeds is displayed in Figures 1 and 2.

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NESTING BEACH SURVEYS: THE IMPORTANCE OF COMPLETE DATA REPORTING

Barbara A. Schroeder

National Marine Fisheries Service, Office of Protected Resources, 1315 East West Highway, Silver Spring, MD, 20910, U.S.A. barbara.schroeder@noaa.gov

Nesting beach surveys are the most widely implemented monitoring tool in use by the global sea turtle community and are an important component of a comprehensive program to assess and monitor the status of sea turtle populations. These assessments are necessary to evaluate the effects of recovery and conservation activities which are being implemented at all life history stages. Monitoring techniques employed on nesting beaches range from highly structured standardized sampling to 'snapshots' of nesting activity within a nesting season. While nesting surveys are currently widespread, the variability in techniques often hampers our ability to make meaningful assessments of the status of nesting populations. Problems may occur when attempting to assess the status of nesting populations within nesting seasons but between survey areas, between and among nesting seasons at a particular nesting site, and/or across some nesting range of a particular population or stock (*e.g.* within country or state). With these problems in mind, the principal purpose of this paper is to emphasize the importance of reporting complete information when presenting nesting beach survey data, in order that those data may be used appropiately for both management and research purposes.

GREEN TURTLE GROWTH RATES: EVIDENCE FOR A DENSITY-DEPENDENT EFFECT AND CARIBBEAN-PACIFIC DIFFERENCES

Karen A. Bjorndal[1], Alan B. Bolten[1], and Milani Y. Chaloupka[2]
[1]Archie Carr Center for Sea Turtle Research, University of Florida, Gainesville, FL 32611, U.S.A. kab@zoo.ufl.edu
[2]Queensland Department of Environment, Brisbane, Queensland, Australia

Growth rates of immature green turtles were evaluated with nonparametric regression models for data collected during an 18 year study in Union Creek, a wildlife preserve in the southern Bahamas. We addressed three questions: (1) do growth rates change with population density; (2) are movements of green turtles from a low quality area to a high quality area associated with decreased growth rates; and (3) are there differences in the growth functions for green turtle populations in the Greater Caribbean and in the Pacific Ocean?

GREEN TURTLE NESTING AT TORTUGUERO, COSTA RICA: AN ENCOURAGING TREND

Karen A. Bjorndal[1], Jerry A. Wetherall[2], Alan B. Bolten[1], and Jeanne A. Mortimer[3]
[1]Archie Carr Center for Sea Turtle Research, University of Florida, Gainesville, FL 32611, U.S.A. kab@zoo.ufl.edu
[2]National Marine Fisheries Service, Honolulu, HI 96822, U.S.A.
[3]Caribbean Conservation Corporation, Gainesville, FL 32609, U.S.A.

The green turtle population that nests at Tortuguero, Costa Rica, is the largest in the Atlantic. Twenty-six years of survey data are analyzed from 1971-1996. Annual estimates of nesting emergences were derived by fitting a cubic smoothing spline to survey track counts using the Generalized Additive Model function and integrating over the entire season. The cubic spline procedure was also used to smooth the 26-year time series of annual nesting emergences. Trends reported in this study are discussed in the context of the shifting baseline syndrome and must be evaluated with caution.

MODELLING THE SUSTAINABILITY OF SEA TURTLE EGG HARVESTS IN A STOCHASTIC ENVIRONMENT

Milani Chaloupka
Queensland Department of Environment, PO Box 155, Brisbane Albert Street, Queensland, 4002. Australia
m.chaloupka@mailbox.uq.edu.au

I have developed a stochastic simulation model for loggerheads (*Caretta caretta*) comprising the southern Great Barrier Reef stock. The model was designed to support risk-based evaluation of (1) trawl fishery impacts on stock viability given competing mortality risks (Chaloupka and Limpus, 1998a) and (2) egg harvesting policies given environmental stochasticity and management uncertainty.

METHODS

The model used finite difference equations linked with dynamic vital rates characterised by nonlinear, time variant, distributed lag and stochastic properties. It comprised a stage-structured demography comprising both age-based and reproductive status-based stages (see Chaloupka and Limpus, 1996 for concept). Mortality rates were derived from (1) known hatching rates (Limpus *et al.*, 1994), (2) proxy hatchling mortality estimates for green sea turtles from the same sGBR location (see Chaloupka and Limpus, 1998a) and (3) multinomial CJS statistical modelling of immature and adult sGBR loggerhead sex-specific survival rates (see Chaloupka and Limpus, 1998b). Demographic stochasticity was included with stage-specific logistic pdfs reflecting 95% confidence interval estimates of survival rates. Environmental stochasticity was included by a 2-state stochastic breeding likelihood function derived from empirical breeding rates (see Limpus *et al.*, 1994). Stage-transition rates were based on Erlangian functions to ensure distributed maturation (see Chaloupka and Musick, 1997). The simulation period was 200 years after a 50 year no harvest period.

RESULTS AND DISCUSSION

The strategies evaluated were (1) constant number of eggs removed each year, (2) constant annual harvest rate and (3) threshold-based harvesting, where egg harvesting occurred at a constant annual rate while the adult substock remained above a threshold level. See Lande *et al*, (1997) for a discussion of threshold strategies. Performance criteria were (1) population size at simulation period end, (2) cumulative egg yield at simulation period end and (3) proportion of simulation period with no yield. Adult stock thresholds were set at 90%, 75%, 50%, 25% and 10% of pre-harvest period stock size and subject to constant annual egg harvest rates (10%, 20%, 30%,40%). Threshold levels are risk levels where a decison-maker is willing to allow the adult stock to fall to say 75% of virgin adult stock but no further. Harvesting ceases until the stock recovers above the threshold.

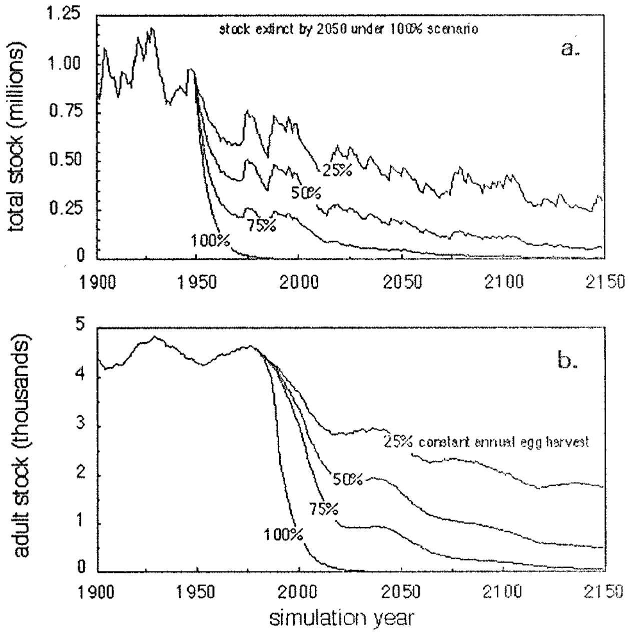

Figure 1: Post-1950 constant annual egg harvest rate scenarios

A harvest strategy with constant number of eggs removed each year leads to a declining stock unless the annual take is less than 20,000 eggs (ca. 160 clutches) or ca. 5-10% of the annual egg production for the pre-harvest stock. Limpus (1993) proposed that a strategy would be to ensure that at least 70% of the annual egg production of a sea turtle stock yields hatchlings to escapement to the pelagic phase. This is equivalent to ca. a 20-25% constant egg harvest rate for this stock. A range of constant rate scenarios is shown in Figure 1.

Clearly any of these rates leads to a declining total stock (Figure 1a) or adult component (Figure 1b). The simple rule-of-thumb of 70% escapement of annual egg production to hatching is useful but over-estimates the potential harvest take for this stock. Figure 2 shows a several threshold-based harvest scenarios (adult threshold=75 or 50% and annual harvest rate=20%) compared to a constant harvest rate=20%. Imposing a threshold of 75% (assuming no error in stock assessment) results in a viable stock ca. 50 years after harvesting started in simulation year 1950. A stable stock occurs for a 50% threshold around 125 years after harvesting started. The stock subject to no threshold and the constant annual egg harvest = 20% shows a stock also declining (Figure 2). Clearly, given the same harvest rate, imposing thresholds into the strategy would lead to a sustainable stock under exploitation (especially if the threshold is high such ca. 75%). Figure 3 shows the cumulative yield from the scenarios shown in Figure 2.

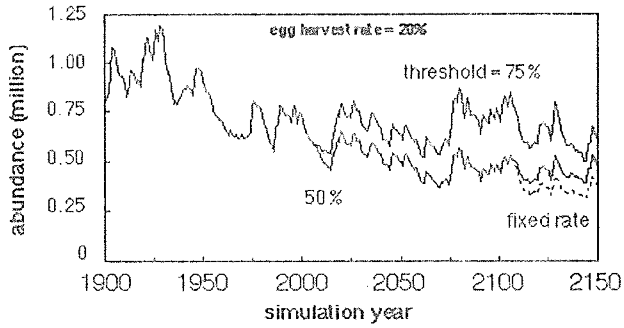

Figure 2: Total loggerhead stock given threshold harvest levels

While a threshold=75% resulted in a viable stock it does not provide a reasonable yield compared to a threshold=50% or a threshold=25% (equivalent to no threshold and an annual 20% harvest rate). The trade-off is between high stable stock and high yield.

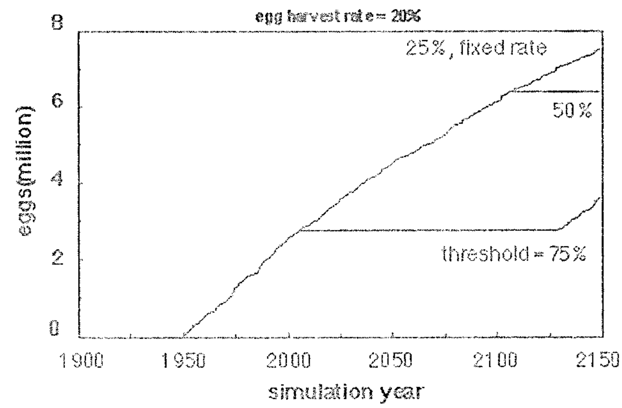

Figure 3: Cumulative egg yield from threshold models

Threshold harvesting strategies seem a means for managing the sustainability of turtle stocks compared to fixed number of fixed rate strategies. The disadvantage of threshold-based harvesting is that it results in high yield variability and a proportion of years where there is no harvest at all. Figure 4 shows this outcome for a threshold=90% and two stock assessment error rates (management under uncertainty).

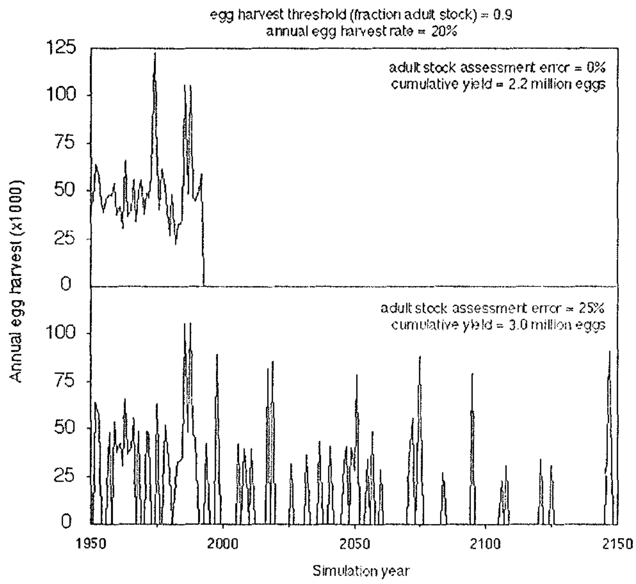

Figure 4: Egg yield given thresholds and uncertainly in adult stock assessment

Figure 4 (top panel) shows that the harvest ceases after 50 years because the stock has declined below 90% virgin stock and has not recovered. Figure 4 (bottom panel) shows the harvest outcome given 25% error in annual assessment of the adult stock size used to set the threshold. The assessment uncertainty leads to a higher cumulative yield and fewer years without zero harvest. Decreasing the threshold decreases the proportion of zero harvest years (Figure 5) and so increasing the cumulative yield (Figure 3) but decreasing stock size (Figure 2). A suitable harvest strategy for this stock maximising stock viability but ensuring some harvest would be a scheme comprising a stock threshold ca. 50% coupled with an egg harvest rate=20%. Harvest management involves complex trade-offs that can only be evaluated given clear risk-based management objectives. Harvesting eggs is also a risky business for green turtle stocks (Chaloupka and Limpus, 1996), a finding consistent with empirical estimates of declining

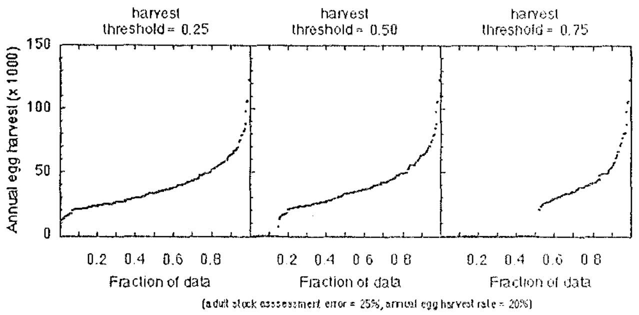

Figure 5: Egg yield plots showing probability of no yield given thresholds an uncertainty in adult stock assesssment

green turtle stocks in the SE Asian region where extensive egg harvesting has occurred for many years.

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SEA TURTLE GROWTH DYNAMICS: A REVIEW

Milani Chaloupka
Queensland Department of Environment PO Box 155, Brisbane Albert Street, Queensland, 4002. Australia
m.chaloupka@mailbox.uq.edu.au

A thorough knowledge of the somatic growth dynamics of a species is essential to support the development of life history theories and the modelling of population dynamics for species subject to harvesting. Sea turtles are subject to a wide range of anthropogenic impacts including commercial and subsistence harvesting. Yet the growth dynamics of sea turtle species has not been well understood as discussed in a recent review published in the Biology of Sea Turtles (see Chaloupka and Musick, 1997). Since that review a number of studies have been completed that will make important contributions to improving our understanding of sea turtle somatic growth. For instances, recent studies on hawksbill, green, loggerhead and Kemp's ridley sea turtles have revealed a complex range of age- and size-specific growth responses including the following:

(1) size-and sex-specific growth rate functions for green sea turtles (Chaloupka and Limpus 1996, Chaloupka and Limpus 1997, Limpus and Chaloupka 1997)
(2) spatial (Chaloupka, Limpus, Miller in prep) and temporal growth variability (Chaloupka and Limpus 1996, Limpus and Chaloupka 1997, Chaloupka, Limpus, Miller in prep) for green sea turtles between foraging grounds within the same genetic stock
(3) density dependent growth in immature greens (Bjorndal, Bolten and Chaloupka submitted) and the complex delayed response between immature survivorship and growth rates (Chaloupka and Limpus 1998, Chaloupka and Limpus in prep)
(4) age-specific growth of greens for green sea turtles from multiple foraging grounds within the same genetic stock (Chaloupka and Limpus 1996, Limpus and Chaloupka 1997, Chaloupka, Limpus, Miller in prep)
(5) inter-regional somatic growth rate differences between Caribbean and sGBR green stocks (Bjorndal, Bolten and Chaloupka submitted)
(6) polyphasic growth inferring ontogenetic shifts in growth rates for Kemp's ridleys and pelagic loggerheads (Chaloupka and Zug 1997, Chaloupka 1998, Chaloupka, Caillouet and Zug in prep)
(7) age-specific growth comparisons between headstarted and wild stock Kemp's ridleys (Chaloupka, Caillouet and Zug in prep)

I discuss these 7 new developments in sea turtle growth studies and emphasise the importance for growth studies to be designed within a spatially-explicit and sex-specific age/year/cohort modelling framework (see Chaloupka and Musick 1997) to support robust inference about sea turtle somatic growth dynamics.

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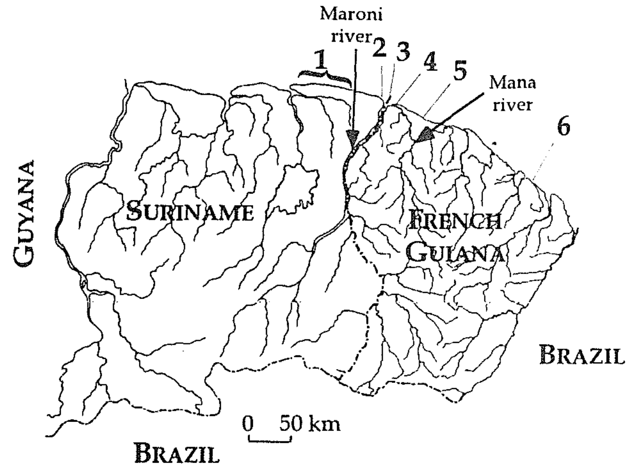
RECENT POPULATION TREND FOR *DERMOCHELYS CORIACEA* IN FRENCH GUIANA

Johan Chevalier[1 and 2] and Marc Girondot[1]
[1] URA 1137, Case 7077 - Université Paris VII - 2 place Jussieu- 75251 Paris Cedex 05- France chevali@ccr.jussieu.fr
[2] WWF France - 151 boulevard de la Reine- 78000 Versailles, France. mgi@ccr.jussieu.fr

French Guiana is located at 400 km north-west of the Amazon River estuary. It is the most important Leatherback turtle (*Dermochelys coriacea*) nesting zone of the world where 40% of the world's leatherbacks are nesting (Spotila *et al.*, 1996). During the last decade, all the other known major nesting beaches for *D. coriacea*, in Mexico, Irian Java or Malaysia have displayed a decline in the total number of nests laid during the nesting season (Spotila *et al.*, 1996). Within this context, the trend of the nesting Leatherback population in French Guiana has strong implications for the long-term survival status of this species. Within French Guiana, 90% of all Leatherbacks nests are laid on Ya:lima:po beach near the other nesting beaches of French Guiana at the border with Suriname (Girondot *et al.*, 1996). Thus the number of nests for Ya:lima:po beach is close to the global number of nests for the country. The yearly number of nests has been established since 1978 in Ya:lima:po beach, except for five years (1980-81, 1984-85, 1990) (Girondot *et al.*, 1996; Chevalier and Girondot, in press). The missing data from these 5 seasons have impeded analysis of trends in the numbers of laid on Ya:lima:po beach in the last 30 years.

apica, (2) Galibi, (3) Ya:lima:po, (4) Apo:tïlï, (5) Organabo, (6) Remire-Monjoly.



Map 1: Localizaition of the ensting beaches in French Guiana and in east Suriname. (1) Matapica, (2) Galibi, (3) Ya: lima: po, (4) Apo: tili, (5) Organabo, (6) Remire- Monjoly

We looked for correlations between the yearly number of *D. coriacea* nests among three nesting zones : Ya:lima:po beach in French Guiana, and Galibi and Matapica beaches in Suriname (Reichart and Fretey, 1993, Schulz, 1975, and Biotopic, pers. comm.). Data for Matapica beaches include the nest number for all the minor beaches at the West of Galibi beach. However, a high level of autocorrelation exists in the data due to the common trend and such phenomenom impeds the use of direct correlations between nesting beaches. Particularly, the number of nests increases significantly more rapidly along years in Galibi when compared to Matapica (comparison of linear regression slope: Nests=Year.a+b; a=217.52 for Galibi and a=105.85 for Matapica, t=1.745, 36 ddl, p<0.05). The linear regression of the angular transformation of the relative number of nests laid in Matapica compared to all the nests in Suriname has been established and it is highly significant statistically (figure 1A). The residual of this equation is not significantly correlated with the total number of nests in Suriname (r=-0.234, 16 ddl, p=0,35). Therefore, a displacement from West (Matapica) to East (Galibi) of the location of the nests is sufficient to explain the changes in the number of nests on the different nesting beaches in Suriname since 1967. Using the equation 1, we were able to estimate the number of nests in Galibi and Matapica for the years 1979-83, in Galibi for 1990-92 and in Matapica for 1995. We then looked for a correlation between the number of nests for beaches within the Maroni and Mana rivers estuary (Galibi for Suriname and Ya:lima:po for French Guiana). A linear regression using the method of least rectangle with null constant term permitted us to obtain equation 2 which is also highly significant statistically (Figure 1B). This equation has been used to estimate the number of nests missing for Ya:lima:po beach or for Galibi beach. Estimates of the number of nests in Matapica beach from data-deficient seasons were based on the number of nests in

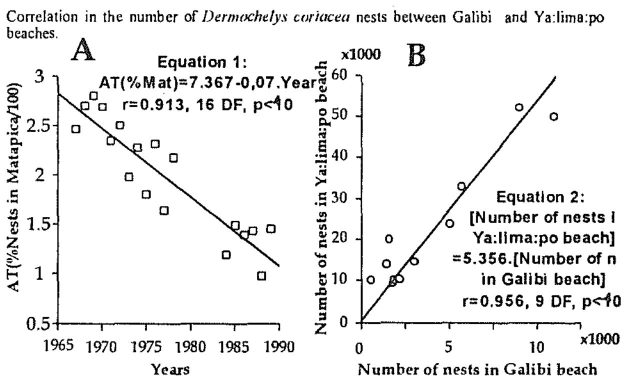


Figure 1: (A) Linear regression of the angular transform [AT(x)=2.Arc.Sin(x1/2)] of the relative proportion of all surinamian nests deposited in Matapica beach upon years; (B) Correlaition in the number of Dermochelys coriacea nests between Galibi and Ya: lima: po beaches

Galibi beach using equation 1.

A strong increase of the number of nests laid each year until around 1992 was observed (Figure 2). Since around

1992, an important decline of the number of nests laid in Ya:lima:po beach and in Suriname has been observed. In French Guiana, the low incidence of poaching of eggs and females does not explain the recent negative trend of the overall number of nests. Almost no Leatherbacks are eaten and the only turtles killed by the local Amerindian villagers are those caught in the fishing nets. Although it is difficult to accurately estimate the level of occurrence of this slaughter,

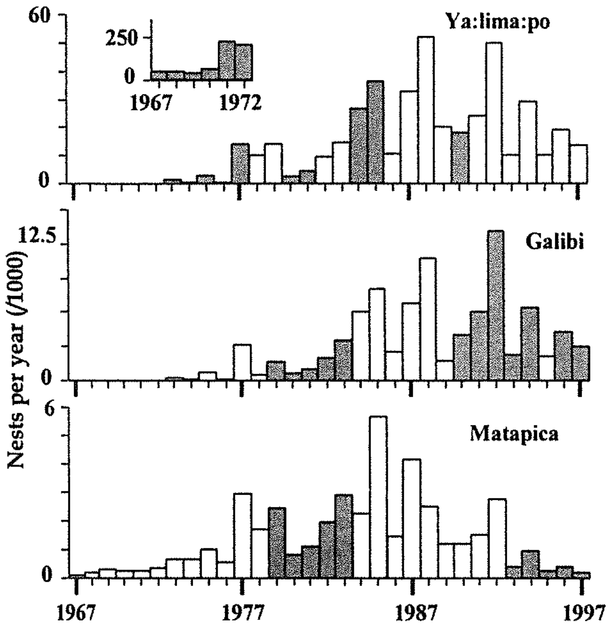


Figure 2: Evolution of the number of Dermochelys coriacea nests on Ya: lima: po beach in French Guiana, and Galibi Matapica beaches in Suriname since 1967. Nests numbers for gray bars are estimated using equation 1 or 2 (see text and figure1).

it is certainly not widespread enough to responsible for such a decline.

The shrimp fisheries of French Guiana have undergone important changes during the last decade. Whereas previously shrimp used to be fished by American and Japanese boats for export to U.S.A. and Japan until 1986, now almost all the shrimp fishing boats are French (Table 1). Since 1986, these French boats can obtained permit to fish closer to the coast to catch smaller-sized shrimp (Béné, 1996). Studies from other nesting beaches have shown that during the internesting interval within a nesting season Leatherback females tend to remain most of the time close to their nesting beach (Chan *et al.*, 1991). Therefore, trawling for shrimp nearer to the coast might increase the incidence of capture of female Leatherbacks in fishing net. The shrimp fishing activity may be an important factor in the decline of the number of sea turtles in French Guiana. TEDs are not still used in French Guiana.

If confirmed, the decline of the number of nests in the Guianas would be a bad sign for this already endangered species. Defining more clearly the population dynamics and uncovering the cause(s) of the actual decline thus will be our priority. It is very important to work on the level of the nesting population, and we are working to improve collaboration among the researchers of Suriname, Guyana and north-

Table 1: Shrimp fishing effort in French Guiana from 1980 to 1992. More recent informaition is not available.

	1980	1982	1984	1986	1988	1990	1992
Number of fishing boats	80-90		70-80			70	
% French boats	<5%			30%		60%	
% export to France				0%		50%	95%
Mean fishing depth			46.5 m		43 m	41 m	
Fishing legislation		Fishing forbiden from May to December below 30 m			Derogation for French fishing boat to fish below 30 m during all the year		

ern Brazil, where perhaps there may be unmonitored nesting beaches used by Leatherbacks.

ACKNOWLEDGMENTS

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COMPARISON OF THREE METHODS FOR ESTIMATING THE SIZE OF OLIVE RIDLEY (*LEPIDOCHELYS OLIVACEA*) ARRIBADAS AT NANCITE BEACH, SANTA ROSA NATIONAL PARK, COSTA RICA

Susanna Clusella Trullás, Joel Sáenz, and María T. Fernández
Programa Regional en Manejo y Conservación de Vida Silvestre, Universidad Nacional de Costa Rica, Apartado 1350-3000, Heredia, Costa Rica. loras@una.ac.cr

The olive ridley sea turtle (*Lepidochelys olivacea*) exhibits the most extreme case of the strategy of aggregated nesting, known as arribadas. This species nests in huge concentrations over a period of several days at two beaches in Pacific Costa Rica, one in Pacific Nicaragua, two in Pacific Mexico and three in India. Depending on the location, there may be just two or three, or up to a dozen arribadas per year. It is likely that the nesting grounds in Pacific Mexico and Central America support all the Ridley turtles in the entire Eastern Tropical Pacific (ETP) (Ross 1995).

Nancite beach, one of the two arribada beaches of Costa Rica, is located on the north Pacific coast in Guanacaste Conservation Area, and it is of worldwide importance for olive ridley sea turtles. Arribadas of more than 100,000 turtles have been recorded in periods of less than a week on this 1.1 km long beach. Because of the concentration of nesting turtles, eggs and hatchlings, many ecological processes in the Nancite watershed are influenced by this unique phenomenon.

In 1980 a systematic study monitoring abundance, distribution and migration of olive ridleys on Nancite was begun by Cornelius, and this has been continued by the Regional Widlife Management Program of the National University of Costa Rica. Tag recapture and satellite telemetry studies have determined that these turtles nest in groups, but later disperse independently throughout the ETP (Cornelius and Robinson 1986; Plotkin *et al.*, 1995).

At present, population counts of nesting females are the only tool by which the stability of populations can be monitored and dangerous trends detected (Meylan 1995). Traditionally, two methods have been used to estimate the size of the arribadas at Nancite: the quadrant method developed by Cornelius and Robinson in 1982 (Cornelius and Robinson 1982) and the transect method developed by Gates and colleagues in 1996 (Modified Instantaneous Count Procedure, Gates *et al.*, 1996). Since their application, the two methods have given different population estimates (Mo, pers. com.). In this study we compared the results of these two estimates as well as the values produced by direct, or total, counts of the number of turtles nesting in an arribada.

METHODS

The total count and the two sampling methods were employed simultaneously during three nights of the August 1997 arribada.

The quadrant methodology: The quadrant method (Cornelius and Robinson 1982) samples turtle activity in 19 quadrants located on the beach. The following counts are made every two hours, in each of the 10x10 m quadrants:

T: total number of turtles;
D: number of turtles in the process of digging a nest cavity;
L: number of turtles laying eggs;
C: number of turtles covering nest cavity.

The calculations are:

The total number of turtles nesting during the arribada, P = Pm (middle zone) + Ph (high zone), where

$$Pm = \{\{(L + 0.98(D+C) + 0.52(T-(L+D+C))\}1.25*A*H\}/Q*1.13*n$$

$$Ph = \{\{(L + 0.98(D+C) + 0.52(T-(L+D+C))\}0.7*8500*H\}/Q*1.13*n.$$

0.98 = Estimate of the percentage of turtles observed either digging or covering a nest cavity that actually lay eggs.
0.52 =Estimate of the percentage of turtles encountered in pre-nest cavity stage which eventually nest.
1.25 = Extrapolation of the estimate for turtles in the mid-beach zone to include those nesting in low-beach, below the high tide line.
1.13 = Average time in hours that a turtle spends on the beach during a successful nesting emergence.
0.7 = Maximum estimated nesting density (turtles/m²) in the high-beach zone.
8500 = Size of nesting area under woody vegetation (m²).
A = Total available nesting area in mid-beach zone (m²).
H = Number of hours which arribada lasted.
Q= Number of quadrants * area of each quadrant.
N = Number of quadrant counts during the arribada.

The transect methodology: The transect methodology consists of a Modified Instantaneous Count Procedure for arribadas (Gates *et al.*, 1996). During arribadas, a total of 20 transects, distributed regularly across the beach, is sampled every two hours. The transect lines are extended perpendicular to the shore, from the high tide line to the farthest point inland used by nesting turtles. The width of a transect is determined by the arm-span of the person doing the counting. Counts include only turtles inside a transect that are exhibiting an Unambiguous Egg-laying Activity (UELA) (*e.g.*, turtles ovipositing and the eggs have actually been observed). The calculations allow variance and confidence intervals to be determined.

The calculations are:

Number of laying female turtles =

Total UELA turtles seen / Area and Time expansion factors;

*Area expansion factor =

Sample area / Total available nesting area;

*Time expansion factor =

(Average time spent in UELA * Number of sampling periods) / Duration of the arribada.

The total count methodology: The beach was divided into eleven contiguous sectors, each 100m wide. In each sector, two persons counted and marked every turtle during the arribada. All turtles in a sector were marked on the carapace with paint (the paint was tested on a piece of carapace submerged in a sea water to verify that the mark would last at least a week). Previously marked turtles were not counted twice, but were marked with paint a second time.

The transect and quadrant methods estimate the number of egg laying turtles during the arribada, while the direct count is the estimate of the total number of turtles coming ashore during the arribada. Because we wanted to compare the three methods, a correction to this direct count was applied, based on the same factors used in the quadrant methodology (0.75) to correct for the number turtles that come ashore but do not lay eggs.

RESULTS AND CONCLUSIONS

Contrary to what we were expecting, both the transect and quadrant methods overestimated the total counts; the difference was even more notable when the corrected total counts were used (Table 1).

Table 1 Results of three methods of counting olive ridley arribadas at Nancite, Costa Rica.

Date	Total Counts	Total Counts With Correction (0.75)	Transects Mean (95% Confidence Limits)	Quadrants
02/08/97	1716	1287	3820 (2009; 5631)	1857
03/08/97	1349	1012	1486 (281; 2690)	1418
04/08/97	594	446	849 (34; 1664)	598
TOTAL	3659	2744	6268.5 (3903; 6807)	873

Although the total counts for the 3rd and 4th of August were lower than the estimates for both transects and quadrants, the values were within the 95% confidence limits for the respective transect estimates. The main problem with these transect estimates is that the confidence intervals are very large. However, the transect estimate for the first night, during which the highest density of nesting occurred, was significantly greater than the direct count.

The quadrant method consistently overestimated the direct counts, with values averaging almost 140% higher. Quadrant estimates have been used since 1980 at Nancite, and it is fundamental to emphasize that these estimations do not include any measure of variance, or confidence intervals. Thus, these estimates do not include sufficient information with which to make statistically valid comparisons.

We did this experiment during an arribada with certain characteristics (relatively small number of turtles, weather, tides, turtle behavior, etc.), so this experiment needs to be repeated in several more arribadas to see if this tendency is common or not.

Since there are several arribada beaches where people are making efforts to estimate the size of the nesting populations (Nicaragua, Panamá, Costa Rica, Mexico and India), it is urgent that we develop a standardized and comparable estimation method for all arribada beaches.

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KEMP'S RIDLEY HABITAT SUITABILITY INDEX MODEL

Michael S. Coyne[1 and 2], Mark E. Monaco[1], and André M.Landry, Jr.[2]
[1]National Ocean Service/NOAA, 1305 East-West Hwy, Rm 9216, Silver Spring, MD 20910, U.S.A. mcoyne@seamail.nos.noaa.gov
[2]Sea Turtle and Fisheries Ecology Laboratory, Texas A&M University, Galveston, TX 77551, U.S.A.

NOAA's Strategic Environmental Assessments (SEA) Division has developed Habitat Suitability Index (HSI) models as management tools to: 1) Map living resources in areas that lack adequate sampling data; 2) refine existing maps; 3) evaluate impacts of alternative regulatory scenarios; and 4) assess effects of environmental change. These HSI modeling methods are based on an approach developed by the U.S. Fish and Wildlife Service which calculated the value of an area by determining what a species needed from its habitat, followed by quantification of habitat availability. SEA Division has adapted this approach to address estuarine and marine issues, adding a spatial component utilizing GIS technology. This Kemp's ridley HSI model represents an exploratory analysis of the potential use of HSI in sea turtle management and speculative distribution and density research using currently available data.

Suitability indices were estimated for Kemp's ridley sea turtles in the Gulf of Mexico and western Atlantic for sea surface temperature (SST) and depth. Bathymetric and monthly SST map layers were created for the Gulf of Mexico and U.S. Atlantic coast. Each layer was reclassified to a gridded surface with a suitability index value applied to each grid cell. An HSI model was derived for each month by calculating a geometric mean of suitability of SST and bathymetry for each grid. Model outputs were classified into five quantiles for spatial analysis. Quantiles are defined relatively rather than specifically as it is uncertain how HSI values relate to biological density.

The model displayed a distribution trend for Kemp's ridley of: U.S. Gulf of Mexico - "warm" period during May - October, near-shore habitat characterized as "good"; "cooling" period during November - December, near-shore habitat decreased in quality; "cool" period during January - February, near-shore habitat characterized as "bad"; and "warming" period during March - April, near-shore habitat increased in quality; U.S. Atlantic coast - suitable habitat extended northward during warm months, reaching New England waters during July - September, and receded southward to Florida during cool months.

The utility of HSI modeling as a tool to focus research and management efforts both spatially and temporally was discussed, as well as, the need to establish long-term index sites for monitoring Kemp's ridley abundance and biology. Follow-up work should include acquiring additional data on Kemp's ridley distribution to improve the model, identifying other habitat variables that may limit Kemp's ridley distribution, refining the model to include sex and/or life-history stage specific information, and, finally, model validation utilizing telemetric tracking or historical stranding records.

BEYOND D-0004: THIRTY-FOUR YEARS OF LOGGERHEAD (*CARETTA CARETTA*) RESEARCH ON LITTLE CUMBERLAND ISLAND, GEORGIA, 1964-1997

M. Kirsten Dahlen, Rebecca Bell, James I. Richardson, and Thelma H. Richardson
Institute of Ecology, University of Georgia, Athens GA 30602-2202
Little Cumberland Island, Box 13127, Jekyll Island, GA 31527

The on-going saturation tagging program on Little Cumberland Island (LCI) started in 1964. The study area is a barrier island that falls within the confines of the Cumberland Island National Seashore off the southeast Georgia coast. In an effort to intercept every nesting female, the beach is covered nightly at hourly intervals, from dusk until dawn, late May through early August each year. D0004 was one of the first nesting loggerheads to visit the beach in 1964. She returned and nested for 20 seasons until her death in 1984.

The population of nesting loggerheads on LCI has declined from an initial 120 individuals in 1964 to 17 individuals nesting in 1997 (Figure 1a). Over the first ten years of the project, the LCI population averaged 100 females per season. During the second decade, there is a similar stability in the population with an average 65 nesting females per season (Figure 1b). These data show that a ten year period is not sufficient to reveal trends within this population. It is only during the last decade that a decrease within the population is observable in so short a time span (Figure 1c). The long-term trend over 34 years, however, indicates clearly that the continuing viability of this population is questionable.

While nesting populations of loggerheads in South Florida are growing, LCD's population continues to decline. What are the factors affecting this change? Incidental mortality continues from capture in shrimp trawlers and impacts with recreational boats and dredges, but this alone seems insufficient to account for the loss of individuals on LCI. Other factors may also play a role. Little Cumberland is a dynamic island with nearshore sandbars forming and eroding over time. Currently, the offshore sandbars on the north and ocean facing beaches are growing, preventing turtles form reaching much of the prime nesting beach. Since surveys on the entire Cumberland Island National Seashore began in 1982, there is evidence of a shift in nesting concentration to the less heavily patrolled South Cumberland Island study area (Richardson 1992, 1987). Nesting on the three areas of Cumberland surveyed, including Little Cumberland Island, the north end of Cumberland Island and the south end of Cumberland, averaged between 50 and 150 nests per study area per year from 1982 through 1997. Since 1982, observed nesting on LCI has decreased by 7 nests per year. Nesting on the north end of Cumberland has decreased by 4 nests a year. Over the same time period, nesting on the south end of Cumberland has decreased by 4 nests a year. Over the same time period, nesting on the south end of Cumberland has increased by 2.5 nests per year. As there is no tagging effort continuing on the north end of Cumberland, and there has not been a tagging effort on south Cumberland, it is impossible to say if any of this shift represents a true movement of LCI individuals to beaches further south in the study complex.

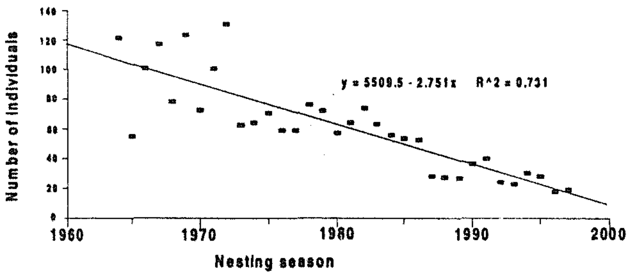

Figure 1a). Number of nesting females per season, 1964 - 1997

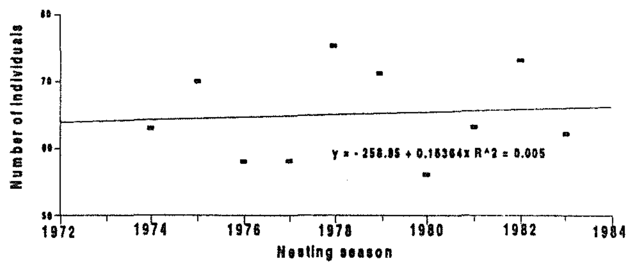

Figure 1b). Number of nesting females per season, 1974 - 1983

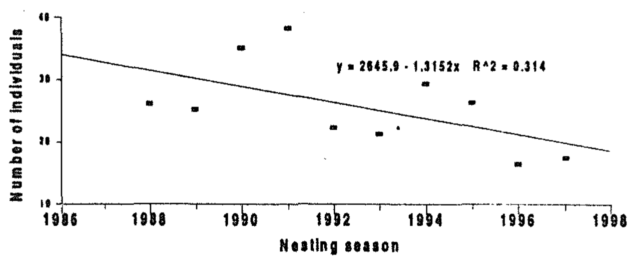

Figure 1c). Number of nesting females per season, 1988 - 1997

In order to estimate the fecundity of the LCI population, the average number of nests per female is calculated

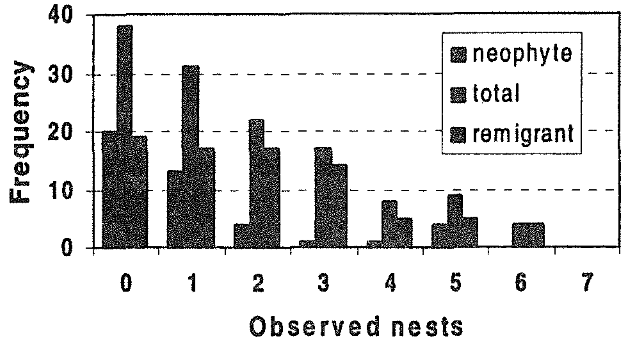

Figure 2a. Observed nests per female on LCI, 1979 and 1980

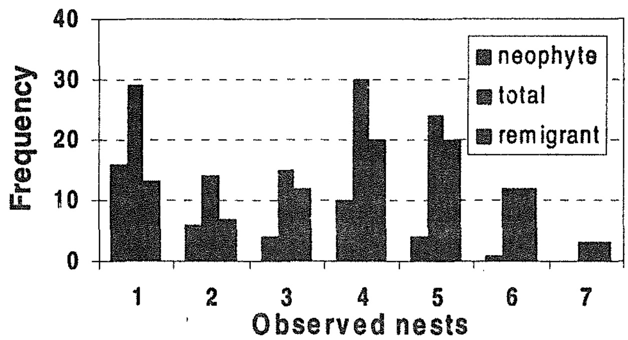

Figure 2b. Predicted nests for LCI females on all nesting beaches, 1979 and 1980

for each year of the study. Over the fist two decades, fecundity averaged 1.9 to 2.1 nests per female per year. Over the past decade, the average number of nests decreased to 1.5 nests per female per season. As loggerheads nest up to seven times in a season (Lenarz *et al.* 1981), this average is low. To get a better estimate of fecundity, two years of data (1979 and 1980) representing thorough coverage on LCI and adjacent beaches is examined. Initially, only observed nests on LCI are counted, resulting in a mean of 1.7 nests per female per season (Figure 2a). Neophyte (untagged) and remigrant (previously tagged) turtle nesting events are then separated, with a mean of 1.0 nests for neophytes and 2.1 nests for remigrants (Figure 2a). In order to realize a more accurate fecundity estimate, sampling efficiency is increased threefold in the following manner: 1. Nesting events without an observed clutch are counted as probable nests, 2. Nesting events attributed to LCI females on nearby nesting beaches are counted, and 3. An additional nest is assumed for any female observed on the nesting beach for a 28 days or greater interval. This results in an increase in mean estimated fecundity to 3.60 nests per female for neophytes, 4.27 for remigrants, and 4.10 for the population (Figure 2b). This remains a conservative estimate, because no nests are assumed before an individual's first observed appearance on a nesting beach or after her last observed visit. The true population mean, unmeasurable because of limitations in beach coverage, is certainly closer to five nests per female per season.

When maximum estimated fecundity for the LCI population is plotted, a bimodal distribution is noted, with a peak of observed nesting behavior corresponding to a single nest per female in addition to the 4.5 nests per female mode (Figure 2b). As an arbitrary means of defining these two behaviors, individuals appearing for only a single nesting visit are called "alpha" females and those observed on two or more nesting visits are identified as "beta" turtles. Beta turtles are those who exhibit fidelity to the Cumberland Island area. Observed alpha behavior may be caused by several different factors, including the following: 1. Missed nesting events on Little Cumberland and Cumberland Island, 2. "Cross-over" turtles nesting on near-by Georgia beaches and turtles nesting on more distant Georgia and north Florida beaches, both of which are verified by tag records, 3. Turtle mortality due to drowning or impacts with recreational boats, supported by tag recoveries, 4. Turtles that may only nest once per season and 5. Cross-over from more distant south Florida beaches, which is supported by over a dozen tag records.

Some of the most interesting beta turtles on LCD's beach are those that return to nest for periods of twenty or more nesting seasons, including the individual with tag number D0004. Since her appearance on our beach in 1964 (20 seasons), three other individuals have nested for greater than twenty seasons: P0003 (25 seasons), P0307 (23 seasons) and P0450 (24 seasons). There is evidence for continued carapace growth of approximately 1 millimeter a year throughout the nesting history of these four individuals.

ACKNOLEDGMENTS

Since thanks are due to the Little Cumberland Island Association and membership, through whose generosity we are able to continue, and to the numerous team members who have patrolled LCD's beach, especially our most dedicated volunteer, Courtney M. Owens.

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IN-WATER POPULATION INDEX SURVEYS: NORTH CAROLINA, U.S.A.

Sheryan P. Epperly[1], Joanne Braun-McNeill[1], Anna L. Bass[2], David W. Owens[3], and Rhonda M. Patterson[3]
[1]NOAA, National Marine Fisheries Service, Beaufort, NC 28516, U.S.A.
[2]Dept. Fisheries and Aquatic Sciences, Univ. Florida, Gainesville, FL 32653, U.S.A.
[3]Department of Biology, Texas A&M University, College Station, TX 77843 email: sheryan.epperly@noaa.gov

Surveys conducted since 1988 have underscored the importance of North Carolina's inshore waters, particularly the Pamlico-Albemarle Estuarine Complex, to juvenile loggerhead (*Caretta caretta*), green (*Chelonia mydas*), and Kemp's ridley (*Lepidochelys kempii*) sea turtles. Sea turtles are present in the Complex April-December. During their emigration in fall and early winter, the turtles are vulnerable to capture in pound nets set behind the barrier islands. Pound nets, as set in N.C., are a passive gear that allows turtles to feed and to surface to breathe. The Core Sound and eastern Pamlico and Albemarle Sounds area was established as a pilot index area for sea turtles in 1995, using catch rates in pound nets as an index of abundance. The feasibility and methodology was established and the fishery was sampled again during fall 1996 and 1997. The goal of this 3-yr project was to establish the area as an index abundance area to monitor, assess, and predict the status of and impacts to sea turtles and their ecosystems. The cooperation of pound net fishermen in the area provides data not only on abundance, but also on movement and demography of these populations. In additions, blood samples were utilized for analyses of health status, sex, and genetics.

GROWTH OF HAWSKBILL TURTLE *ERETMOCHELYS IMBRICATA* OFF RÍO LAGARTOS, YUCATÁN, MEXICO

Mauricio Garduño Andrade
INP Centro Regional de Investigación Pesquera de Yucalpetén. México. mgarduno@minter.cieamer.conacyt.mx

Von Bertalanffy growth model was fits to hawksbill turtle *Eretmochelys imbricata* by capture-recapture measurements of wild turtles in Río Lagartos. Sample was 29 measurements from juveniles (n=20) and adults females (n=9). Growth model estimates Lt=93 (1-0.95 e143t). It yields estimates from 20 cm smallest turtles in the feeding ground area between 2 or 3 years age. Also yields estimates of between 13 and 23 years to reach the size of the smallest nesting female (80 cm) and modal carapace measurements of all (1994) nesting females (90 cm) respectively.

ESTIMATING ANNUAL SURVIVAL OF NESTING HAWKSBILLS (*ERETMOCHELYS IMBRICATA*), JUMBY BAY PROJECT, LONG ISLAND, ANTIGUA

Rhema Kerr and James I. Richardson
Institute of Ecology, University of Georgia, Athens GA 30602, U.S.A. rhemaker@uga.cc.uga.edu

The rate at which animals die is one of the most critical population parameters in the management of wildlife populations (White and Garrott, 1990). Thus estimates of annual survival (1-mortality rates) form the cornerstone of demographic studies.

Most sea turtles (including hawksbills) are potentially long-lived (in excess of 50 years) with overlapping generations. Individuals are iteroparous, with multiple nesting episodes per season. Hawksbills are not known to nest annually, with re-migration intervals of 2 and 3 years being most common. This life history pattern poses challenges to estimating demographic variables from tagging studies. Most complications arise from violations of the key assumption of "equal catchability" of the main open population models such as Jolly-Seber and Cormack-Jolly-Seber. More recent models such as Pollock's Robust Design (Pollock, 1982) combining open and closed models have proven useful in providing robust survival estimates. However, the staggered return of females to a nesting beach over an extended period deprives sea turtle researchers of a comparable closed season as is available for many other animal populations.

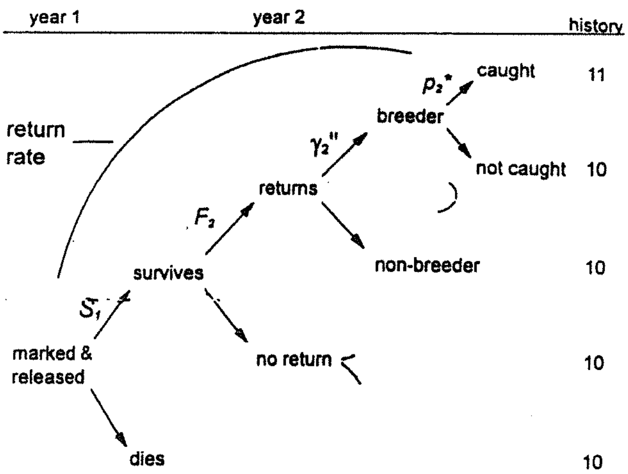

Figure 1

One other method remains available. The enumeration method is similar to Jolly-Seber models in that it is based on marked animals. Animals caught in sample period i and never seen again are assumed to have died or emigrated between and i and $i + 1$. This results in a minimum known alive estimator (Pollock *et al.*, 1990). The non-annual nature of the return rate is transformed in to annual survival estimate (s) by taking the k^{th} root of the proportion surviving k periods. This estimator is thus a complicated function that involves every survival and capture probability subsequent to period i (Pollock *et al.*, 1990). This results in a negative bias in survival estimates (Figure 1). The enumeration method is also limited by the lack of the statistics (standard error, confidence intervals) that drive inferences and hypothesis testing.

Enumeration was used to calculate the annual survival of a Caribbean population of nesting hawksbills. The Jumby Bay Project, on Long Island Antigua, is a saturation- tagging project that has recently completed its eleventh year. The sampling effort is considerable, as the nesting beach is covered by hourly patrols between dusk and dawn, from June 15[th] through to November 15[th]. Capture probabilities during this period are very close to 1.

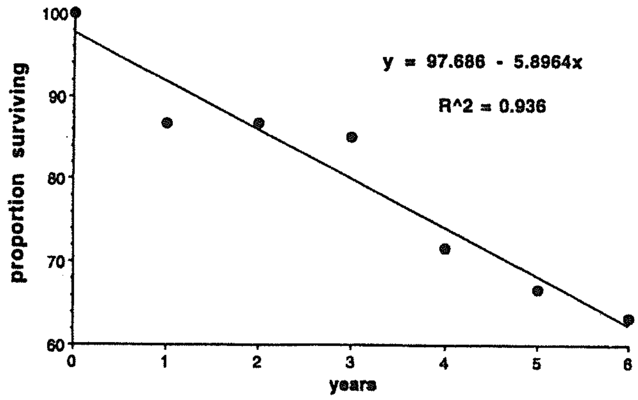

Figure 2. Survivorship courve: 60 individuals followed for 6 years

The results are presented in two ways. Table 1 presents the annual survival as the k[th] root of the proportion surviving k periods (n=73). Figure 2 graphically presents the data of the proportion known alive fitted to a linear model (n=60). The estimates are comparable. Tabular estimates range from 0.90 to 0.93. These estimates converge at 0.91, which probably represents a decrease in the bias created by animals with particularly long re-migration intervals. The linear model estimate of annual survival is 0.94 (an average decline of 0.6% per annum).

Table 1

k	return rate (p)	k^{th} root of p (s)
1	61/73	0.84
2	61/73	0.91
3	59/73	0.93
4	50/73	0.91
5	46/73	0.91
6	42/73	0.91

Improved models for annual survival estimates for sea turtle are a distinct possibility. Schwarz and Stobo (1997) used an open-open model design for Grey Seals (*Halichoerus* *grypus*). However their model assumes random temporary emigration, and requires sampling through either the start or end of the breeding season We will be working with demographic specialists to formulate models that will be robust to violations of these assumptions.

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DEMOGRAPHICS OF THE JUMBY BAY NESTING HAWKSBILLS (*ERETMOCHELYS IMBRICATA*) AT PASTURE BAY BEACH, LONG ISLAND, ANTIGUA, WEST INDIES

James I. Richardson[1], Rebecca Bell[2], and Thelma H. Richardson[2]
[1]Institute of Ecology, University of Georgia, Athens, GA 30602-2202, U.S.A.
[2]Little Cumberland Island, P.O. Box 13127, Jekyll Island, GA 31527, U.S.A. rainforestry@earthlink.net

Eleven years of intensive surveys are scarcely sufficient for a demographic study of sea turtles, but a picture of the Jumby Bay nesting hawksbill (*Eretmochelys imbricata*) population appears to be taking shape, assisted by strong beach fidelity by the adult females and the near absence of tag loss. Annual survival, mean remigration, and seasonal fecundity are used to estimate lifetime fecundity. Production of hatchlings by the population and by individual adults is discussed. A trend in numbers of nesting females over the decade of surveys is not clear, but annual recruitment appears to match annual mortality, suggesting stability in numbers of individuals in the Jumby Bay population. Future goals for the project are discussed, including a unique opportunity to monitor possible behavioral changes in the nesting population in response to intensive island development currently under way.

A COMPARISON OF MORPHOLOGICAL AND REPRODUCTIVE CHARACTERISTICS OF NESTING LOGGERHEAD POPULATIONS

Manjula Tiwari and Karen Bjorndal
Archie Carr Center for Sea Turtle Research, University of Florida, P.O. Box 118525, Gainesville, FL 32611
mtiwari@zoo.ufl.edu

Few studies have addressed intraspecific trends within a marine turtle species over a large area. The main objective of this study was to quantify whether loggerheads nesting in Florida, Brazil, and Greece differ significantly in their morphology and reproductive output. Data on body size, clutch size and egg size were collected from nesting females. To place ideas in a more general perspective, morphological and reproductive data on other loggerhead populations were compiled from the literature and examined for latitudinal trends within the Atlantic and Mediterranean. This study highlights important differences among populations, broadens the concept of life history variation to a turtle species not confined to a single geographic location, and emphasizes the need for conserving genetic and phenotypic variation in marine turtle populations.

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HAWKSBILL TURTLE FEEDING HABITS IN CUBAN WATERS

Blanca Lázara Anderes Alvarez
Centro de Investigaciones Pesqueras, Ministerio de la Industria Pesquera, Habana, Cuba. cubacip@ceniai.inf.cu

INTRODUCTION

Studies on hawksbill turtle feeding in the Caribbean report that these animals are mainly sponge eaters, but occasionally consume other invertebrates (Carr and Sancyk, 1975; Meylan 1984, 1988; Anderes and Uchida, 1994; van Dam and Diez, in press; León and Diez, unpublished). The present study investigated differences in feeding habits between adults and subadults, as well as between sexes, and females in different stages of gonadal development.

MATERIALS AND METHODS

The sample consisted of the 74 stomach contents included in Anderes and Uchida's (1994) preliminary study, with an additional 72 collected between 1994 and 1996, yielding a total of 146 stomachs sampled. The methodology was the same as that previously used by Anderes and Uchida (1994). Subadults, 34 cm or more in straight carapace length (SCL) (Witzell 1983), included 22 females (19 full stomachs, 3 empty) and 10 males (8 full stomachs, 2 empty). Adults, 60 cm SCL or above (Moncada and Nodarse 1994), included 62 females with no gonadal development (39 full stomachs, 22 empty); 19 females with follicles (17 full stomachs, 2 empty); 5 females with follicles and eggs (5 full stomachs); and 29 males (24 full stomachs, 5 empty).

RESULTS AND DISCUSSION

Subadult stomachs contained between 78.4 and 92.5% sponges, with *Chondrilla nucula* dominating; the ascidian *Polycarpia pomaria* and the algae *Hypnea musciformis* also occurred with notable frequency in female subadults (Table 1). These results, notable with the females, coincide with previous reports by Carr and Stancyk (1975), Anderes and Uchida (1994), van Dam and Diez (in press) and León and Diez (unpublished) in the sense that there is a preference for sponges, even when other invertebrates and vegetation are included in the diet.

The relative composition of food items in adult females and males (Table 1, see next page) did not vary in relation to Anderes and Uchida's (1994) previous observations. This coincides with Meylan (1984, 1988) in the high occurrence of *Ch. nucula*, while van Dam and Diez (in press) reported the presence *G. neptuni* in a male. When females were separated by stage of gonadal development, it was observed that animals with follicles and eggs showed a distinct composition (Table 1). They had only 60% sponges (with a different composition of sponge species, 15% other invertebrates and 25% vegetation; just the green alga *Halimeda incrassata* was 17.7%.

Mean value for weight of stomach contents was 112 g in females with follicles, and only 70 g for females with both eggs and follicles. The greater consumption by females with follicles is attributed to the physiological needs of animals in this stage.

Menge's (1972) Index of Diet Superposition showed that male and female subadults had an 80% overlap in diet. In the case of animals classified as adults, the respective Indices indicate at least 59% overlap in diets of the different categories, except in the case of females with follicles and eggs, which are consistently below 30%. This confirms the differences in diet between females in different stages of gonadal development (Table 2), a phenomenon pointed out previously by Meylan (1984, 1988), Anderes and Uchida (1994) and van Dan and Diez (in press).

Table 2. Diet superposition (%): F = females without follicles; W/F = females with follicles; W/F/E = females with follicles and eggs; M = males; GF = gravid females (see Anderes and Uchida , 1994)

	W/F	W/F/E	M	GF
F	72	13	59	70
W/ F	-	9	75	87
W/ F/E.		-	11	26
M			-	72

CONCLUSIONS

Subadults and adults of both sexes consume more encrusting sponges than any other food item, with between 74.8 and 98% occurrence in stomach contents; *Chondrilla nucula* was the most abundant species of sponge.

Females with both follicles and eggs differed from other females, and had 60% of sponge, 15% jellyfish and 25% of vegetation; the alga *Halimeda incrassata* was 17.7% of stomach contents.

The Index of Diet Superposition also showed that females with both follicles and eggs were distinct from other females, with values consistently below 30%, again confirming that turtles in this stage have different diets.

Females with follicles had greater mean weight of the stomach contents then either females without follicles or females with both follicles and eggs; this may be related to greater nutritional needs of animals is this stage of gonadal development.

Table 1. Stomach contents (percent occurrence) of Eretmochelys imbricata in Cuban waters "-" = not detected; "folls." = follicles.

	SUBADULTS		ADULTS			
	Females	Males	Females			Males
			No folls.	Folls.	Folls. & eggs	
Sample Size	22	10	61	19	5	29
Sponges						
Amphimedon rugosa	-	-	-	-	-	2.4
Chondrilla nucula	45.3	82.5	28.0	-	12.0	19.9
Chondrosia collectrix	10.95	3.6	43.0	36.0	0.8	17.5
Erylus ministrongylus	2.8	-	2.2	14.0	3.2	13.2
Geodia gibberosa	3.3	2.4	13.0	-	37.0	31.0
Geodia sp.	5.7	-	2.4	30.0	6.8	0.5
Hemaectyon ferox	-	-	0.3	6.5	-	-
Tethya aurantia	0.1	3.1	0.2	-	-	-
Iotrochota birotulata			-	-	-	8.6
Oxiciella calla			0.3	-	-	0.9
Unidentified	10.26	1.0	6.1	4.6	-	4.7
Other Invertebrates						
Acropora cervicornis	-	-	0.1	4.2	-	-
Aurelia aurita	-	-	3.7	-	15	-
Gorgonia flavellum	0.6	0.3	-	-	-	-
Jellyfish, unidentified	-	-	0.1	-	-	-
Panulirus argus	-	-	1.2	-	-	-
Polycarpia pomaria	8.96	2.6	-	-	-	-
Plants						
Acanthophora spicifera	0.1	-	-	-	-	-
Anadyomene stellata	-	-	0.1	0.8	-	-
Bryposis sp.	-	-	0.01	0.2	-	-
Caulerpa paspaloides	-	-	0.7	-	-	0.1
Codium sp.	-	0.05	-	-	-	-
Colpomenia sinuosa	-	-	0.05	-	-	-
Dilophus alternans	0.06	-	0.02	-	-	-
Gelidiella acerosa	0.004	-	-	0.8	-	-
Gracilaria sp.	-	2.1	-	-	-	-
Halimeda incrassata	-	-	0.12	-	17.7	0.07
Hypnea musciformis	11.5	-	-	-	-	-
Padina vickersiae	-	-	-	0.4	1.0	0.26
Pterocladia bartlettii	-	-	-	-	3.7	-
Pocokiella sp.	-	-	0.01	-	-	-
Rodoficeas unidentified	0.004	-	-	-	-	-
Thalassia testudinum	0.02	0.05	-	-	-	-
Sargassum spp.	-	-	0.04	0.01	0.4	0.1
Stypopodium zonale	-	2.4	0.03	1.4	1.9	0.1

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SPATIAL AND SEASONAL DISTRIBUTION OF HAWSKBILL TURTLE NESTINGS IN LAS COLORADAS, YUCATAN, MEXICO

Mauricio Garduño Andrade
INP Centro Regional de Investigación Pesquera de Yucalpetén.México. mgarduno@minter.cieamer.conacyt.mx

This paper show the spatial and seasonal distribution of hawksbill nests in Las Coloradas, Río Lagartos, Yucatán. The nesting season begins in second half of April to ends of August or principles of September, 5 to 6 months with maxima in May and June. It was determined a period between nest in the same year between 14 and 16 days and between years the hight frequency is 2 years followed by 3 years. Inside the area of 21.5 km there are places with preference for the turtles that another, year by year. The maxima frequencies between distance between nest inside the years are 0.0 to2.0 km, with maxima of 20 km. Between years the range is wide 0.0 to 5.0 km.

CHARACTERISTICS OF CONSECUTIVE NESTING OF KEMP'S RIDLEY (*L. KEMPI*) AT RANCHO NUEVO, TAMPS.

Ma. del Carmen Jiménez Quiroz, René Márquez M., Noé A. Villanueva L., and M.A. Carrasco A.
Centro Regional de Investigación Pesquera-Manzanillo. Apdo. Postal 591. Manzanillo, Col. México cjimenez@bay.net.mx

The spatial and temporal distribution of each nest placed at the beach by females in each nesting season was determined with the information of 1985-1995. The number of nests laid by each female was between 1 and 3, quantified by the mark - recapture registers. The temporal distribution of each nest indicated that most of the gravid females arrived at the beach between April and May, and it is possible that nearly all the nest deposited in subsequent months are laid by the same turtles. The period of time between two nest was multimodal and depended on the first lay and on the presence of "arribazones". The distance between the nest of the same female is less than 6 km apart, fewer females have greater displacements.

LONG-TERM MONITORING OF NESTING OF THE GREEN SEA TURTLE (*CHELONIA MYDAS*) IN THE SOUTHWEST PLATFORM OF CUBA

Gonzalo Nodarse, Felix Moncada, Alexis Meneses, and Carlos Rodriguez
Centro de Investigaciones Pesqueras, 5ta Ave y 248 Santa Fè, Ciudad de la Habana, Ministerio de la Industria Pesquera, Cuba. Fax: (537) 249827 cuba cip@ceniae.inf.cu

INTRODUCTION

In Cuba, the most important areas for nesting are in the southern coast of the archipelago. The current work presents the results collected between 1982 and 1996, on the southern coast of the isle of Youth, on the nesting characteristics of the Green Sea Turtle (*Chelonia mydas*).

MATERIALS AND METHODS

The work was undertake at Playa Larga, situated on the southern coast of the Isle of Youth. A 4 km long section, from Punta el Guanal to La Canoa was monitored annually. It is a high energy beach (Pritchard *et al*, 1983) in the first 1.5 km (western end) and the remainder is low energy beach, with a reef barrier about 100 m from the coast. The dominant vegetation is Salvia marina (*Tournefortia anaphalode*), Cuabilla de playa (*Suriana maritima*) y Boniato de playa (*Batis maritima*). The fauna includes crabs, jutias and wild pigs, found to be the main predator of eggs.

Observations were made by walking the beach at night (2100-0400 h), mainly between May and August, for the period 1982-96 (Table 1). Females were tagged with monel tags, and other data relating to tides, moon phase, distance from the high tide mark were recorded. Eggs were removed to a protected area, eggs were taken from the nests following the method of Marquez *et al*, (1981), and transported to a protected area.

RESULTS

The period of nesting comprised the last week of May until the first half of September, with a peak of nesting in July. These results are similar to those cited by Marquez (1990) for the general area. Nesting activity does not occur two hours before and after nocturnal high tide, and the first nest is associated with a full moon.

Numbers of nests and hatchlings are in Table 1. A maximum of 177 nests were located in 1990, and there is a pattern of low numbers of nests followed by high numbers of nests. This pattern is similar to that at Las Coloradas, Yucatan, Mexico (M. Garduno, pers. comm.). The hatching rates for relocated nests (up to 1994; 27-63%; Table 1) are considered to be the result of transportation of the eggs to the protected area. For the last 3 years, nests were left *in situ*, and hatching rates have been much higher (91-92%; Table 1). This period coincided with a direct hunt to reduce number of wild pigs, which were the main predator of nests. The mean clutch size (1982-96) was 110.7.

In Table 2 are data relating to tagging of nesting females. A total of 98 females have been tagged to date, of which 73 were observed nesting once, 18 twice, 4 three times, one four times, one six times and one seven times. Nesting intervals were found to be 7-14 days, with most between 9 and 11 days.

Year	Dates	Days	Nests	Eggs	Hatchlings	Hatching (%)
1982	8/7-2/9	57	20 *	1899	***	
1983	17/7-26/8	41	72 *	7185	1360	18.9
1984	11/6-10/9	92	21 *	2021	1264	62.5
1985	31/7-18/8	19	8 *	704	375	53.3
1986	7/7-5/9	61	39 *	4077	1105	27.1
1987	20/6-31/8	73	87 *	8624	3881	45.0
1988	22/6-15/8	62	71 *	7375	3227	43.8
1989	1/6-26/8	87	78 *	8709	3797	43.6
1990	5/6-20/8	71	177 *	20,411	11,267	55.2
1991	13/5-8/8	88	38 *	4272	2481	58.1
1992	15/5-23/8	100	159 *	18,879	9672	51.2
1993	25/5-8/8	76	10 *	1376	523	38.0
1994	13/5-14/8	94	108 *	12,632	4118	56.3
1994	"	"	24 **	2796	2533	90.6
1995	29/6-19/7	21	18 **	1998	1834	91.8
1996	24/5-31/8	100	123 **	13,653	12,588	92.2

* In area of incubation (protected)
** *In situ*
*** Predated

Table 1. Periods of survey, numbers of nests and hatchlings, and percentage hatch for the monitored area, for the period 1982-96.

Table 2. Numbers and mean size of nesting females tagged. CCL= curved carapace length.

Year	No. of Females Marked	Mean CCL (cm)
1989	7	105.3
1990	10	105.8
1991	2	103.0
1992	40	104.6
1993	2	110.0
1994	22	106.5
1995	2	109.0
1996	13	106.7

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CANID PREDATION ON MARINE TURTLE NESTS AT AKYATAN, TURKEY, EASTERN MEDITERRANEAN

Monica Aureggi[1], Guido Gerosa[1], and Sedat V.Yerli[2]
[1] CHELON, Marine Turtle Conservation and Research Program, V.le Val Padana, 134/B . 00141 ROMA, Italy. email: chelon@tin.it
[2] Department of Biology, Hacettepe University, P.O. Box 40, 06692 Ankara, Turkey

INTRODUCTION

Akyatan National Park is situated on the South-east coast of Turkey, in the Cukurova region (Figure 1). The beach of 19.7 km is the main green turtle (*Chelonia mydas*) nesting area in the Mediterranean (Gerosa *et al.*, 1995). The study was conducted from the 12th of June to the 25th of August, 1995, covering most of the breeding season. The aim of the research was to investigate predator species, nest predation rates and timing of nest predation. It focused on 4 km of the total beach, which in a previous study had been the zone with the highest density of nests (Gerosa *et al.*, 1995).

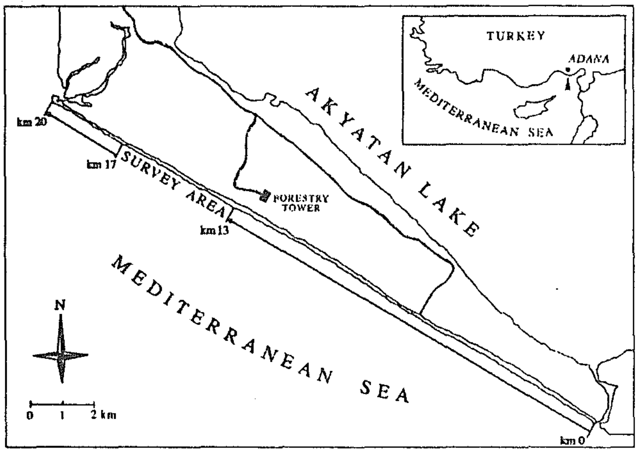

Figure 1

MATERIALS AND METHODS

Daily surveys were conducted each morning by at least two people to identify all fresh turtle nests and predator tracks. Turtle and predator species were identified from their prints in the sand. Nests were mapped within beach sectors of 250 m and individually marked with numbered sticks; their location and distance from the sea were recorded. In cases of nest predation, date, time and nest number were recorded. Non-parametric statistical tests were used (Siegel and Castellan 1988), with a rejection level for the null hypothesis of $P = 0.05$.

RESULTS

Daily records of both newly laid and predated nests were obtained for the entire eleven-week study period. Egg laying activity was high until the 23rd of July, whereas the predation was very low until the beginning of July (Figure 2).

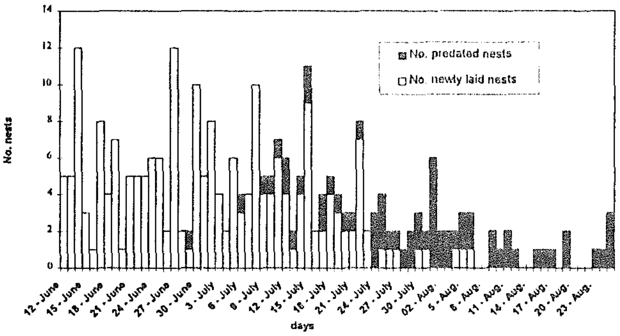

Figure 2. Nightly variation in nesting and predation during the breeding season 1995

A total of 237 nests were recorded in the survey area. Most of the nests (86.9%) were of green turtles, 5.1% were loggerhead turtle and 8.0% were not idenrifiable to species (Table 1).

An increase in predation activity was recorded until the beginning of August, after which it declined, even though a considerable number of available nests was still present on the beach (Fig.3). Available nests are the total of newly laid nests each day plus the number of nests laid before our arrival (12th of June) minus nests found empty after predator attack. During the study a total of 63 nests were predated

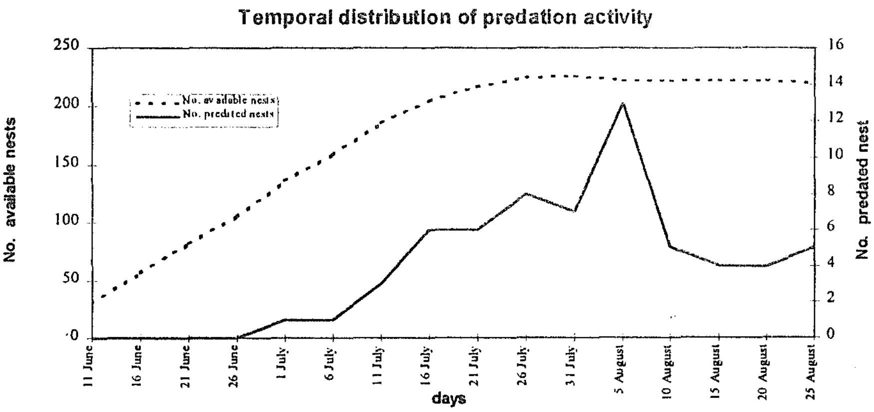

Figure 3 Temporal distribution of predation activity. Number of nests were grouped in days of five. Available nests: newly laid nests each night plus the No. of nests before the 12th June, minus the empty nests after a predator attack.

Table 1. Marine turtle species nesting at Akyatan beach, 1995: "?" = unknown; "% of pred nests" = predation rate calculated on the total number of nests for each species.

Species	No. Nests	% of nests	No.pred nests	% of pred nests
Chelonia mydas	206	86.9	49	23.8
Caretta caretta	12	5.1	4	33.3
?	19	8.0	10	52.6
Total	237	100.0	63	26.6

(26.6 % of all nests present) and 14 of the predated nests were raided twice. The second predation event always occured the day after the first.The majority (83%) of nests was taken by predators after the fourth week of development; the interval between the date of egg laying and first predation (pre-predation time) had a mean value of 35.5 days. A Mann Whitney U-test showed a significant difference in pre-predation time between twice predated nests and nests predated once (z = -3.45, P<0.001; Figure 4).

DISCUSSION

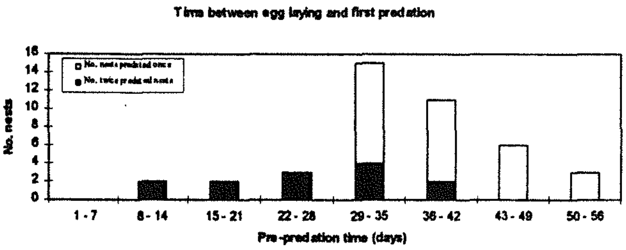

Figure 4. Interval of time between the date of laying the egg and first predation (pre-predation time)

The preponderance, and high density, of green turtle nests found in 1995, were comparable to the 1994 results (Gerosa *et al.*, 1995; Brown and Macdonald, 1995). In addition, the 4 km study area had the same high density of nesting as found in 1994 (Gerosa *et al.*, 1995).

Studies from eight Turkish nesting beaches show that canids are the main egg predators: Goksu Delta (van Piggelen and Strijbosch, 1993); Kazanli (Baran *et al.*, 1991); Dalyan (Macdonald *et al.*, 1994); Belek, Fethiye and Patara (Baran and Kasparek, 1989); Side, Alanya (Geldiay *et al.*, 1982). Three species of predators are known: red fox (*Vulpes vulpes*), golden jackal (*Canis aureus*) and feral dog. Red fox was the main predator at Akyatan (nests predated = 38), but golden jackal also occurred (1 nest predated) during the study period.

It is a commonly claimed that nest predation is highest the first two nights after oviposition because turtle sign, such as tracks in the sand and liquid secreted from the cloaca during the egg laying process, are still visible on the beach. Predation has also frequently been observed to occur just before the emergence of hatchlings (Demetropoulus and Hadijchristophorou 1989; van Piggelen and Strijbosch, 1993). At Akyatan during the 1995 nesting season, the first case of nest predation was recorded when the season was well advanced (29 June). Predators found nests throughout the incubation period, but mainly after the fourth week; they were seemingly unable to find nests before the fourth week of incubation. In fact, no nests were predated before the 29th of June, although fresh fox tracks were continually observed on the beach, and fresh nests were available. Nests predated twice were mostly recorded at the beginning of the research, when it is believed that predator incentive to find nests was highest. Nests predated twice (22% of all nests) were always attacked on two subsequent nights, a behaviour that has also been observed for foxes at Kapirissa Bay, Greece (Margaritoulis *et al.*, 1996). Egg caching was more common among foxes on other beaches (Macdonald *et al.*, 1994), but this has never been observed at Akyatan. Attacking twice on subsequent nights could be considered as an alternative behaviour to caching. At Dalyan, Turkey, foxes retrieve caches on subsequent nights (Macdonald *et al.*, 1994), whereas foxes raid a nest on subsequent nights at Akyatan.

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NUTRIENT TRANSFER AND ENERGY FLOW FROM MARINE TO TERRESTRIAL ECOSYSTEMS BY LOGGERHEAD SEA TURTLES AT MELBOURNE BEACH, FLORIDA, U.S.A.

Sarah S. Bouchard and Karen A. Bjorndal
Archie Carr Center for Sea Turtle Research, PO Box 118525, University of Florida, Gainesville, Florida, 32611, U.S.A.
bouchard@zoo.ufl.edu

Some species play critical roles in the functioning of ecosystems by transporting energy and nutrients from one ecosystem to another. Sea turtles act as such biological transporters when they migrate from feeding grounds to nesting beaches where they introduce large nutrient loads in the form of eggs. The purpose of this study was to quantify the energy and nutrients introduced into the nesting beach at Melbourne Beach, Florida, by loggerhead sea turtles. Nutrient analyses of (1) freshly laid eggs, (2) eggs at various stages of development, (3) hatchlings, and (4) hatching remains were used in conjunction with nest inventories to estimate the fate of the introduced nutrients. Conserving sea turtle populations will ensure that this important ecosystem function is maintained.

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SPATIAL AND TEMPORARY MOVE TO ADJACENT SUITABLE NESTING SITES OF BLACK TURTLE (*Chelonia agassizii*) IN MICHOACAN, MEXICO: IMPLICATIONS FOR CONSERVATION

María Luisa Herrera Arroyo, Carlos Delgado Trejo, and Alfredo Figueroa Lopez
Laboratorio Tortuga Marina y Biología de la Conservación, Facultad de Biología UMSNH, Edif. 'R' Ciudad Universitaria, Col. Felícitas del Río, Morelia, México. jadiaz@zeus.ccu.umich.mx

Philopatry and Nest Site Fidelity are two characteristics that form an ancient reproductive strategy in sea turtles. Once it has returned to the region of its birth and selected a nesting beach, will tend to renest in relatively close proximity during subsequent nesting attempts within that nesting season. The genus Chelonia show a high degree of nest fidelity (most renesting attempts within 200 to 600 m of previous attempt). However, little is know about the disrupt of this ancient behavior in sea turtles. The analysis of data obtained during six seasons (1988, 1990, 1991, 1994 and 1996), by University of Michoacán on black sea turtle (*C. agassizii*) population in Michoacán, México, show an spatial and temporal movement in three diferent zones on Colola beach. The ANOVA and Tukey análisis was due to know wich zones shown statistical significance diferences. Zone East show statistical diferences with both Mid and West zones (F2df013.8; Fo.o5(2,12,d.f.)=3.84

SEX RATIO OF HATCHLINGS IN NESTS CAN BE ESTIMATED FROM THE MEAN TEMPERATURE DURING THE MIDDLE THIRD OF INCUBATION

Yakup Kaska[1], Robert W. Furness[2], and Ibrahim Baran[3]
[1]Pamukkale Üniversitesi, Fen Edebiyat Fakültesi, Biyoloji Bölümü, Denizli, Turkey. 9406804k@udcf.gla.ac.uk
[2]Institute of Biomedical and Life Sciences, University of Glasgow, Glasgow G12 8QQ, U.K.
[3]Dokuz Eylül Üniversitesi, Buca Egitim Fakültesi, Biyoloji Bölümü, Buca-Izmir, Turkey.

Laboratory and field experiments have shown that sex in many turtle species is determined by egg incubation temperature, usually during the middle third of development (Yntema and Mrosovsky, 1980; Janzen and Paukstis, 1991; Mrosovsky, 1994). Few studies have monitored incubation temperatures in the field, but experiments using artificial nests, or incubators with cyclic temperature fluctuations, suggest that sex is determined as though eggs were incubated constantly at the mean temperature. When eggs are incubated at constant temperatures, there is a narrow range of temperatures over which around 50% of each sex will be produced (pivotal temperature or threshold temperature), and wider ranges above this temperatures produce females and below this threshold produce males (Bull, 1980). Pivotal temperatures for all sea turtle species are reported to lie within a 1 °C range (28.6-29.7 °C).

Estimates of the sex ratio have also been obtained by combining the nesting distribution with the sexing of samples of hatchlings from different times during the season and termed Seasonal Sex Production Profiles (SSPPs) by Mrosovsky (1994) or from pivotal incubation duration (Marcovaldi *et al.*, 1997). If the temperature of a nest during the middle third of development is known, then the sex ratio of hatchlings from that nest can be predicted. If in turn this information is known for all parts of a beach throughout a nesting season, then the overall primary sex ratio can be predicted for all hatchlings produced from that beach (Standora and Spotila, 1985).

In this study, we investigated the intra-clutch temperature differences of two species of turtles nesting in the Mediterranean, and the sex ratio of these nests by sexing a sample of hatchlings from each level where temperatures were recorded. The results are presented in detail in Kaska *et al.* (1998).

MATERIALS AND METHODS

Temperature was measured using "Tiny talk" temperature recorders (Orion Components (Chichester) Ltd., U.K.). The accuracy of the device was tested under laboratory conditions against a standard mercury thermometer, and they were found to have a mean resolution of 0.35 °C (min. 0.3 °C, max. 0.4 °C) for temperatures between 4 °C and 50 °C. We launched the tiny talk by computer for a recording period of 60 days with readings taken at 48 min. interval. This gave 30 readings per day. They were placed at three different depths (top, middle and bottom) of the nest, during the oviposition or after excavating the nest in the morning of laying (approximately 10 hours after oviposition). The nest was then covered, and protected with wire mesh against dog and fox predation. These temperature recorders and a sample of eggs (3-7) were taken a few days before anticipated hatching time. Temperature data were offloaded to a computer and gonads of the sacrificed hatchlings dissected and preserved in Bouin's solution for sex determination. The gonads were cut in half transversely and one half was embedded in paraffin wax, sectioned at 8-10 µm from the middle of the gonad, and stained with the Periodic Acid Schiff reaction (PAS) and Harris' hematoxylin. Sex designation was based on development of cortical and medullar regions and presence and absence of seminiferous tubules (Yntema and Mrosovsky 1980). The middle third of the incubation period was calculated from the total incubation period, from the night of laying to the day of first hatching.

RESULTS

Temperatures of green turtle nests and loggerhead nests were recorded on six Eastern Mediterranean beaches during the nesting season of 1995 and 1996. The depths of top and bottom level of any green turtle nest was around 70-90 cm., and 30-50 cm. for loggerhead turtle nests. The clutch size varied from 65 to 118. Two of the loggerhead nests did not hatch. One of these was inundated twice during the middle third of incubation period and the other was under a vehicle track. The hatching success of these nests varied between 48% and 94%.

The data on temperature and sex ratio of sea turtles are presented in Table 1. Maximum temperature increase during the incubation period for loggerhead turtle nests was 9.6 °C (min. 24.5 °C , max. 34.1 °C). Temperature of the middle third of the incubation ranged from 27.4 to 32.5 °C. Mean temperature differences during the middle third of the incubation period between the top and bottom of loggerhead turtle nests ranged from 0.3 °C to 1.3 °C. The mean temperature of the whole incubation period for 5 green turtle nests ranged from 29.5 to 31.3 °C. Maximum temperature increase during the incubation period for green turtle nests was 9.6 °C (min. 24.9 °C , max. 34.5 °C).

All the nests during the middle third of the incubation period experienced above the pivotal temperature, except for one nest. The sex ratio of hatchlings for all nests was also calculated. 10-18 hatchlings per nest were sexed, and the results showed a female biased sex ratio for both species, except for one loggerhead nest which had experienced below the pivotal temperature during the middle third of the

*Table 1. The results of temperature and sex ratio of green and loggerhead turtle nests (*Temperatures are not recorded at those levels)*

	TOP (T)		MIDDLE (M)		BOTTOM (B)		MEAN OF		Inc.	Sex
Nest no	Mean temp.±SE	Middle third±SE	Mean temp.±SE	Middle third±SE	Mean temp.±SE	Middle third±SE	Mean temp.	Middle third	Period (day)	(%Female) Mean (T-M-B)
C.mydas 1	29.8±0.05	30.2±0.03	29.9±0.05	30.2±0.03	29.4±0.05	29.8±0.02	29.5	30.1	63	60(60-60-60)
C.mydas 2	30.3±0.03	30.9±0.03	30.0±0.04	30.6±0.03	29.5±0.04	30.1±0.02	30.0	30.5	60	73(100-82-40)
C.mydas 3	31.5±0.05	32.1±0.04	31.3±0.06	31.8±0.05	31.0±0.06	31.5±0.04	31.3	31.8	54	94(100-100-80)
C.mydas 4	30.7±0.03	31.0±0.03	30.4±0.04	30.5±0.03	30.0±0.04	30.2±0.02	30.4	30.6	59	78(100-83-50)
C.mydas 5	31.2±0.05	31.9±0.05	30.9±0.05	31.6±0.05	30.6±0.05	31.1±0.04	30.9	31.5	55	89(100-83-83)
C.caretta 1	29.4±0.03	29.8±0.07	28.6±0.03	29.1±0.05	28.2±0.03	28.8±0.03	28.7	29.2	-	—
C.caretta 2	30.9±0.04	31.3±0.05	30.6±0.04	31.1±0.04	30.0±0.04	30.6±0.04	30.5	31.0	54	83(100-83-67)
C.caretta 3	29.6±0.03	29.1±0.04	29.7±0.03	29.2±0.03	29.4±0.02	28.8±0.04	29.6	29.0	53	53(60-60-40)
C.caretta 4	31.7±0.03	32.2±0.03	31.7±0.02	32.2±0.01	31.4±0.02	32.0±0.01	31.6	32.1	50	100(100-100-100)
C.caretta 5	31.6±0.03	32.1±0.03	31.1±0.03	31.5±0.02	30.8±0.03	31.2±0.02	31.2	31.6	51	89(100-83-83)
C.caretta 6	32.1±0.03	32.5±0.02	31.8±0.03	32.1±0.02	31.1±0.04	32.1±0.01	31.2	32.2	50	100(100-100-100)
C.caretta 7	28.8±0.01	28.7±0.02	28.1±0.01	28.1±0.01	27.4±0.02	27.4±0.01	28.1	28.1	61	44(50-50-33)
C. caretta 8	27.7±0.01	27.6±0.01	27.3±0.01	27.2±0.01	27.0±0.01	27.0±0.01	27.3	27.3	-	—
C.caretta 9	30.9±0.02	30.2±0.01	30.4±0.02	30.2±0.01	29.8±0.02	30.1±0.01	30.4	30.2	55	75(83-80-60)
C.caretta 10	30.5±0.01	30.8±0.01	29.9±0.01	30.2±0.01	29.3±0.01	29.8±0.02	29.9	30.3	52	72(83-83-50)
C.caretta 11	*	*	*	*	29.2±0.01	29.5±0.01	29.2	29.5	54	61(67-67-50)
C.caretta 12	31.2±0.09	31.5±0.01	*	*	*	*	31.2	31.5	50	83(100-83-67)
C.caretta 13	31.9±0.01	32.3±0.01	*	*	*	*	31.9	32.3	48	100(100-100-100)
C.caretta 14	30.9±0.02	31.3±0.01	*	*	30.5±0.03	30.6±0.08	30.7	30.9	52	83(100-83-67)
C.caretta 15	*	*	29.6±0.01	29.9±0.01	29.2±0.01	29.5±0.01	29.4	29.7	54	61(67-67-50)
C.caretta 16	*	*	30.7±0.01	30.7±0.01	30.3±0.01	30.3±0.00	30.5	30.5	54	78(83-83-67)
C.caretta 17	30.0±0.01	30.1±0.01	*	*	29.6±0.00	29.7±0.00	29.8	29.9	53	67(83-67-50)
C.caretta 18	31.6±0.02	32.1±0.03	31.0±0.02	32.0±0.01	29.5±0.03	31.1±0.02	31.0	31.7	52	90(100-83-67)

incubation period. There is a positive correlation between the mean temperature of the middle third of the incubation period ($r^2 = 0.96$) and sex ratio (percent female), but inverse relation between the mean temperature of a nest and incubation period. The mean incubation temperatures can be use for estimating the incubation period. In general, we can say that an 1 °C decrease in the mean incubation temperature means 4 days increase in incubation period. Since the top of nests was warmer than the bottom during the middle third of incubation, we can expect the percentage of females to be higher among eggs at the top of the nest. This was the case. The percentage of females in eggs sampled from the top of nests was higher than in samples from the bottom of the same nest in 20 of 23 nests, was 100% at all levels in two and was 60% in all levels in one. For both species the overall difference in numbers of males and females between top and bottom of nests was statistically significant (green turtle nests X^2 1df=6.86, loggerhead turtle nests X^2 1d.f= 9.82 $P < 0.01$ in both).

DISCUSSION

Bustard (1972) reported the optimal temperature range for sea turtle egg incubation as 27-32 °C. Reported temperature rises in natural nests are between 2 and 7 °C (Hendrickson, 1958; Carr and Hirth, 1961; Bustard and Greenham, 1968). Our data generalize that the temperature of marine turtle nests in the Mediterranean is between 24 and 35 °C and rises by up to 10 °C during incubation.

Our data also showed that top eggs were warmer and bottom eggs were cooler with the middle ones intermediate in the first third of incubation; but later in incubation middle temperatures become the same as the temperature of the top eggs or even sometimes warmer due to metabolic heat.

There was a female biased sex ratio from these results. Similar results were also reported elsewhere (Mrosovsky, 1994). Mean incubation temperatures may be adequate to predict sex ratios only in sea turtles that have deep nests which experience little temperature fluctuation (Bull, 1980; Morreale *et al.*, 1982), but the results of this work show that mean temperatures can be used for predicting the incubation period but provide a poor prediction of sex ratio.

The variety of relationship between pivotal and beach temperatures suggested that diversity of sex ratios in different populations should be expected (Mrosovsky, 1994). From our results it can be said that the pivotal temperatures for sea turtles in the Mediterranean is just below 29 °C, and the mean temperature during the middle third of the incubation period was closely correlated with the percent sex ratio.

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THE IMPACT OF TOURIST DEVELOPMENT ON LOGGERHEAD NESTING ACTIVITY AT DAPHNI BEACH, ZAKYNTHOS, GREECE

Kostas Katselidis and Dimitrios Dimopoulos
The Sea Turtle Protection Society of Greece, 35 Solomou St, GR-10682 Athens, Greece. stps@compulink.gr

INTRODUCTION

Caretta caretta is the only sea turtle species nesting in Greece. Extremely important nesting areas were discovered in 1977 on the island of Zakynthos (Margaritoulis, 1982).

The most important threat for the loggerhead nesting areas, in Zakynthos, is the uncontrolled development of tourism (Arianoutsou, 1988). On Zakynthos, all of the areas adjacent to nesting beaches are privately owned. The Greek State, in order to stem the destruction of the sea turtles' nesting areas, has implemented restrictive legal measures since 1984. However, legislation is poorly enforced and the failure of the state to compensate the affected by restrictions landowners, has led to uncontrolled development adjacent to nesting beaches (Charalambides, 1990; Dimopoulos, 1991).

In this paper we focus on the effects of uncontrolled development on the nesting beach of Daphni and how this situation was reversed.

SITE DESCRIPTION

The island of Zakynthos is situated in the Ionian Sea west of the Greek mainland. The nesting beaches of Zakynthos are found at the southern part of the island, in the Bay of Laganas. The bay is almost semicircular in shape with an opening of about 12 km and a total length of coastline exceeding 20 km. Only 5 km of the 20 km of the coastline of the Bay are used by the turtles. The six nesting beaches of Laganas Bay, starting from the western part of the Bay, are Marathonissi, East Laganas, Kalamaki, Sekania, Daphni, and Gerakas.

Daphni beach is situated between the beaches of Sekania and Gerakas at the Northeast part of the bay. It is about 800 m in length and 20 to 30 m in width. The beach has generally a large proportion of pebbles and stones but there are also parts with fine soft sand. Daphni is backed by steep hills covered with sclerophyllous, evergreen vegetation (maquis). Two dirt roads lead to a flat area on the western part of the beach.

METHODOLOGY

The Sea Turtle Protection Society of Greece (STPS) has been monitoring Daphni beach since 1984, in order to determine nesting activity. The nesting activity is determined by surveying the beach early in the morning on foot, from the end of May until the beginning of September every year. The aim is to locate the previous night's adult sea turtle emergence. Emergences are checked, by visual examination of the nesting spoor, whether they have resulted in egg laying or not and then recorded. The results of the beach surveys provide information on the total number of emergences and nests made during the nesting season. The same methodology is used on the other nesting beaches in the Bay, allowing comparisons between the nesting beaches of Laganas Bay.

RESULTS

After 14 years of monitoring it was found that Daphni is the second most important beach in terms of nests with 12.1% (157 nests per annum) of the total number of nests made in the Bay of Laganas (Figure 1).

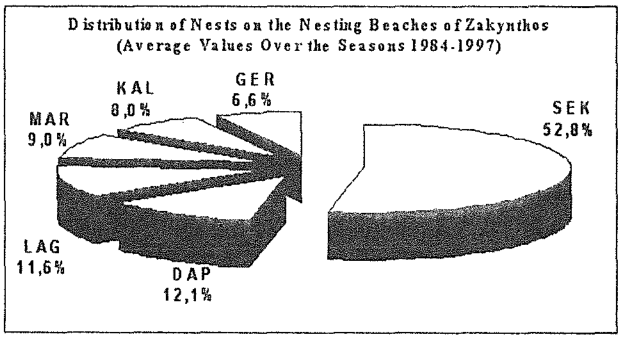

Figure1. Beaches in geographical order from west eastwards. MAR: Marathonissi, LAG: East Laganas, KAL: Kalamaki, SEK: Sekania, DAP: Daphni, GER: Gerakas.

Daphni is also the second most important nesting beach in terms of emergences with 18.4% (913 emergences per annum) of the total number of emergences in Laganas Bay (Figure 2).

The annual fluctuation of the percentage of nests on Daphni, in relation to the total number of nests recorded on Zakynthos nesting beaches, over the last 14 years is shown in Figure 3.

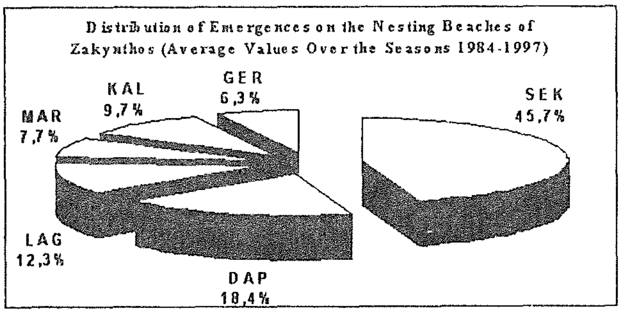

Figure 2. Beaches in geographical order from west eastwards. MAR: Marathonissi, LAG: East Laganas, KAL: Kalamaki, SEK: Sekania, DAP: Daphni, GER: Gerakas.

DISCUSSION

As described before, Daphni beach is a small beach, running only for about 800 meters. The west sector is the main nesting area of the beach, as the east sector is very narrow (6 m to 15 m in width) and only a very few turtles nest there. The west sector is about 400 m long.

The most important problem that Daphni beach is facing, at present, is that of uncontrolled and unplanned tourist development. The effects of this kind of development are various and can be very important for the characteristics of a beach as a nesting beach. These threats may be the direct influence of human activities, such as light, noise disturbances and the human presence on the beach during the night, or the loss of the nesting habitat due to the beachfront development.

Prior to 1989, there was only one small tavern at the back of Daphni beach, which was operated only during the daytime. A small-unpaved road led to this taverna through the hills. In 1990, a second tavern was built at the back of the beach and a new dirt road was opened through the hills, leading to the new tavern. Another two huts were settled on the hills above the beach. In that year the two tavern's operated only during the day. In the following two years the construction of new buildings and the expansion of the old ones continued. Thus at the end of 1992 there were 13 buildings at the back of Daphni beach, including the two taverns and one bar. In the beginning of the 1993 nesting season, the two taverns started to operate during the night. All of these new buildings were illegally built, with the tolerance of the local authorities, and without any planning permission. Most of these buildings were used as holiday homes or were rented to tourists.

The consequences of these constructions and their use, for the nesting beach of Daphni were multiple:

- The erection of these buildings and the removal of the surrounding vegetation caused considerable erosion, which degraded the sand quality of the beach.
- The operation of these buildings, as holiday homes or rooms for rent, increased human presence on the beach, especially at night.

As a result of the above, the nesting activity was seriously affected in the years, 1993 and 1994 on Daphni beach.

From Figure 1 it can be observed that Daphni beach holds the second place in terms of nests with 12.1% mean value. It is also in second place in terms of emergences with 18.4% mean value (Figure 2), in comparison to the nesting beaches of Zakynthos. In 1993 a drop in nesting activity brought Daphni beach to the fifth place, in terms of nests, among the nesting beaches of Zakynthos. The percentage of Daphni's nests in relation to the total number of nests on Zakynthos beaches during 1993 nesting season dropped to

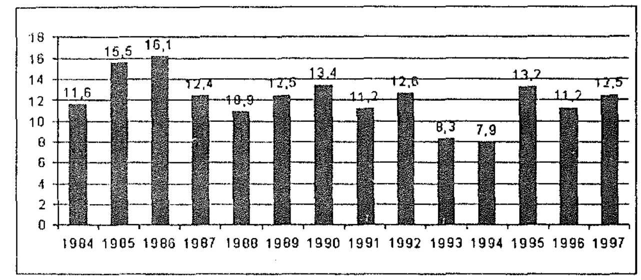

Figure 3. Fluctuation of the contribution (in percent) of Daphni's nests to the total number of nests per year.

8.3% (Figure 3), a decrease of 3.8 points compared to the average.

Another drop occurred in 1994 when Daphni beach held fourth place, in terms of nests, among the nesting beaches of Zakynthos. The percentage of the number of nests to the total number of nests dropped to 7.9% in 1994 (Figure 3), a decrease of 4.2 points compared to the average.

Following national and international pressure the Greek government enforced existent legislation, in the beginning of 1995, and closed down the illegal business and buildings on Daphni beach before the nesting season. This consequently reduced human presence on the beach during the night. As a result the nesting activity increased to initial levels and the percentage of Daphni's nests, to the total number of nests, bounced back to 13.2% in 1995, 11.2% in 1996 and 12.5% in 1997 nesting season (Figure 3).

There are many sea turtle nesting beaches around the world with much greater levels of development. However we believe that the small size of the beaches in Zakynthos and the very high nest density mean that any development of them has a significant effect on nesting activity. We believe that the drop in nesting activity on the one single beach of Daphni that has been observed during the nesting seasons of 1993 and 1994 was due to the construction and the operation at night of these illegal buildings. The closing down of these buildings is a temporary solution, but the final solution must be the demolition of these buildings that have been officially declared as illegal.

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SAND COLOR, TEMPERATURE, AND SEX RATIO OF EMERGING HATCHLINGS ON LOGGERHEAD' S NESTING BEACHES IN JAPAN

Yoshimasa Matsuzawa[1], Wataru Sakamoto[1], Katsufumi Sato[2], Kiyoshi Gotou[3], Kazuyoshi Ohmuta[4], Yasuyuki Asai[5], and Hajime Ueda[6]
[1]Laboratory of Fisheries Environmental Oceanography, Graduate School of Agriculture, Kyoto University, Kyoto 606-01, Japan
[2]National Institute of Polar Research, 1-9-10 Kaga, Itabashi, Tokyo173, Japan email: caretta@kais.kyoto-u.ac.jp Japan
[3]278 Higashiyoshida, Minabe-town, Wakayama 645, Japan
[4]1161 Nagata, Kamiyaku-town, Kagoshima 891-42, Japan
[5]Minamichita Beachland Aquarium, 428-1 Okuda, Mihama-town, Aichi 470-32, Japan
[6]6171-1 Shirahane Omaezaki-town, Shizuoka 421-06, Japan.caretta@kais.kyoto-u.ac.jp

We examined the latitudinal difference of thermal character of 18 nesting be aches for loggerhead turtle in Japan. By using data logger, sand temperature of each rookery was recorded every one hour throughout the reproductive seasons from 1993 to 1997. During rainy seasons the higher latitudinal beach was cooler than the lower one, while after the seasons the higher latitudinal temperature increased over that in the lower one. At the higher latitudinal beaches sand temperature often rose to 31.6 or higher in summer and dropped rapidly in fall, hence lower hatchling-emergence success. In order to examine such latitudinal difference, irradiative sand reflectance was measured at each rookery. This measurement showed that the reflectance was inversely correlated with latitude. Estimated annual sex ratios of emerging hatchlings at four rookeries will be also reported.

NESTING BEACHES AT NICARAGUA'S PACIFIC COAST

Carlos Peres Roman, Ivan Ortega Gasteazoro, and Jose Gabriel Caceres Diaz
Dirección de Fauna; Ministerio del Ambiente y los Recursos Naturales (MARENA); Km 12 1/2 Carretera Norte; Managua, Nicaragua. nicam@ns.sdnnic.org.ni

At the Pacific Coast Nicaraguas are 17 nesting sites of seaturtles. Two of them have 'arribadas' of Olive Ridley the rest leg the eggs as solitairs. Where depot from 1 to 37.000 nests and from 1 to over a million hatchlings are common.

The datas are taked from July to January each year. Four of these nestingbeaches The Environment and Natural Resources Department (Ministerio del Ambiente y los Recursos Naturales [MARENA] has Rangers and other governmental Institutions.

In one of these sites give colaboration to local population and organisations that voluntary work for the conservationof seaturtles

SEASONAL CHANGES IN PLASMA STEROID AND TRIGLYCERIDE CONCENTRATIONS IN ADULT FEMALE GREEN SEA TURTLES FROM SOUTHERN QUEENSLAND

Mark Hamann[1], Tim S. Jessop[1 and 2], Matt Forest[3], Colin J. Limpus[4], and Joan M. Whittier[1]
[1] Department of Anatomical Sciences, University of Queensland, Australia m.hamann@mailbox.uq.edu.au
[2] Department of Zoology, University of Queensland, Australia
[3] P.O Box 526 Thursday Island, Queensland, Australia
[4] Threatened Species and Ecosystems Unit, Queensland Department of Environment, Australia

The reproductive physiology of the green sea turtle, *Chelonia mydas*, has been studied in southern Queensland from 1995 to 1997. Non nesting adults and immature turtles were captured using rodeo techniques in Moreton Bay, Shoalwater Bay and Heron Lagoon and bled soon after capture (<3min). Blood samples were collected from nesting turtles post oviposition from the beaches of Heron Island. Nesting data indicated that green sea turtles sampled on Heron Island return to lay every 6-7 years; each year females lay multiple clutches (range 1 -10) of 115 eggs at 12 day intervals. Plasma triglyceride levels peaked during late vitellogenesis / courtship then declined gradually throughout the nesting season reaching nadir 6 months following the end of nesting. Plasma testosterone levels showed a similar pattern, peaking during courtship and then gradually declining to basal levels following the last clutch for the season. Corticosterone levels were low throughout non breeding periods and courtship then increased during the early nesting season and declined with the number of clutches laid. These results suggest that plasma testosterone and triglycerides are two main factors involved with regulating the duration of the nesting season of the green sea turtle.

REWARDS FOR THE BIG, DUMB AND SOCIALLY INEPT: HORMONAL EVIDENCE FOR LIFE-HISTORY TRADE-OFFS IN THE GREEN TURTLE, *CHELONIA MYDAS*

Tim S. Jessop[1,3], Colin J. Limpus[2], and Joan M. Whittier[3]
[1] Department of Zoology, University of Queensland, Brisbane, Q4072, Australia. Tjessop@zoology.uq.edu.au
[2] Department of Environment, PO Box 155, Brisbane Q 4002, Australia
[3] Department of Anatomical Sciences, University of Queensland, Brisbane, Q4072, Australia

The fitness of green turtles is dependent upon the success of a very small proportion of the numerous offspring produced. Presumably, adult green turtles must exhibit life-history strategies that maximize reproductive success. However, such reproductive strategies can compromise adult survivorship, resulting in a classic life-history trade-off. Hormones are capable of forming the mechanistic or physiological basis to such life history trade-offs. In this paper we examine the notion that reproductively active green turtles utilize adrenocortical modulation to suppress the corticosterone stress response. This may represent a life-history tactic to prevent corticosterone inhibition upon reproductive physiology, despite the potential for decreasing survivorship by temporarily removing this important physiological defense mechanism. In this study we compared the adrenocortical response of reproductively active and inactive adult green turtles to a number of ecological (mass-nesting, inter male aggression during courtship), environmental (heat stress) and anthropogenic (capture) perturbations. Our results suggest that, compared to non-reproductive adults, reproductively active green turtles desensitize themselves to disturbance by suppression of the adrenocortical corticosterone stress response. The evolutionary significance of these observations will be discussed.

WHAT CAN A GREEN SEA TURTLE LEARN?

Roger L. Mellgren[1 and 2] and Martha A. Mann[1 and 2]
[1]Department of Psychology, The University of Texas at Arlington, Arlington, TX 76019, U.S.A. mellgren@uta.edu
[2]Acuario Xcaret, Carretera Chetumal-Pto. Juarez, km 282, Playa del Carmen, Quintana Roo, México

INTRODUCTION

Sea Turtles, like other reptiles, are often characterized as having a limited capability to learn from experience (Subowski, 1992). However, any conclusion about a sea turtle's ability to learn is limited by a lack of data. Only recently have there been attempts to study learning in sea turtles (Mellgren, Mann and Zurita, 1994; Mellgren, Mann and Arenas, 1998) and the results of those experiments suggest that sea turtles are comparable to other reptiles in their capacity to learn (Burghardt, 1977 for a review). Here we report an experiment that evaluates the learning ability of young green sea turtles (*Chelonia mydas*) using the two most commonly used laboratory procedures for studying learned behavior (*e.g.*, Domjan, 1998).

One procedure used to study learning is classical conditioning, first popularized by Ivan Pavlov (1927). A neutral stimulus such as a noise or visual signal is presented and followed by a biologically significant event such as food. Behavior relevant to the food such as salivation and other appetitive behaviors begin to occur to the signal prior to the presentation of the food as the signal-food pairings are repeated. Often the subject of the classical conditioning procedure comes to respond to the signal as if it were the food, approaching and "eating" to signal, a phenomenon referred to as "autoshaping" (Locurto, Terrace and Gibbon, 1981).

A second procedure used to study learning is instrumental (or operant) conditioning. In this procedure the subject of the experiment is required to engage in a designated behavior in order to produce a biologically important event such as food. The rat that learns to press a bar in a "Skinner Box" to produce a piece of food is a familiar example of this procedure.

In a review and analysis of existing data on the learning capacities of reptiles and amphibians, Subowski (1992) concluded that the data can be adequately understood by assuming that these species are capable of learning based on classical conditioning, but do not show evidence that they are capable of instrumental conditioning. This conclusion claims that sea turtles (and other reptiles) are capable of acquiring information about the significance of signals, but are insensitive to the outcomes their own behaviors produce. We compared the classical and instrumental procedures in green sea turtles to evaluate the ability of these turtles to learn using each procedure. Included is a control condition where the signal and food are not presented together to insure the classical and instrumental procedures produce behavioral change through an associated process.

METHODS

The subjects were 18, 4-5 month old captive green sea turtles (*Chelonia mydas*). They were deprived of food for 48 hours prior to the start of the experiment.

A piece of PVC pipe was presented at a 45° angle to the horizontal with the end of the pipe slightly below the water level in the tank. For the classical conditioning (autoshaping) group the piece of fish appeared through the end of the pipe after 15 sec. For the instrumental (operant) conditioning group the piece of fish appeared through the end of the pipe immediately following the turtle's bite on the pipe. If a turtle failed to bite within 15 sec. the pipe was removed and no fish was given for that trial. For the unpaired group the pipe was presented for 15 sec. and removed. The piece of fish was presented 40, 60 or 80 sec. after the pipe had been removed in the same location where the pipe was presented.

RESULTS

Both the classical (or autoshaping) and instrumental (or operant) conditioning procedures resulted in the rapid development of approach and contact (biting) to the pipe while the unpaired group showed a decline in both behaviors to near zero. Figures 1 and 2 (approaches and contacts, respectively) show these results across blocks of trials (5 trials/block). An analysis of variance (mixed model, groups X blocks of trials) confirmed the obvious superiority of the classical and instrumental groups over the unpaired group on both measures. An analysis of just the classical and instrumental groups showed that there was no difference between the groups on the approach measure, but for biting (contact), the instrumental group was significantly higher than the classical group. In fact, every subject in the instrumental

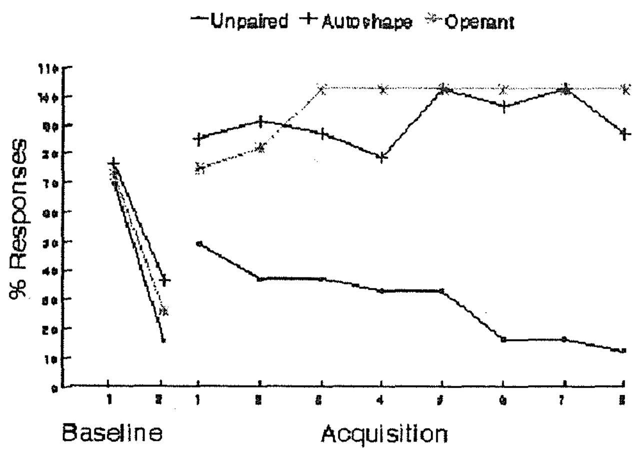

Figure 1. Approaches

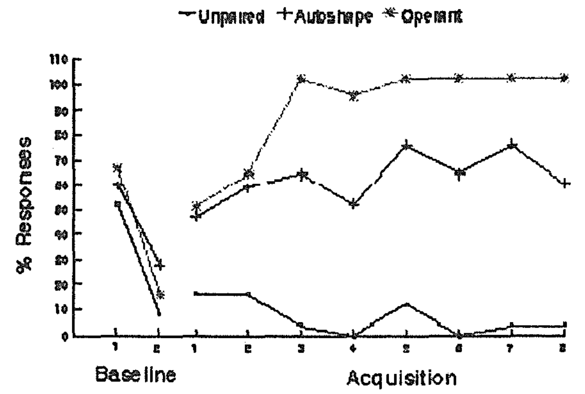

Figure 2. Contacts

group bit the pipe on every trial over the last 20 trials of the experiment. The classical conditioning group bit on approximately 65% of the trials during the same number of trials.

DISCUSSION

The turtles showed rapid acquisition of the association between the pipe and food. The unpaired control groups quickly stopped approach and contact to the pipe when the pipe and food were temporally unpaired, showing that the experimental groups were responsive to the association of pipe and food and their behavior cannot be interpreted by nonlearning processes (*e.g.*, indiscriminate biting of anything placed in the tank).

The fact that the instrumental group showed a higher asymptotic level of response as compared to the classical group, is consistent with the idea that the sea turtle is sensitive to the outcome produced by its behavior, and inconsistent with the hypothesis that reptiles are limited to learning only about the relationship between signal and outcome and not about behavior and outcome.

In addition to revealing a mechanism by which sea turtles can better adapt to their environment, this experiment also provides a methodological basis for evaluating other aspects of sea turtle biology. Morley-Bartol in this volume shows how visual acuity can be measured in sea turtles using a version of this general procedure.

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MEASUREMENTS OF VISUAL ACUITY OF THE JUVENILE LOGGERHEAD SEA TURTLE (*CARETTA CARETTA*): A BEHAVIORAL APPROACH

Soraya Moein Bartol
School of Marine Science, Virginia Institute of Marine Science, College of William and Mary, Gloucester Point, VA 23062 U.S.A. moein@vims.edu

Research performed on the sea turtle visual system has focused mainly on aerial vision. However, sea turtles spend the majority of their lives in the marine and estuarine environments and yet their visual capabilities in water remain unanswered. Visual acuity, the ability to discriminate between separate elements of an object, was measured from loggerhead sea turtles (*Caretta caretta*) using a two response forced-choice method. Loggerheads were trained, in a 500-gallon tank, to discriminate between a vertically striped panel and a 50% gray panel. Test panels were illuminated simultaneously and a correct response (contact with PVC pipe below the striped panel) was reinforced with presentation of a food reward. Training continued until the turtle chose the striped panel greater than 80% of the time. Acuity thresholds were then collected by decreasing the stripe size in blocks of several trials until both striped and gray panels were chosen equally. Thresholds were recorded from three animals and ranged from a minimum resolvable angle of 16 to 32 minutes of arc. This acuity threshold is analogous to others in the aquatic environment and suggests that vision may play an integral role in the loggerhead's perception of its surroundings.

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EFFECT OF THE THERMAL ENVIRONMENT ON THE TEMPORAL PATTERN OF EMERGENCE OF HATCHLING LOGGERHEADS

Kathleen Moran, Karen A. Bjorndal, and Alan B. Bolten
Archie Carr Center for Sea Turtle Research, PO Box 118525, University of Florida, Gainesville, Florida, 32611, U.S.A
kmoran@zoo.ufl.edu

It is critical to the survival of sea turtle hatchlings that they emerge from the nest at night, both to avoid predators and to prevent over-heating that would result in heat torpor and perhaps death. One way for them to gauge the onset of darkness is to respond to decreases in sand temperature. Various theories exist as to what changes in the thermal regime are actually important to the hatchlings. They may wait for a threshold temperature, below which it is safe to emerge; they may wait until the top layers of sand become cooler than those below them; or they may wait for a particular rate of cooling of the sand.

By marking loggerhead nests and then inserting thermocouples at depths of 0, 5, 10, 15, and 20 cm in the neck of each nest prior to emergence, we were able to measure sand temperatures that the hatchlings experienced prior to and during emergence. We also counted the number of hatchlings in each emergence, and the time and duration of each emergence. We used these data to determine the nature of the cues that the hatchlings use and the overall thermal regime under which emergence can occur.

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A SEASONAL PROFILE OF PLASMA TRIGLYCERIDE LEVELS IN NESTING FLATBACK (*NATATOR DEPRESSUS*) TURTLES ON CURTIS ISLAND, QUEENSLAND, AUSTRALIA

Leigh Slater[1], Colin Limpus[2], and Joan Vmittyer[1]
[1]Department of Anatomical Sciences, The University of Queensland, Brisbane QLD 4072, Australia Lslater@zoology.uq.edu.au
[2]Department of Environment, PO Box 155, Brisbane Q 4002, Australia

This investigation examines the relationship among plasma triglyceride (TG) levels, nesting episode and egg production in nesting flatback turtles, Natator depressus. Plasma was collected from a series of females after each oviposition for each of their four successive clutches within a breeding season, Plasma TG levels, measured by spectrophotometry, had significantly decreased by the final nesting episode. Decreases in TG levels corresponded to a significant decrease in the number of eggs as well as the weight and diameter of the eggs within the last clutch. Differences in plasma TG levels during the first nesting episode were observed between females. No correlation was found between curved carapace length and TG levels, however a weak but significant correlation was found between TG level and clutch size. Together these data suggest that an important biological mechanism may be occurring in association with the final clutch of the season. Decreases in plasma TG levels may reflect a possible physiological termination of vitellogenesis.

EVIDENCE FOR THE LACK OF HYPERGLYCEMIC ACTIVITY OF CORTICOSTERONE IN THE OLIVE RIDLEY SEA TURTLE (*LEPIDOCHELYS OLIVACEA*)

Roldán A. Valverde, David W. Owens, Duncan S. MacKenzie, and Rhonda M. Patterson
Department of Biology, Texas A&M University, College Station, TX 77843-3258, U.S.A. roldan@biology.lsa.umich.edu

Reproductively active olive ridley sea turtles migrate hundreds of kilometers from their feeding grounds in the Eastern Pacific to their nesting beaches in Costa Rica. During their migration and nesting periods animals exhibit a marked hypophagic behavior. Capture and sampling of adults in the water at six hr intervals during a 24 hr period indicate that serum glucose levels are maintained at a mean value of 39.1 + 0.8 mg/dl. After subjecting a group of 30 females and seven males to stress and inducing an overall 12 fold increase in corticosterone (B), glucose levels remained unchanged at a mean of 49.2 mg/dl. Adrenocorticotropic hormone (ACTH) injection (0.6 IU/Kg BW) induced a 10 fold increase in B levels by four hours of injection. These levels were maintained for up to 23 hrs postinjection. During this experiment glucose levels exhibited a 2.0 fold decrease by 14 hrs postinjection, maintaining these lower levels during the remainder of the experiment. These data indicate that basal glucose levels are lower in reproductively active olive ridleys than in adult, gonadally quiescent conspecifics and that B lacks hyperglycemic activity in these reptiles. It is possible that the lack of a hyperglycemic effect of B is due to the reduced internal energy stores of reproductively active animals.

PERMANENT EDUCATION SUPPORT FOR PROTECTION AND CONSERVATION OF THE SEA TURTLES IN MAZATLAN SINALOA, MEXICO

Angeles Cruz Morelos
Acuario Mazatlán, Ecological Department, Mazatlán Sinaloa, México. acuario@red2000.com.mx

To share working experience with the proposal of inculcate affectivity and respect values for sea turtles conservation through teaching knowledges about chelonia biology, its marine ecosystem and fundamental aspects about natural resources in problems. The permanent project has three programs; it's a joined effort. The first program started in 1987 with the organization of the Children's meeting in South of the State of Sinaloa. Conservation of the Sea Turtles. The second program started in 1991 with the protection for sea turtles in the tourist zone from El Delfin beach to North beach. And the third one started in 1996, it's an educational program for supporting nature science in elementary school, with the objetive to join actions that will help the biodiversity protection through continue educational programs for a variety of people in our community.

A.- THE CHILDREN'S MEETING IN SOUTH OF THE STATE OF SINALOA.

Conservation of the Sea Turtles" was planning for supporting education for kids of elementary schools of sixth grade that have an average of 11 and 12 years old. Five counties of the southern part of the State are involved (Elota, San Ignacio, Mazatlan, Rosario and Escuinapa). The meeting is a reunion for 100 kids in a DIF camp, it's a complete week living together learning through social, cultural and sport activities. The program is design with goals so kids will notice the scencial part of our region, how important are sea turtles and why we're helping these animals. Kids analize chelonia group and decide by themselves in what level of participation in conservation they want to be. The knowledges and vocabulary are according with the scholar grade so their understanding level will allow them to know human activities and their behavior. It's a week singing, playing, theory classes, workshops so kids are able to get the relation between sea turtles and the other animals and also will able to use these knowledges in their daily life. Since 1987 to 1997 Acuario Mazatlan, DIF camp support, speakers, volunteers and organizers are part of the formation process of 100 kids each year. The past year 1997 in September and October we did surveys to kids that have been already in these meeting since 1987. We were looking for the beginners and these data will allow us to actualize, change and correct the activities in the program.

B.- PROTECTION TO NESTS ON THE TOURIST BEACHES IN MAZATLAN SINALOA, MEXICO.

1991 - 1997 398 nests
37,576 hatching
25,499 hatchling

The technique subdirection of Acuario since 1991 has the program of recover turtles nesting in 28 kilometers from Delfin beach to North beach. In the program there are institution and groups as hotels, scouts, lifeguards and community that colaborate. Since there are reports of a sea turtle nesting, the nest is picked up taking it to the incubation room until hatchling and then are taking to the beach. Also there are speeches to different people of our community about we're doing.

C.- ENVIROMENTAL EDUCATION PROGRAM FOR SUPPORTING SEA TURTLE CONSERVATION SCHOOL YEAR 1996 - 1997 3,740 KIDS.

In 1996 started this program on sea turtle conservation for elementary schools in every grades. To design this program we analized the nature science subjects of Public Education in Mexico. The content program for every grade has two subjects: 1.- animals and plants 2.- enviroment and protection. Each theme will guide kids to understand which factors might protect better. To apply the class plan we use concepts about health, science, tecnology, energy, social and economic factors using proper vocabulary. The class is theory and practice using slide projector, over head projector and designed material for each part of the theme, also with a notebook that was designed for it and the tour to the exhibition tanks. The participant institution is the National Committee for protection and conservation of the sea turtles. The program is accept by local and State authorities of the Public Education Secretary and since 1993 there is a commissioned teacher from this institution in Acuario Mazatlan. At the begining this program was only for school groups, now we know that this same program should be adapt for inhabitants of coastal regions that don't have enough information about their natural resources and is urgent to involve these communities.

It's not difficult to do educational job and because we can not still indifferetn about this situation in the world the enviromental education is a strategy; it's a process that has conditions and requirements for an educator. Elements such time, methodology, evaluation, etc., become our limits to overcome; and is urgent to prepare us to still continue opening more paths as enviromental educators and beign optimist to reach it. Our job is to do it with our preparation and with the affective part of each educator. When we accept the commitment to be a pionner between pionners we must trust that even though with minimum human resources we are building metaphorically a new Noah's Ark called "Eviromental Education"

DIAGNOSTICO SOCIOECONOMICO EN LAS COMUNIDADES

Celia Gutierrez
Departamento de Ecología y Recursos Naturales, Universidad Centroamericana, Nicaragua. cmgaa@ns.uca.edu.ni

The beach called "La Flor" is one of the two beaches in Nicaragua where every year thousands of sea turtles arrive to lay their ggs. Near this beach there are six communities that are seriously impacting the population through egg poaching. Based in this social problem we made participative theaters-workshops where the people of the communities talked about the different reasons why they participate in egg poaching. One of the main reason why they do that is because the lack of economic opportunities to work near the area. The workshops have helped to identify work alternatives near the area which should minimize the impact on the turtle population.

Previously to this work we made a diagnostic where 10% of the total population surveyed has at some time or another participated in the poaching and/or distributionof sea turtle eggs.

SUSTAINABILITY AND EDUCATION FOR CONSERVATION: FIVE PARADIGMATIC VIEWS

Edgar González Gaudiano
Centro de Educación y Capacitación para el Desarrollo Sustentable

Some of the main discussions related to available options for sustainable development within the current world frame are analyzed. Some of the more critical points, particularly those of interest to developing countries are identified and their associations to educational projects are established. Lucie Sauve's and Michael Colby's classifications are used as points of reference to analyze the pedagogic implications from five different points of reference. The presentation proposes a frame of reference for environmental education, appropriate for the conservation needs of developing countries.

ENVIRONMENTAL EDUCATION A STRATEGY FOR SEA TURTLES CONSERVATION

Federico Hernández Valencia[1], Luis Fernando González Guevara[2], Francisco Valadez Fernández[2], Minerva Campos Sánchez[3], José Acuña Domínguez[2], Mario Sandoval Ramos[1], Alvaro Francisco Castillo Ceja[1], and Daniel Díaz Rodríguez[3]
[1]Laboratorio de Investigación en Tortuga Marina y Biología de la Conservación. Facultad de Biología, Universidad Michoacana de San Nicolás de Hidalgo. México.
[2]Programa Universitario de Conservación a las Tortugas, Marinas. Centro de Ecología Costera. Universidad de Guadalajara. México.
[3]Laboratorio de Investigación en Educación Ambiental. Facultad de Biología. Universidad Michoacana de San Nicolás de Hidalgo. México. fhvalen@zeus.ccu.umich.mx

In México, environmental education is an important issue of the strategy for sea turtles conservation. However, efforts are commonly focused on training of university students and graduates for research activities on sea turtles and sea turtles camps management, but not on environmental education.

Today, people involved in environmental education doesn't have a place to reach an adequate development of their capabilities, besides domestic workshops or local meetings.

Recently, an interactive workshop was carried out at Playa la Gloria, Jalisco, México, by two Universities of México (University of Michoacan and University of Guadalajara). Together, they joined to conduct a training program of graduates, teachers and students of elementary schools and local people in order to interchange experiences on promoting environmental education and to encourage it, as an important tool for sea turtles conservation in México.

As a result, a preliminary strategy for sea turtles conservation based on environmental education is presented.

CONSERVATION OF THE LEATHERBACK TURTLE (*DERMOCHELYS CORIACEA*) IN NOVA SCOTIA, CANADA

Michael C. James[1] and Chris Harvey-Clark[2]
[1] North Atlantic Leatherback Turtle Working Group, Centre for Wildlife and Conservation Biology, Acadia University Wolfville, Nova Scotia, Canada , BOP 1XO. 030136j@acadiau.ca
[2] Life Sciences Centre, Dalhousie University, Halifax, Nova Scotia, Canada, B3H 4H6
030136j@acadiau.ca

Public awareness of the globally endangered leatherback turtle in Nova Scotia, Canada, is poor, and most observations of leatherbacks go unreported. At the same time, circumstantial evidence indicates that coastal Nova Scotia may be experiencing the highest incidence of leatherbacks and leatherback-fisheries interactions in the Northwest Atlantic region, with significant accompanying turtle mortality (due to drowning in nets and deliberate killing of by-catch turtles to facilitate disentanglement). To address these and other issues concerning leatherback turtle conservation in Maritime Canada, a North Atlantic Leatherback Turtle Working Group was formed in October 1996. In 1997, a public information campaign, focussing on rural fishing communities and commercial fishermen in particular, was initiated to increase awareness of leatherback turtle biology and conservation, and encourage the detailed reporting of all sightings. A novel fishermen-scientist collaborative program was engaged recently to assess the abundance and distribution of leatherback turtles seasonally encountered in Maritime waters and to facilitate the PIT tagging, photo identification, treatment and release of leatherbacks stranded or entangled in fishing gear. A Canadian leatherback turtle database has been established to catalogue reports of all leatherbacks (free swimming, stranded and entangled). Numbers of reports appear to vary from year to year. Despite the lack of a formal collection network, over 40 turtles were reported in 1995. In contrast, even though a network was established in the interim, only 8 sightings were reported in 1997. This would indicate significant annual variation in abundance, probably due to variable surface conditions and current patterns in coastal waters. With the recent expansion of the leatherback turtle public education campaign and the return of normal summer inshore movement of the Gulf Stream in 1998, we anticipate an increase in leatherback sightings

CREATION OF TALENTED ANIMATORS FOR ENVIRONMENTAL EDUCATION

Anna Kremezi-Margaritouli
The Sea Turtle Protection Society of Greece, P.O. Box 51154, GR-14510 Kifissia, Greece. stps@compulink.gr

INTRODUCTION

The concept of youth is equated throughout the world with the notions of dreams, vision, scepticism and militancy for freedom, democracy and social justice.

In those countries where human freedom, democracy and social justice may be taken for granted, young people with restless minds often find their niche in the pursuit of justice among living creatures, within the framework of the maxim: «we all share the same planet».

I come from the country where democracy was born. A country where scepticism and militancy are the natural characteristics of people and our civilisation.

A species threatened by extinction through human indifference and egotism, i.e. by the suppression of its rights on the planet, provides a good opportunity to canalise the inherent notion of justice of the young and draw their militancy in order to safeguard the species' place on earth.

Such opportunity becomes unique when the species in question is a marine turtle, who reflects life on earth from the era of dinosaurs. Whose size is impressive, who moves slowly and majestically, whose gaze is wise, who is silent and peaceful.

IMPLEMENTATION

Approximately 300 young people from all over the world come to work every year on various projects organised by the Sea Turtle Protection Society of Greece (STPS), mostly in field work. Most of them deal with the turtles themselves, collecting information that documents the importance of their habitats, the state of the populations etc.

The most outgoing of those young people, who preferably speak Greek, are the ones who get in touch with the public in order to give information and spread ideology to people, who are, in their vast majority, indifferent to environmental concerns.

From this pool of volunteers as well as from those working at the sea-turtles' hospital in Glyfada, out of Athens, we select those people who will become animators in the STPS Education Programme.

This Program runs since 1985 and consists of live presentations at schools, throughout Greece, creation and distribution of portable traveling kits and other educational items. The program is conducted with the approval of the Ministry of Education and the cooperation of the Education Departments at each Prefecture. The last years about 300 presentations per year , are conducted, either by the STPS special teams, or by the schoolteachers using STPS portable kits (Kremezi-Margaritouli, 1992).

The selection criteria for prospective animators are simple:

- Ability to communicate with people and exchange ideas.
- A strong point of view and militancy.
- Sociability.
- Co-operativeness and team spirit.
- Good diction.

Availability at least once a week. After the initial selection, the future animators go through constant and versatile training aiming to create capabilities of:

- Inspiring trust.
- Having in-depth knowledge on turtles as well as on environmental issues in general.
- Being courteous and conciliatory with opponents.
- Being likeable and enthusiastic.
- Being able to keep audiences interested and to improvise during potential adversities.
- Understanding their audience and knowing the school curricula.
- Caring for the good reputation of the Society and being ready to promote and defend its positions.

The training activities begin at the start of the School term by bringing together old and new members in a common group. We believe that collective activity is superior to individual efforts as it ensures continuation, co-operation, and enthusiasm. It is of beneficial importance to establish special meetings for the group.

Those meetings should take place at least once a month at pre-arranged times and places. For example, our group meets every first Thursday afternoon of each month at the sea-turtle hospital which also happens to be the main place of contact with school-children.

This has been going on since 1993 except for the summer months, during which schools are closed and the members of the group participate in the field work. In the meantime the members are trained on site during live presentations, were they are asked to undertake a specific role.

We thus have at least nine meetings of the group each year and as time goes by, the contact between members is constantly improved. Naturally the co-ordinator has the main responsibility for the formation of the group spirit and the quality of the work produced. He or she, must inspire the members, look after their inter-relationships and ensure that they carry out their responsibilities.

Every September, at the first meeting all members get to know each other. All new members are given the so far activities of the education programme and documentation on the biology of the turtles and the positions of the Society as well as a bibliography on general subjects of Natural History and the Environment. Old members review and evaluate the work of the past year, set goals for the future and plan a yearly programme.

During the next seven meetings, members exchange positive and negative experiences concerning the program. Furthermore at each meeting specific activities take place that aim to the improvement of the group capabilities. For instance:

- Briefings on exemplary presentations by experienced and talented lecturers.
- Completion and discussion of a questionnaire entitled «I define myself as a turtler» which asks theoretical questions derived from hypothetical events that often happen in real life.
- Lectures by specialised scientists on environmental subjects.
- Information about the education programmes carried out by other NGO s' and exchanges of experiences.
- Attendance at lectures and seminars on educational programmes at other institutions (museums etc.).
- Hands-on exercises and exercises of body language aiming at liberating ourselves and facilitating communication among the members as well as with children.
- New ideas for publications and other activities are tested and if they are successful, they are adopted.

The last meeting is a celebration: we meet to eat and drink together, to dance, to joke, to thank one another and to look forward to the next school year starting in September.

Beyond those monthly meetings the group undertakes many other activities that deal with the public (sales stands, publications, fund-raising special events etc.). For example, this year we have to organise the activities for the 15th anniversary of STPS.

One important part of the educational process consists of criticism and commentary on every detail of an activity so that we can learn from our mistakes and those of others and also to be able to repeat satisfactory activities or avoid those with flaws. The co-ordinator encourages the animators to make well meaning comments on people and circumstances. By putting themselves in others' place they aim to obtain theoretical knowledge and experience.

DISCUSSION

From the educational program throughout the last 13 years we can deduce the following:

It has been carried out continually since 1985 and kept ties with old communication methods, while also building new.

The programme never lacked membership.

We approach about 15,000 children every year in small groups, either through direct contact or by the portable kits.

So we have succeeded in rendering the Sea Turtle, most popular among threatened species in Greece and also among wildlife in general. This has been found by research done at the University of Thessaloniki.

The animators trained in our group are in demand for other positions at the Society as well as at other NGO's and Institutions (and I'm afraid they are sometimes taken away from us).

The STPS has claimed and obtained a special space for educational purposes which is unique among NGO's in Greece.

However, the major achievement of the Environmental Education Group is that it has opened communication between children and adults while giving the opportunity to the animators to express their ideologies on justice among wild species, through the example of the marine turtle and to express a new environmental ethic.

Furthermore, a chance is given to young people to find a goal in life beyond themselves. To deal with the philosophy of, so to say, a «Democracy of the species » and at the well-being of the Planet.

Thus a charismatic species of fauna, unites children and adults, helps bring out selfishness, creates pure friendships and finally promotes civilisation and a wider sense of democracy.

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TELEMATICS FOR TEACHER TRAINING - SCIENCE AND EDUCATION: "EUROTURTLE" - A MEDITERRANEAN SEA TURTLE BIOLOGY AND CONSERVATION WEB SITE FOR SCIENCE AND EDUCATION.

Roger H. C. Poland[1], Linda Baggott[2], and Lily Venizelos[3]
[1]Biology Department, King's College, Taunton, Somerset, U.K. TA13DX. roger@kingscol.demon.co.uk
[2]School of Education, University of Exeter, Heavitree Road, U.K.
[3]Mediterranean Association to Save the Sea Turtles - MEDASSET, c/o 24 Park Towers, 2 Brick Street, London, W1Y 7DF, U.K.

INTRODUCTION

The concept of a database for Mediterranean Sea Turtles arose when the Biology Department at King's College carried out two large scale conservation expeditions involving pupils aged 17-18 to the Mediterranean (Poland, *et al.*, 1996). Work carried out during these field trips illuminated the difficulty of finding and co-ordinating information about turtle conservation. The "EuroTurtle" web site came into existence in 1996 and is a joint project between the University of Exeter's School of Education, the Biology Department of King's College, Taunton (Somerset UK) and MEDASSET - Mediterranean Association to Save the Sea Turtles. The site resides on the information server of the University of Exeter and can be accessed at http://www.exeter.ac.uk/MEDASSET. "EuroTurtle" has a strong emphasis on Environmental Education and has been included as part of the EU funded Telematics for Teacher Training (T3) project directed by Prof. Niki Davis. Through the T3 project, teachers across the European Union will be able to adopt telecommunications and new technologies in schools and universities. It is establishing courses for teachers within a growing consortium of universities and commercial services, and these will continue to develop beyond the millennium.

ENVIRONMENTAL EDUCATION AND AWARENESS

As far back as 1968 at the Biosphere Conference (UNESCO, Paris) the basic outlines for Environmental Education were formulated using all local, national and international experience and expertise available at that time. Since then, environmental education has developed significantly but has not yet resulted in its expected final goal, which is a general change of attitude and practice toward the environment (Cerovsky 1996).

Cerovsky has suggested that this partial failure has been due to the rather abstract appeal of some educational programmes. The Internet has a major role to play in making environmental education less abstract and more exciting and the "EuroTurtle" approach aims to achieve awareness through interest, excitement and communication.

Aims

The aims of "EuroTurtle" are to:

- provide accurate and wide ranging scientific information for serious scientific projects and to educational groups at all levels.

- promote environmental awareness and education via the Internet.
- provide a cheap and effective information site with the emphasis on easy and exciting information retrieval.
- to keep close links with conservation groups, universities and involved inter-governmental bodies.
- to enhance information flow between conservation groups, individuals, education and other scientific bodies.

Design of the "EuroTurtle" Web Site

From the outset, the material was designed for use via the Internet and not simply transferred text from traditional sources of information. Many of the earlier web sites were largely composed of text files adapted to run via the web, with very little interaction or interest. Sampling the Internet has been likened to drinking from a high pressure hose - lots of water but difficult to swallow! Well designed web sites should make good use of the available technology yet ensure that access to the information is simple and intuitive (DO-IT Brochure Guidelines, 1997; Guide to good practices for the WWW author, 1997). Links between pages should be comprehensive, allowing for a high degree of cross-linking and referencing.

Content

With these design principles in mind, the aim was to make the pages of "EuroTurtle" interactive and dynamic and to give the user the feeling that information and feedback are readily communicated. The site therefore presents valuable information in a variety of different formats designed for learning. The Department of Biology at Glasgow University, monitor the quality of the scientific data and all pages are proof read and corrected accordingly for accuracy and content.

Information is presented in the form of high quality graphics, animation, sound clips, photographs, work sheets, diagrams and a keyword search engine. Data has been provided by a recent King's College Expedition to four Mediterranean nesting sites (July, 1996) and much of the scientific information has been provided by MEDASSET, an international non-governmental organisation whose ultimate goal is to stop and eventually reverse the decline of the Mediterranean Sea Turtles through research, publicity, political liaison, public awareness and environmental education. Within the web site is a special Education section designed to help teachers use "EuroTurtle" in the classroom. Work continues on a comprehensive scientific reference section and plans are in hand to translate the web site into the major European languages. As a pilot Environmental program for "EuroTurtle", the students of The Fourth Alimos High School in Athens have translated the Adventure game into Greek. The "EuroTurtle" web site is being trialed with students from the Old Malthouse School in Dorset, UK., Hale School in Perth, Australia, School of Education, Exeter University, UK., and the American Community Schools in Athens, Greece.

1) ADVENTURE GAME: One section of the "EuroTurtle" web site contains an exercise in the form of an interactive "snakes and ladders" type game in which participants take the part of a female Loggerhead turtle chancing all the threats and hazards of modern turtle life in the Mediterranean in trying to get to a nesting site to lay her eggs. Use of graphics, sound and animation enhance the overall experience of playing the game (Thornton 1996).

2) IDENTIFICATION KEY: One section of this major database contains identification keys which enable students and scientists to identify the 8 endangered species of sea turtle. The aims of this key exercise are to -

- learn to identify sea turtle species from photographs, descriptions and diagrams;
- teach the principles of dichotomous keys and biological classification in a meaningful way- thus stimulating an interest in Ecology and Conservation;
- learn to use the information-gathering opportunities of the Internet as a teaching, learning and scientific resource;
- learn to use the communications opportunities of the Internet (e-mail) and its value as a device for information transmission in a rapidly expanding world community.

3) SPECIES OUTLINES: This section attempts to give an overview of the world's sea turtles with an emphasis on the three endangered Mediterranean species.

4) BONE KIT: Here users can see detailed drawings of the sea turtle skeleton.

SUMMARY OF AIMS/ACHIEVEMENTS

"EuroTurtle" has been trialed and evaluated in a number of schools and Universities. Initial results clearly indicate the value of the site in environmental education and awareness (Poland, R., Baggott, L.M.1997, Poland, R., Lee, H., Baggott, L.M. 1997). An account of a trial and evaluation of the "EuroTurtle" Adventure Game and Identification Key can be seen in Poland and Baggott, !997 and Poland, Lee and Baggott, 1997, respectively.

Close links have been developed between "EuroTurtle" and key conservation groups, Universities, teachers and students from all over Europe and the World with significant contributions from MEDASSET, Exeter, Glasgow and Utrecht Universities, the KMTP (Kefalonian Marine Turtle Project) and conservationists in Italy, Greece and the U.S.A.. Work will continue on construction and evaluation of "EuroTurtle" well into the next millennium.

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THE SEA TURTLE CLUB BONAIRE: IDEAS FOR CREATING AWARENESS

Niels P. Valkering and Tom J.W. van Eijck
Sea Turtle Club Bonaire, Madurastraat 126 hs, 1094 GW Amsterdam, The Netherlands. tvaneyck@bio.vu.nl

INTRODUCTION

The Sea Turtle Club Bonaire (STCB) is a non-profit, non-governmental organization, its main goal being the conservation of the sea turtles of Bonaire, Netherlands Antilles. The STCB has executed several conservation projects from 1993 onwards, following the recommendations of the WIDECAST Sea Turtle Recovery Action Plan for The Netherlands Antilles (Sybesma 1992). Thorough research surveys have been undertaken and an awareness program on turtle conservation has been implemented. As a result, the STCB has presented the first clear overview of both nesting activity on Bonaire and sea turtle populations residing in its coastal waters (Van Eijck and Eckert 1994). In addition, an increase in interest, enthusiasm and participation in conservation activities has been established among Bonairians, tourists, dive staff and the media (Valkering *et al.*, 1996). This paper discusses various efforts that have successfully contributed to an increase in public awareness about sea turtle conservation in Bonaire.

BONAIRE AND SEA TURTLES

Bonaire is part of the Netherlands Antilles; in the Leeward Islands, it is close to the Venezuelan mainland. The Island has a land area of 288 km^2 and a resident population of approximately 14,000, with 6 primary schools and one secondary school. Each year, about 50,000 tourists visit the island, mainly to make use of one of the 12 dive schools. The shoreline of Bonaire consists of coral rock, regularly interrupted by small, sandy beaches. These beaches offer nesting habitat for hawksbill (*Eretmochelys imbricata*) and loggerhead (*Caretta caretta*) turtles (Van Eijck 1993). Nesting activity is concentrated on Klein Bonaire, an uninhabited islet off Bonaire's west coast. Bonaire is almost completely surrounded by live coral reefs and sea grass beds, in which numerous juvenile hawksbill and green turtles (*Chelonia mydas*) reside (Valkering *et al.*, 1996).

Although forbidden by law since 1991, the capture of sea turtles in Bonairian waters still continues, but at a low rate (Van Eijck and Eckert 1994). A more serious threat, however, are the human developments along the shore. Together with sand mining activities, large-scale building sites have been developed over the years, most often leaving half-finished ruins. Thus, turtle habitats are under continuous threat from irresponsible exploitation.

PUBLIC AWARENESS INITIATIVES

Public awareness activities are essential for the survival of Bonaire's fragile ecosystems. The STCB focuses specifically on young people, such as schoolchildren. The STCB encourages collaboration with other local NGO's, such as the Bonaire Marine Park, STINAPA Bonaire and Amigu di Tera. There are four main programmatic thrusts.

* Educational materials: the STCB has several approaches to increase public participation. One method is the production of educational materials about sea turtles which are distributed among schools, youth centers, diving industry, other NGOs, governmental institutions, etc. These materials include: a brochure about sea turtle conservation, sea turtle posters, a booklet written in papiamentu (the local language), annual STCB Newsletters and 'Turtle Corners'. The last-named consist of a folder rack, attached to a sign, urging divers to fill in a sighting sheet. These are placed in all dive schools and also various hotels (Valkering *et al.*, 1996).

* Slide presentations: in cooperation with the Department of Education, STCB visits all primary schools in order to present slides and videos, as well as to provide teaching personnel with educational materials (Van Eijck 1993). In 1995, STCB started giving presentations at the local youth centers (Valkering *et al.*, 1996), and the success resulted in an extension of these activities. Recently, the STCB has invited local speakers with interest in and knowledge about nature to participate in the presentations (Norde and van Rossum 1997). In addition to education of residents, fostering awareness amongst tourists is also of importance. Therefore slide shows are given at two hotels each week. Tourists also participate in our sighting-network; they are requested to fill in a sighting sheet after having encountered a sea turtle. Consequently, the STCB receives an enormous amount of day-to-day information on the biology of the resident sea turtles (the mean number of sheets per year has exceeded 1500).

*General education initiatives: two environmental programs have proved successful in reaching a substantial part of the local public. First, the STCB cooperates with several other organizations during the World Clean-up Day, in organizing a coastal clean up. Each year approximately 200 people participate in cleaning nesting beaches which are subject to an accumulation of marine debris. Last year, the number of trash bags - with identified and quantified debris - totaled 809, an increase compared to the previous two years, 1995 and 1996, in which 225 and 509 bags were collected, respectively (Norde and van Rossum 1997). The STCB reports the findings to the Center for Marine Conservation in Washington D.C. Second, the STCB cooperates with the Bonaire Marine Park in the 'Turtuganan di Boneiru' (Turtles of Bonaire) Project. This children's snorkel program is designed to teach children more about their coastal environment at the same time as they participate in snorkeling lessons (Valkering *et al.*, 1996). In the past, certified children ('turtles') have been invited for special snorkel trips to Klein Bonaire. In cooperation with the Education Conservation Officer on Bonaire, Turtuganan di Boneiru has evolved into a more extended program, where the 'turtles' are offered additional indoor and outdoor educational programs, such as slide presentations and beach assignments.

*Media attention: locally, the STCB issues regular press releases concerning its activities, as well as radio and television interviews. In past years, international broadcasting companies have also shown interest in our work, such as ABC-network, Discovery and various Dutch broadcasting organizations. Recently, the STCB and its activities have been shown extensively on Dutch television, in a jubilee program of the World Wildlife Fund - The Netherlands.

CONCLUSIONS

Main factors that account for the success of our awareness campaign are:

- an increase in local cooperation and participation;
- the ongoing production and distribution of educational materials;
- a culturally sensitive approach to matters of social and economic importance;
- the use of the sea turtle as a 'flagship' species for the marine environment.

One should bear in mind that the STCB is dealing with a relatively small human population, with a moderate standard of living. These two characteristics ensure that virtually all the local target groups are attainable for the STCB. At the same time, the ease with which publicity is created does not imply instant success. Within a small community, rumors are quickly spread and can seriously damage the cause that is being work for. Thus, the STCB regards local cooperation as one of its main aims. We believe that our methods and initiatives could work well at similar locations over the world, and the STCB invites cooperation with other organizations with an interest in nature conservation, for example by exchange of information and educational materials.

ACKNOWLEDGEMENTS

We gratefully acknowledge the financial support of The David and Lucile Packard Foundation and the Sea Turtle Club Bonaire, which enabled our project coordinator to attend the Symposium. Thanks also to Jack Frazier for his comments on the text.

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THE SEA TURTLES OF SURINAME, 1997- AWARENESS

Luc H. G. van Tienen, Willem E. J. Hoekert, Paul van Nughteren, and Sacha Denz
Biotopic Foundation, Plantage Middenlaan 45, 1018 DE Amsterdam, Netherlands. tienen@biotopic.demon.nl

REACHED GOAL

Last year an awareness program has been executed in Suriname. This led to a better understanding of the problems concerning sea turtle conservation in Suriname.

AWARENESS IMPORTANCE

In Suriname four species of sea turtles make use of the beaches as a nesting habitat. As turtle eggs provide economical benefits, many nests are poached. There is no supervision on the fishing of the sea near the nesting beaches and during the nesting season. Because of this many female sea turtles get caught even before they get the opportunity to lay their eggs. Both factors have a negative influence on the sea turtle populations of Suriname. Awareness plays an important part in finding solutions to these problems.

TRADITION AND ECONOMICAL BENEFIT

The most important nesting beaches of Suriname are in the Galibi Natural Reserve. In this area two Amerindian villages have a history of collecting sea turtle eggs. This tradition is important for the local inhabitants. Since the availability of motorized transport, the sale of collected eggs has increased. On other nesting beaches the total number of poached nests has grown because of the economical benefit. The enforcement of the laws to preserve sea turtle nests is not sufficient. A mentality change on a local and national level is important to stop poachers and buyers.

STINASU AND BIOTOPIC

The Foundation for Nature Preservation in Suriname, STINASU, is responsible for conservation and protection of the sea turtles in Suriname. In the 1970's STINASU executed an awareness program which was very successful. In 1995 the Dutch foundation Biotopic started a research project concerning the sea turtles of Suriname. It was found that knowledge about the Suriname sea turtles was scarce among the local Amerindians and other Surinam inhabitants. A new awareness program was desirable.

RESEARCH, INTERNATIONAL COLLABORATION, AWARENESS

In 1997 Biotopic carried out a sea turtle conservation project, which consisted of three separate programs. A protection and research program, an international collaboration program, and an awareness program. One of the advantages of this combination was that information derived from the separate programs could be used in presentations and publications. This way the information exchange was up to date and therefore more accurate. The awareness program consisted of giving presentations, getting local media involved in sea turtle preservation activities, presenting booklets and posters, and in getting local and international institutes involved.

PRESENTATIONS

Several presentations have been held for different groups within the Surinam society. Schoolchildren are a priority group that needs immediate attention. The local Amerindian villages are important because their history and future are traditionally and economically connected to the sea turtles. Other presentations have been held on institutes and organizations like the University of Paramaribo, the STINASU, and to other groups within the Surinam community. Two different slide shows were used to give information about research, ecology, conservation, and threats to sea turtles.

THE OLDEST VISITORS OF SURINAME, OLIVE THE WARANA, THE SEA TURTLES OF GALIBI

One slide show has been accompanied by a photo book called "The oldest visitors of Suriname". Copies of these have been distributed among local nature conservation institutes with the intention of stimulating future presentations.

Two children's books (Olive the warana and The sea turtles of Galibi) have been printed to use as teaching aids at schools, libraries, and by local nature conservation institutes. The books have been presented officially to the education minister.

LOCAL MEDIA

All presentations were announced in the local newspapers. These publications were often accompanied by more background information. Furthermore the media were used to present additional information concerning sea turtle ecology and conservation.

INTERNATIONAL COLLABORATION

A mini symposium has been organized aiming to stimulate an exchange of information among the neighboring countries. Several speakers and a wide variety of guests have been invited. More collaboration between these countries is important to create more awareness on a regional level.

RESULTS AND REACTIONS

After the project in Suriname ended I went to visit a small village in the jungle. Here I found out how effective the awareness program had been. Although radio's and newspapers were scarce, a local inhabitant started talking to us about sea turtle conservation. He had read an article in an old newspaper and wondered how the poaching problem could be solved.

Many groups and individuals reacted positively to the information they received. Not only during information sessions but also on the street people stopped us to talk about the sea turtles. Even while eating in a restaurant or during shopping on the market people started asking questions about sea turtles.

A collaboration with local institutes safeguard future awareness programs. The local institutes should continue giving information about the sea turtles of Suriname. If more and more people do know, understand, and react, the Suriname community will be able to realize a healthy future for the sea turtles of Suriname.

ACKNOWLEDGEMENTS

We would like to thank the Surinam inhabitants for the welcome feeling they gave us. Special thanks to Henk Reichart and his wife Judy, and Harold Sijlbing for supporting us. Also we would like to thank STINASU for their support and appreciation they showed. Ronnie, Jan, Gerard, Andre and Saulus are thanked for their help in getting around in the Indian villages. We appreciated the help and friendship of Arnoud, Michael, Helena, Paul and Iwan.

SALVEMOS A LAS TORTUGAS MARINAS UNA PROPUESTA EDUCATIVA PARA SU CONSERVACION ECONCIENCIA A. C.

Ecociencia A.C.

ECONCIENCIA A.C. fué ftindada en 1989 en la ciudad de Felipe Carrillo Puerto, Quintana Roo México; su principal objetivo es diseñar Programas de Educación Ecológica y para la Salud y aplicarlos directamente a niños jóvenes y adultos que habitan en las comunidades de la selva y costa de Quintana Roo.

Para desarrollar este Trabajo ECONCIENCIA abrió su Centro de Educación Ecológica llamado Casa de la Naturaleza, que ha sido apoyado por donaciones altruistas e instituciones u organizaciones nacionales e internacionales como el Sistema Educativo Quintanarroense, la Secretaría de Salud Estatal, SEMARNAP, el Fondo Mexicano para la Conservación de la Naturaleza, Smithsonian Institution, Manomet Observatory y Fish and Wild Life Service de Alaska.

La Casa de la Naturaleza cuenta con invaluables materiales de apoyo como colecciones zoológicas de aves y reptiles disecados, cráneos de mamíferos terrestres y acuáticos, además de las especies propias del arrecife caribeño (los ejemplares que conforman esta colección han sido encontrados muertos en las carreteras o playas, está registrada conforme a las normas del CITES y cuenta con el permiso oficial del INE para utilizarse con fines educativos); también incluye una biblioteca con información regional, nacional y mundial, así como artículos especializados y guías de identificación; proyector de diapositivas, binoculares, equipo de fotografía y video. Para los Programas de Salud están a disposición dos microscopios, colección de parásitos, carteles, juegos y otros implementos especializados. Todos los materiales educativos y actividades se ofrecen de manera gratuita a los participantes que asisten y colaboran en los diversos Programas imartidos en la Casa de la Naturaleza, los cuales incluyen: visitas guiadas a sus instalaciones, pláticas, talleres, sesiones de diapositivas y videos, conciertos de Ecomúsica, exposiciones, prácticas de campo, reuniones de dibujo, consulta de información en la biblioteca, etc.

Algunas áreas de estudio y desarrollo consideradas en los Programas Educativos son:

- Biodiversidad
- Animales en peligro de extinción
- Aprovechamiento sostenido del bosque tropical
- Areas protegidas Quintana Roo
- La Vida en el mar -Los humedales
- Zoología y botánica regional
- Geografía y manejo de mapas (terrestres y estelares)
- Micribiología
- Contaminación
- Manejo de desechos, basura y agua
- Lactancia materna, nutrición y salud
- Prevención de enfermedades y accidentes
- Herbolaria
- Tradiciones milenarias y valores culturales indígenas
- Investigación
- Viajes de campo

Las costas de Quintana Roo poseen playas con gran riqueza biológica, su vegetación Antillana de duna es exclusiva del Caribe y además recibe cuatro especies de tortugas marinas que anidan en sus litorales. Este inigualable paisaje, ha atraído proyectos de desarrollo turístico que están repercutiendo directamente en el entorno natural, sobre todo en la zona norte del estado.

La proliferación de hoteles, la destrucción de la vegetación de duna, el exceso de basura, el inadecuado manejo de desechos, el desgaste de las playas por el continuo uso turístico , la contaminación por aceites y combustibles, además de la presión y destrucción de varias zonas arrecifáles, son algunos de los ejemplos de los efectos negativos que se están presentando en Cancun, Cozumel, 1. Mujeres, Playa del Carmen, Tulúm y otros sitios de la "Riviera Maya".

Las tortugas marinas son algunas de las especies que están resintiendo la modificación y cambios en su habitat. Desde hace varios años, algunas instituciones como el CRIP y la UNAM se han preocupado por estudiar la biología y comportamiento de estas especies; a últimas fechas, Organizaciones No Gubernamentales nacionales e internacionales, también se han interesado en asumir un papel más activo en el proceso de su conservación, a través de campañas de difusión impresa y radiofónica, programas de liberación de crías y de Educación Ambiental.

El Taller ":Salvemos Nuestras Tortugas Marinas", fué diseñado para poder dar los elementos y despertar o fomentar en la niñez y juventud, una actitud responsable respecto a la protección de la tortuga marina y su habitat.

El Programa dura una semana (3 hrs. diarias) y presenta un enfoque interdisciplinario; contempla aspectos teóricos, importancia del habitat, referencias del pasado, además de los esfuerzos científicos que se realizan para lograr su reproducción en cautiverio.

A través de bibliografía básica y complementaria, vivencias personales, muestras biológicas (cráneos, caparachos, etc.), reflexiones, música, compromisos, mensajes de protección, dibujos y carteles, se trata de lograr un cambio de actitud en los participantes.

En años anteriores y con apoyo del Sistema Educativo Quintanarroense se logró presentarlo en 1. Holbox, I. Mujeres, I. Cancún, I.Cozumel y Felipe Carrillo Puerto con resultados muy positivos.

Para 1997 ECONCIENCIA de manera comprometida y con recursos propios organizó nuevamente un Taller con alumnos de 5to y 6to grado de la escuela "Tiburcio May Uh", en la ciudad de Felipe Carrillo Puerto, con el objeto de dar a conocer a los niños la belleza e importancia biológica de estos reptiles y contribuir al trabajo mundial para la conservación de estas especies.

Para lograr un real interés por el tema es fundamental la variedad y el dinamismo en las actividades. En este Taller los niños tienen la oportunidad de ver y tocar los caparachos y cráneos de las especies que arriban a Quinatana Roo; a través de dibujos y entretenidos juegos profundizan conocimientos y aspectos sobre el tema; la canción "Necesito tu Ayuda para Salvar las Tortugas", despierta la imaginación y al interpretarla día a día durante el Taller, sensibiliza el espíritu de cada uno de ellos. Para reforzar los contenidos teóricos se hace uso de diapositivas, publicaciones generales y reportajes actualizados logrando así tener una visión más real de la problemática global.

Considerando que en épocas pasadas la tortuga no estaba en peligro de extinción e inclusive era un recurso utilizado para su comercialización; se pidió que comentaran y reflexionaran de manera directa con sus padres o abuelos la forma en que la aprovechaban en su totalidad: desde la carne para autoconsumo, aceites con fines medicinales, caparachos para bateas, etc., todo esto con el fin de ampliar su criterio y dejar claras las circunstancias que en el pasado permitieron realizar estas prácticas.

La redacción de mensajes de protección donde plasmaron sus ideas y alternativas para la conservación de las tortugas marinas y su habitat, reforzaron su compromiso, expresaron sus sentimientos y difundieron a otros los conocimientos adquiridos.

El\Plan Ordenamiento" el Corredor ' turístico Cancun contempla la preservación de playas donde anidan las tortugas marinas. Recientemente el gobierno del estado confirmó como Area Protegida Estatal, las playas de Xcacel, realizando decreto para asegurar el área desove.

El trabajo coordinado entre las instituciones y organizaciones que se dedican al estudio científico o a aspectos educativos, debe ser constante; la legislación sobre el tema debe continuar para evitar que la presion turística existente en Quintana Roo y otros estados de la República Mexicana, afecte de manera irreversible el ciclo de vida de estos reptiles.

MENSAJES Y OPINIONES

Niños: a las tortugas protejan. La tortuga es un animal indefenso que no te hace daño. No la mates porque si la sigues matando ya no habrán. Ayúdanos a cuidar a las tortugas, compartamos con ellas las playas y mares; aprendamos a vivir con ellas y a disfrutarlas. Conozcamos su forma de reproducirse para conocerlas y quererlas. Cuídalas.

Asís Rahiv Segoviano Reyes 10 Años

Protege a la Tortuga

La tortuga marina está en peligro de extinción y por lo tanto debemos protegerla. No debes echar basura al mar ya que puedes enfermar a las tortugas. Tampoco debes arrancar las plantas de la arena, ya que alguna tortugas ovan a un lado de ellas, y si las acabas no ovaran. No uses aceite de caguamo para curarte de las enfermedades, ya que puedes hacerlo con medicinas. No compres carne ni huevos de tortuga ya que si compras una vez, seguirán matando para venderte.

Francisco J. Angulo Blanco 11 Años

Este curso de tortugas ha sido muy bueno para mí, pues nos ha enseñado muchas cosas. El primer día me gustó todo pues hablamos de los dinosaurios, los dibujamos y hasta pudimos jugar encontrando a su mamá. El segundo día fué un poco diferente, pues hablamos de las tortugas al igual que los otros días. Vimos que las tortugas salen a ovar en las noches, pues el clima es más fresco que en el día. También vimos que la tortuga hace un rastro falso en la arena para que los depredadores no se coman sus huevos; su mamá no vuelve a ver a sus hijos. Vimos los depredadores de las tortuguitas como: cangrejos, gaviotas, perros, cochinos, etc. Mi opinión es que esta clase o Taller ha estado "super" y que he aprendido mas que ayer.

Andrés Bayona de Castro 11 Años

A mí me gustó el Taller porque hablamos de muchas especies de tortugas como carey y laúd, a parte como se aparean, como ovan y su ciclo de vida y su canción. Dibujar, escribir y platicar sobre tortugas y sus enemigos; jugar con el juego de la tortuga, el arrecife disecado, el salón y los pósters, sobre todo los regalos y que me filmen.

José L. Ureña Argáez 11 Años

Los cursos de tortuga me gustaron, pero también fué un poco triste. Fué un poco triste porque ví como matan a la tortuga marina, pero lo más bonito fué que visitemos el arrecife disecado, juguemos y que cantemos, eso fué lo más bonito.

Fanny L. Yam Pat 10 Años

HAWKSBILL TURTLE MOVEMENTS IN THE CORAL SEA

Ian P. Bell[1], Jeffrey D. Miller[1], Kirstin A. Dobbs[1], and Colin J. Limpus[2]
[1]Department of Environment, PO Box 5391, Townsville, Qld. 4810 Australia. ibells@ozemail.com.au
[2]Department of Environment, PO Box 155, Brisbane Albert St, Qld 4002 Australia

Recordings of international and regional migrations of hawksbill turtles, *Eretmochelys imbricata*, between nesting and foraging areas were presented. Data on localized movements of *E. imbricata* between islands within a nesting area and between nesting seasons were also presented.

Five *E. imbricata* originally tagged on reefs of the northern Great Barrier Reef were recaptured outside of Australian territory. Four of these turtles which were originally tagged in foraging areas (Clack Reef, Green Island) were killed following long-distance migrations to nesting beaches in the Solomon Islands, Papua New Guinea and Vanuatu. The fifth tag recovery was from an *E. imbricata* originally tagged while nesting on Milman Island, on the northern Great Barrier Reef. The turtle was subsequently found washed up on a beach at Merauke on the south-west coast of Irian Jaya in Indonesia. Migration distances ranged between 368 km from Milman Island to Merauke, Indonesia, to 2369 km from Clack Reef to Ndeni Island in the Solomon Islands.

Regional movements of three *E. imbricata* were recorded on the Great Barrier Reef. These turtles were originally tagged at Milman Island during two summer nesting seasons (1990/91, 1993/94) and were recaptured during the southern hemisphere winter of 1997 while foraging in reef areas 97 km (Clerke Reef), 300 km (Hedge Reef), and 375 km (Combe Reef) south of Milman Island.

Seventeen *E. imbricata* originally tagged at Milman Island were recorded changing nest sites between and within nesting seasons. Eight of these turtles nested at islands 6 km (Sinclair Island), 7 km (Crocodile Cay), and 8 km (Douglas Island) away, and were not recorded nesting at Milman Island during the 1996/97 nesting season. The remaining nine turtles, tagged at Milman Island in the 1996/97 season, were also recorded nesting at islands 6 km, 7 km, and 8 km away within the same season.

A proportion of reproducing *E. imbricata* migrate across international boundaries and great distances within regions when travelling between foraging and nesting areas. Further, a proportion of *E. imbricata* change their nesting site between and within nesting seasons. These aspects of their biology have been poorly documented and have implications for species management.

IDENTIFICATION OF THE GULF OF NAPLES AS A FEEDING GROUND AND MIGRATORY PATH FOR *CARETTA CARETTA* IN THE MEDITERRANEAN SEA

Flegra Bentivegna and Angela Paglialonga
Stazione Zoologica "A.Dohrn". Villa Comunale. 80121 Napoli. Italy. flegra@alpha.szn.it

INTRODUCTION

Recent data have shown that the Gulf of Naples, located on the west coast of Italy and opening directly into the Mediterranean Sea, is frequented by the loggerhead sea turtle (*Caretta caretta*), especially in the spring and summer. It does not, however, come into the Gulf to reproduce since most of the sea turtles we find are juveniles or subadults (Bentivegna *et al*, 1994 ; 1997). They most likely come in search of good feeding grounds, and they take advantage of the prevailing current patterns off the coast that flow into the Gulf (Ovchinnikov, 1966). Data provided by tagging programs regarding the *Caretta* in the Mediterranean show that it actively migrates back and forth between the eastern and western basins of the Mediterannean Sea (Margaritoulis, 1988; Argano *et al.*,1992;). Thus, it is possible that a portion of this migratory population, while traveling from east to west, disperses into the Tyrrhenian Sea and enters into the Gulf of Naples. In order to both verify this hypothesis and to uncover the migratory habits of *Caretta*, especially during the winter, we began tracking a loggerhead sea turtle in the Mediterranean using satellite telemetry beginning in October 1995 (Bentivegna *et al.*, in press).

METHODS

The movements of three loggerhead sea turtles, two females whose carapaces measured 73.0 cm and 61.5 cm in length, and one male with a 52.5 cm long carapace, were monitored from 1995 to 1998. These turtles were originally found by fishermen using a trawl net in the Gulf of Naples. One of the females and the male were released in the lower Tyrrhenian Sea in the falls of , respectively, 1995 and 1997. The other female was released, thanks to the collaboration of MEDASSET, off the island of Cephalonia (Greece) in the spring of 1997. A Telonics model ST-6 platform transmitter terminal (PTT) with a salt water switch and repetition rate of 50 sec was fitted on each of their carapaces. Satellite transmissions were monitored by Argos tracking which utilizes NOAA satellites that guarantee complete coverage of the earth's surface. Each satellite was equipped with a data collection and location system (DCLS) that received and recorded signals from the PTT during an overpass. The data we received regarded the location of the loggerhead, the surface water temperature, dive times and average dive times. The present report considers only the surface water temperatures.

RESULTS AND DISCUSSION

The first female turtle (ID code number 07581) departed from the island of Stromboli (Italy) on October 1, 1995. The first satellite fix was made on Oct 1 and the last one was on May 31, 1996. Her voyage took 242 days and comprised a 2487 km migration to the southeast which ended at Bodrum, Turkey. (Figure 1)

The male turtle (ID code number 01151) departed from the island of Ustica (Italy) on September 17, 1997. The first satellite fix was made on September 17 and the last one was on January 3, 1998. His voyage took 108 days and covered 1764 km in a east-southeasterly direction, finally arriving at the Gulf of Arta (Greece). (Figure 1)

The second female turtle (ID code number 03844) departed from the island of Cephalonia (Greece) on April 14, 1997. The first satellite fix was made on April 17 and the last one was in Turkey on July 11, 1997.

Her voyage was only followed in part because on May 25 transmission signals ceased just off Cape Tenaro on the Mani Peninsula (Greece). Afterwards, we received only two reliable fixes; one off the island of Kea (Greece) and the other off Dikili (Turkey).

After leaving Cephalonia, she headed southeast and swam in shallow waters very close to the Peloponnesian coast. Thanks to the MEDASSET association, we found out that after the transmissions ceased the turtle was caught by a fisherman off the island of Kea in the Aegean Sea, 190 km away from her last known position. The fisherman was located and he stated that the turtle was released and continued her trip eastward. The last transmission from this turtle was between the island of Lesbos (Greece-Aegean Sea) and Dikili (Turkey).

A comparison of the routes taken by the female and male turtles released in Italian waters (ID code 07581 and 01151, respectively, (Figure 1) makes the following points evident: 1) when surface water temperature goes below 20°C, sea turtles leave the italian coast and travel towards the eastern sector of the Mediterranean Sea; 2) the Strait of Messina serves as a passage for these migrations; and 3) the turtles tend to travel towards, and remain in locations near, nesting sites. Both the male and female showed this tendency even during non-reproductive seasons; their reproductive season in the Mediterranean begins in early June (Margaritoulis, 1988). The first female turtle (ID code 07581), in fact, remained off the coast of Libya in mid-winter for 80 days near a large concentration of *Caretta caretta* nests recently discovered (Laurent *et al.*, 1997).

It is interesting to note that the female turtle released in Greek waters (ID code 03844) also spent time in the waters off the southwestern coast of the Peloponnese and off the

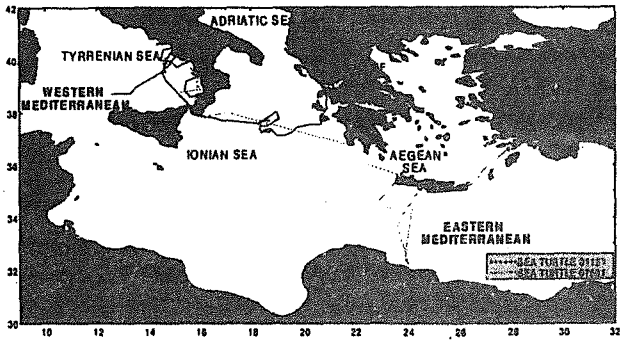

Figure 1. Correlation between sea turtles 07581 and 01151

western coast of Turkey where there are also known *Caretta caretta* nesting sites.

An attempt to place the results of this study and of our previous studies in a larger context could hypothesize that many young loggerheads which pass the winter in the eastern basin of the Mediterranean move on in the spring to the western basin in order to feed. During this dispersion, the loggerheads which arrive in the Tyrrhenian stop in the Gulf of Naples. This Gulf is a rich feeding ground due to geographic and hydrographic reasons: 1) it has an irregular bottom which favors the development of a rich biotic community, and 2) it's shallow coastal waters are highly eutrophic from the spring to fall (Ranzi, 1930; Hapgood, 1959; Carrada *et al.*, 1980).

The dispersal and migratory movements of Mediterranean sea turtles are still very poorly understood. The identification of the Gulf of Naples as one of the preferred habitats of the loggerheads has motivated us to continue out present tracking studies and to further investigate the feeding ecology and range of this species.

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CHELO-TELEMETRY: MORE ON GREAT CHELONIAN TABOOS

J. Frazier

Centro de Investigación y de Estudios Avanzados del I.P.N. Unidad Mérida, Carretera Antigua a Progreso km 6, A.P. 73 "Cordemex", Mérida C.P. 97310, Yucatán, México. frazier@kin.cieamer.conacyt.mx

INTRODUCTION

Telemetry, "biotelemetry" when used with animals, allows the measurement and observation, from a distance, of variables that would otherwise be impracticable, dangerous or impossible. Three basic types of telemetry are used with sea turtles: sonic, "radio" (VHF), and "satellite" (UHF). The most common use of turtle telemetry ("chelo-telemetry") is to locate position. Once this is known, interpretations of other parameters can be made: activity, behavior, habitat type, home range, movements, survival, etc. Specific sensors may also be incorporated in the telemetry package in order to measure displacement, light intensity, movement and temperature.

EFFECT OF THE TRANSMITTER ON THE STUDY ANIMAL

Considerable telemetry research on wildfowl has shown many cases of transmitters affecting the study animal, involving: time budget, feeding behavior, body mass, skin and external body covering, reproductive success and survival (*e.g.*, Paquette *et al.*, 1997). The impact is clearest on small birds and mammals, but even large cats and ungulates have been affected by telemetry packages; research on several species of birds shows that telemeters can increase drag and reduce the speed of flight (White and Garrot, 1990). In general, however, little attention has been paid to the effect of the telemetry package on the study animal. Comments that the subject is "normal", "in good health", or other such generalities, are a long way from proving that there is no effect of the transmitter on its behavior, physiology or survival (White and Garrott, 1990; Slatz, 1994).

Three basic methods are used to affix transmitters to sea turtles: on a tether, on a harness, or directly onto the carapace, using screws, guy wires or fiberglass. Several papers provide advice on how to attach transmitters to turtles (*e.g.*, Eckert and Eckert, 1986; Balazs *et al.*, 1996), and details such as color, shape and coating (Byles and Keinath, 1990). However, systematic studies on the effects of attaching transmitters (called "instrumenting") to sea turtles are rare.

Logan and Morreale (1994) reported that one barnacle on the anterior dorsal of the shell could result in a 30% increase in drag coefficient. As this is the usual site where transmitters - much larger than barnacles - are positioned, the energetic costs of swimming for an instrumented turtle may be greatly increased, resulting in major effects on activity, behavior, metabolism, habitat selection, and other key aspects of the animals' life history. Furthermore, a rigid box on the top of the shell can interfere with copulation; Murphy (1979) inferred that because transmitters remained in place and functioning on adult female *Caretta caretta*, copulation had not occurred.

One study showed that after 18 days a leatherback with a harness was chaffed, and so the equipment was removed;

in addition, a shark had attacked this turtle, evidently attracted to the transmitter and harness that it was wearing (Keinath and Musick, 1993). In their studies using transmitters attached to the carapace, Renaud and Carpenter (1994) discarded the first two weeks of data, to allow the instrumented animals to become "accustomed" to the equipment. No further details were given, but it is remarkable that the authors were so concerned about the effect of transmitters on the animals that they purposely threw out two weeks of hard-earned data. Transmitters, by definition, emit signals, and chelo-telemetry investigators have implicitly assumed that there are no effects of the telemetry signal on the study animal. It is not clear, however, that sea turtles are completely insensitive to these radiations – particularly sonic pulses. In conclusion, the design and attachment of chelo-telemeters is as much art as science.

ERROR IN TRANSMITTER LOCATION DATA

Location is the primary objective of chelo-telemetry. The equipment can be used to home in on and visually track down a study animal, or it can be used to estimate a position remotely. Remote estimates are made by triangulation in the case of sonic and "radio", or by using calculations of Doppler shift, in the case of "satellite". For more than two decades there have been detailed studies and descriptions of the problems of error in biotelemety (*e.g.*, White and Garrott, 1990; Slatz, 1994) but little of this has been applied in chelo-telemetry. Three independent variables affect error: distance from transmitter to receiver, angle of intersection of the bearings used in triangulation, and the error angle of the bearings (Slatz, 1994).

Many studies have used sonic transmitters, but only one team has evaluated position error. Braun *et al.* (1997) studied errors and biases involved in sonic telemetry, describing the limits of the technique for chelo-telemetry. They found a significant bias in test readings, and calculated 95% error angle to be between 4° and 10°, recommending that the transmitter-to-receiver distance be < 326 m to be able to locate a position at 95% confidence limits, in an area of < 10 ha.

"Radio" telemetry has been used in numerous studies to determine turtle position, but problems of error have routinely been ignored. Apparently the only considerations relevant to distance from transmitter to receiver have been signal range (reported to be as much as 30 km in some cases), not the effect on error. Little attention has been paid to the angle of intersection of the bearings, which commonly have been outside the recommended range of 45° to 135° (White and Garrott, 1990). Calculations, or even mention, of error angle are also conspicuously absent, although in a few papers a fleeting mention of error was included, but without clarification of how it might affect the interpretation of the data. In some cases intersecting bearings were taken by sequential – not simultaneous – readings, meaning that the turtle moved an unknown distance between bearings. A few studies have even used single bearings to determine point locations!

To illustrate the importance of error in chelo-telemetry, error polygons can be calculated for studies that assumed no error, by assigning a 95% error angle of 5° (usual for terrestrial studies). One study reported instrumented *Dermochelys coriacea* to average about 19 km offshore, but the calculated 90% error polygon is 58 km², and the turtles had a 90% chance of being from 14.1 to 30.0 km offshore. A study of *Lepidochelys olivacea* in Costa Rica indicated that they were mainly 5.0 km offshore, but the calculated 90% error polygon is 14 km², showing that the turtles had a 90% chance of being 2.8 to 18.6 km offshore. This is not to mention problems of sequential bearings, transmitter to receiver distances > 10 km, bearing intersections < 20°, or the fact that the time available to fix a position of an instrumented sea turtle is often < 1 min – not comparable to most terrestrial studies, so the assumption of a 5° error angle is likely to be a gross underestimate. Hence, many conclusions about the positions, and related activities, based on radio chelo-telemetry may be questionable because they have not taken error into account.

Satellite telemetry does not use triangulation, and is based on the calculation of Doppler Shift, but this sophisticated technique is still subject to error. Depending on the quality of information received by the satellite, the 95% confidence limits of the position data is a circle with radius of 150, 350 or 1,000 m. If insufficient information is received by the satellite, a position may be provided, but without an estimate of precision – these are LC0 data. Because sea turtles spend relatively little time at the surface, the only time when transmissions to the satellite can occur, most sea turtle data is LC0 – without estimates of precision. Nevertheless, many satellite chelo-telemetry studies report not only detailed tracks with point localities, but calculations of distances between consecutive positions (to tenths of a km), swimming speeds (to meters per hour), bottom types and other environmental variables. Since most of the position data have an unknown level of precision, it is risky at best to present results and conclusions that are based on levels of precision not supported by the data - not to mention effects of oceanic currents on turtle displacement. Hays *et al.* (1991) and Beavers and Cassano (1996) provide notable exceptions to this paradigm, giving detailed explanations of issues related to satellite chelo-telemetry.

CONCLUSIONS AND RECOMMENDATIONS

The issue of error is treated as a taboo in chelo-telemetry, for it is rarely mentioned. This results in work being less valuable than it could be, or even questionable, depending on how the data are used. In some cases, the omission of any discussion of error may be more related to editors' biases than the desires of authors (Plotkin, pers. com.); hence, both authors and editors need to be better informed about these issues. To reduce the chances of producing spurious interpretations, it is essential that any telemetry study take into account several basic considerations:

- Have clear objectives, and use equipment and methods which will best meet those goals;
- Understand and respect the limits of the equipment and methods;
- Take into account possible effects of the equipment and techniques on the study animals;
- Calibrate equipment and methods;
- Determine sources of bias;
- Determine sources of random error;
- Use procedures that produce the most precise estimates;
- Report findings to a level of precision consistent with the methods;
- Be honest and clear about error and uncertainty in the results.

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GREEN TURTLE (*CHELONIA MYDAS*) INTER-NESTING BEHAVIOUR IN THE EASTERN MEDITERRANEAN DETERMINED USING DATA-LOGGING DEVICES

Sandra Hochscheid[1], Brendan J. Godley[2], Annette C. Broderick[2], and Rory P. Wilson[1]

[1] Abteilung Meereszoologie, Institut für Meereskunde, Düsternbroker Weg 20, D-24105 Kiel, Germany. shochscheid@ifm.uni-kiel.de

[2] Marine Turtle Research Group, Division of Environmental and Evolutionary Biology, Graham Kerr Building, University of Glasgow, Glasgow, G12 8QQ, Scotland, U.K.

INTRODUCTION

Conservation related research regarding sea turtles has largely focused on the nesting beaches. However, successful conservation of these species is likely to depend on management decisions based upon detailed knowledge of the behaviour of both immatures and adults in the aquatic environment. This is far more difficult, explaining why data regarding at-sea activity are so scarce. This report details preliminary results of a study in which adult female green turtles (*Chelonia mydas*) from the eastern Mediterranean were equipped with data-loggers to elucidate their movements and activity during the inter-nesting interval.

MATERIALS AND METHODS

The study was based on measurements made by the DK600 data-logger (Driesen and Kern, Am Hasselt 25, 24576 Bad Bramstedt, Germany). We equipped green turtles at Alagadi, northern Cyprus (35°21'N, 33°30'E) during the cover-up phase of nesting activity. Velcro glued to both the underside of the data-logger and to the carapace held the device in position during attachment with epoxy resin. The relatively small (140 mm long x 58 mm wide x 28 mm high), hydrodynamically shaped devices weighed only 200 g each; they recorded and stored data on ambient temperature, light intensity, swim speed and dive depth. Additionally, a compass, combined with two Hall generators, measured change in the position of the animal in three-dimensional space, and data from these compass sensors were used to calculate an index of activity. The logger had a 2 MB flash memory and could store up to one million data points. We set the interval between measurements at 15 seconds to reduce battery use, so that the unit could continue logging for a four-week period.

RESULTS AND CONCLUSIONS

Each logger was detached at the end of the study, leaving no carapace damage, and appearing to have had no deleterious effect on the animals. From the four units retrieved, we obtained data regarding two inter-nesting periods, from two different turtles: 23-days (11 and 12 days) for one turtle and 15 days (11 and 4 days) for the other. In all cases the speed vane had been damaged during employment, which led to a failure in the measurement of swim speed. Hence, data on swim speed were only reliable for two days from one turtle. The mean velocity was between 0.6 and 0.75 m/sec, with a maximum calculated speed of 5.4 m/sec, this last value being interpolated from a calibration regression which was conducted between 0 and 2 m/sec.

The deepest recorded dive was 27 m and the average dive duration was 13 min. For a large proportion of the time, the turtles dived or swam submerged near the surface, in activities we have described as "Messing Around Dives" (MADs), which have no definite pattern and are distinct from the other observed dive types. MADs were never deeper than 2.5 m. Every dive below this depth limit was assumed to be an actual dive and could be distinguished into 3 main types: u-dives, v-dives and s-dives. The expressions "u" and "v" refer to the shapes of the respective dive profiles (Figure 1), whereas "s" only describes the shape of the ascent.

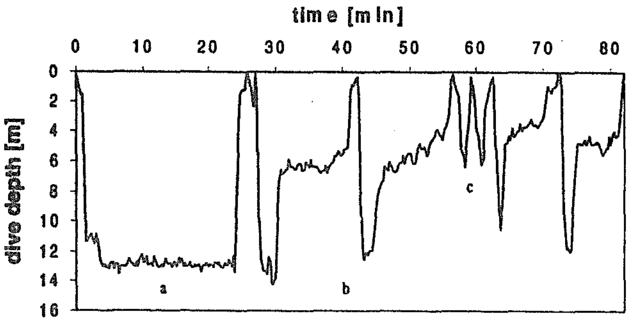

Figure 1. Depth utilization by a green turtle in the eastern Mediterranean showing various typical dive profiles: a = u-dives, b = s-dives, c = v-dives.

A small proportion (6 %) of dives did not fit the above scheme. These "other dives" were a mixture of all of the above categories and could be further recognised due to abrupt "zig-zags" in the profile and between one and several "dive stops" during the descent. The calculated proportions of the different dive types show that the main dive types were u-dives (46 %) rather than s- (11 %) or v- (2 %) dives. In contrast, the MADs played a major role in turtle diving behaviour constituting 35% of all dives, by time spend under water.

We estimated the activity during u-dives with the help of the activity index (Figure 2) and discovered that half of all u-dives showed close to zero activity during the bottom time and therefore conclude that these were resting dives. This means that the turtles spent one quarter of their inter-nesting interval resting on the sea floor, generally at night or late afternoon, in relatively inshore habitats (the water becomes very deep, > 27 m maximum dive depth, within a few kilometres of the coast of the island).

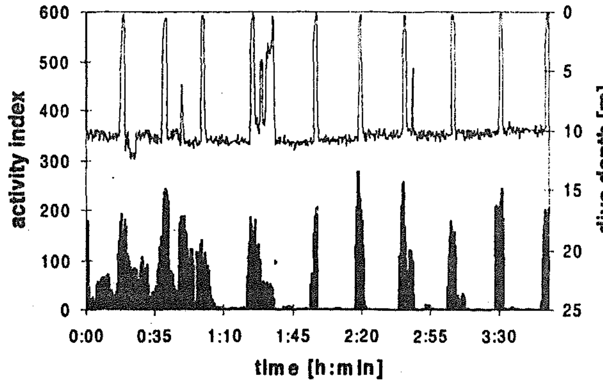

Figure 2. Variation in green turtle activity (high values = high activity) as a function of depth utilization and dive type (see Figure 1).

During about half the u-dives the turtles showed some activity, which could not be assigned to a particular behaviour, we consider it likely to be feeding. There are extensive sea grass beds in the coastal area where the green turtles could be foraging.

More analysis and fieldwork will be necessary to fully determine the role of all dive types. The activity during periods of MADs was consistently high, so it appears that the turtles were actively swimming rather than just hovering near the surface. To elucidate movements further we need to analyse the compass data which could show whether there was a change in location or not. This is anticipated in future work, where a procedure called "dead reckoning" (vectorial calculations using compass-, speed- and depth data) will provide a three-dimensional swimming route for each animal (Wilson *et al.*, 1992).

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MIGRATIONS OF THE LOGGERHEAD SEA TURTLE (*CARETTA CARETTA*) INTO THE ADRIATIC SEA

Bojan Lazar[1], Dimitris Margaritoulis[2], and Nikola Tvrtkovic[1]
[1]Department of Zoology, Croatian Natural History Museum, Demetrova 1, HR-10000 Zagreb, Croatia. blazar@hpm.hr
[2]Sea Turtle Protection Society of Greece, Solomou 35, GR-108 62 Athens, Greece

Data on migrations of sea turtles in the Adriatic Sea are extremely rare, presented, partially, only by Margaritoulis (1988) and Argano *et al.* (1992). In first 10 years of the implementation of tagging programs in the Mediterranean basin (1981/82-1992), 13 tagged loggerheads were recaptured in the Adriatic Sea (Margaritoulis, 1988: 6 specimens from 34 recaptured; Argano *et al.*, 1992: 7 specimens from 51 recaptured). From Croatian waters, only 4 tagged loggerheads have been reported.

Our results are based upon recoveries of tagged loggerheads along the Croatian coast of the Adriatic Sea, in the period between 1993 and 1996. The majority of the records were obtained from local inhabitants and fishermen, through the network of institutions along the Croatian coast, implemented in the Adriatic Marine Turtle Research and Conservation Program in Croatia. All data were gathered at the research center of the Program (Department of Zoology, Croatian Natural History Museum), and forwarded to the tagging institution.

During the four year period, 11 tagged loggerhead females were recovered in Croatian waters, which is almost three times more than in the last 10 years. All the recaptured specimens were tagged in Greece by STPS. However, it is possible that the number of recaptured specimens in Croatia was higher in the past, but due to the lack of a data collecting network and of public awareness, the majority of recaptures were never reported. From 11 tagged loggerhead recovered in Croatia between 1993 and 1996, two turtles were found dead, washed ashore in the northern Adriatic region, while 9 specimens were caught in fishing nets. Six loggerheads were captured in a gill net. Five of them were found dead, while only one specimen was recaptured alive and released. Three more loggerheads were recovered by trawling: one was found alive and released, while data on the condition of the other two recovered specimens were not available. No tagged specimens have been recaptured more than once. In total, only two loggerheads have been recovered alive and released. For two specimens data on recapture-condition were not available, while the mortality rate seems to be even higher than the 60% described by Argano *et al.* (1992). The highest mortality is caused by the gill net, recognized as the most deadly fishing method by Argano *et al.* (1992), with a death-rate of about 75%.

All 11 recaptured tagged loggerheads come from nesting beaches on Zakynthos or on Peloponnesus in Greece. The longest migration, of about 1,200 km, was recorded for specimens recovered in the Northern Adriatic, along the eastern coast. The shortest period between last record on the nesting beach and recovery in Croatia was 43 days. The specimen migrated at least 750 km, which indicates an average speed of about 17.5 km/day. This speed is in the range of the results of Margaritoulis (1988).The 11 in-transit recoveries of migrants in Croatia presented in this paper, as well as data on recaptures by Argano *et al.* (1992) and Margaritoulis (1988), show that part of the Greek loggerhead nesting population migrates through the Adriatic Sea. Although migratory behavior is unknown, it is probable that the Adriatic represents their feeding and developmental area. According to Lazar and Tvrtkovi (1995), a yearly incidental catch of 2,500 specimens has been estihead nesting population migrates through the Adriatic Sea. Although migratory behavior is unknown, it is probable that the Adriatic represents their feeding and developmental area. According to Lazar and Tvrtkovi (1995), a yearly incidental catch of 2,500 specimens has been estimated for the eastern Adriatic region. The evidence of professional fishermen in Croatia is mostly related to "small", subadult turtles caught in the nets. It is interesting that Lazar and Tvrtkovi_ (1995) have presented data on three schools of mostly subadult marine turtles (probably *Caretta caretta*) observed in Croatian waters, while according to Dood (1988) group migrations are unknown in *Caretta.* Furthermore, according to a preliminary analysis of incidental catch in Croatian waters (Lazar, 1995), and due to the maximum peak of the incidental catch by bottom trawlers during the winter months, it is not impossible that part of Greek nesting loggerhead population overwinters in the Adriatic as well.

Although we can not precisely reconstruct the migratory pathway of loggerheads in the Adriatic, it seems that migratory route leads along the eastern Adriatic coast, toward the north. This route overlaps with the current that enters the Adriatic along the eastern coast and surely have an influence on the direction of loggerhead migration. However, migration against the prevailing currents in the Adriatic can not be excluded, so the question about the active passage of loggerheads in the region is still without a proper answer.

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USING MOLECULAR GENETICS AND BIOTELEMETRY TO STUDY LIFE HISTORY AND LONG DISTANCE MOVEMENT: A TALE OF TWO TURTLES

Wallace J. Nichols[1 and 2], Jeffrey A. Seminoff[1], Antonio Resendiz[3], Peter Dutton[4], and F. Alberto Abreu-Grobois[2]
[1]Wildlife Ecology, SRNR, University of Arizona, Tucson AZ 85721, U. S. A jnichols@ag.arizona.edu
[2]Estación Mazatlán, Inst. de Ciencias del Mar y Limnología, UNAM, Apdo. Postal 811, Mazatlán, Sinaloa 82000, México
[3]Centro Regional de Investigaciones Pesqueras, Ensenada, Baja California, México
[4]Southwest Fisheries Science Center, NMFS, La Jolla CA, U.S.A.

Molecular genetics and biotelemetry are powerful tools that have been used to study sea turtle movements and life history (Bowen 1995) (Balazs 1994). Together they can provide empirical evidence for previously stated hypotheses, increase our understanding of habitat use, migration routes, and suggest further research lines on the interrelationships between nesting and feeding areas.

Loggerhead (*Caretta caretta*) and black turtles (*Chelonia mydas agassizii*) are thought to undertake long migrations from nesting beaches in Japan (Villanueva 1991; Ramirez Cruz *et al.*, 1991) and Michoacan, Mexico (Alvarado and Figueroa, 1992), respectively, to distinct feeding grounds along both coasts of Baja California, Mexico. Results from analysis of mtDNA control regions, from this study and presented elsewhere (Bowen *et al.*, 1995), and from our recent satellite telemetry studies confirm these nesting beach-feeding ground relationships and suggest vastly different patterns of use of Baja California waters by each species.

We have observed that eastern Pacific loggerheads primarily occupy offshore areas confirming the observations of Pitman (1990), make long pelagic forays, and feed predominantly on pelagic red crabs (*Pleuroncodes planipes*). In contrast, black turtles utilize primarily nearshore waters, lagoons and bays, migrate along the coast, and consume sea grasses and algae. Mortality due to incidental catch is common for both species in this region (pers. obs.).

These results reiterate the need for management and protection efforts on sea turtle feeding grounds in Baja California, the importance of a species by species approach to turtle conservation, and the utility of multi-faceted research programs. These studies have also led to an increase in intra- and inter-regional cooperation.

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WHERE DO TURTLES SWIM WHEN THEY SWIM?

Edward A. Standora[1], Stephen J. Morreale[2], James R. Spotila[3], and Frank V. Paladino[4]
[1]Department of Biology, State University College, Buffalo, NY 14222, U.S.A.
[2]Cooperative Research Unit, Cornell University, Ithaca, NY 14853, U.S.A.
[3]Department of Bioscience and Biotechnology, Drexel University, Philadelphia, PA 19104, U.S.A.
[4]Department of Biological Sciences, Purdue University, Fort Wayne, Indiana 46805, U.S.A. standoea@buffalostate.edu

Turtle diving patterns are likely influenced by environmental conditions, such as bathymetry, temperature, and currents; behavior, such as nesting or migrating; and physiological demands, as influenced by factors such as energy acquisition, and depth constraints. Using different combinations of radio, sonic and satellite transmitters, we have examined diving patterns of adult female leatherback turtles, and have outlined some important aspects of submergence and diving behavior. Diving of the turtles was recorded both during internesting periods and while turtles were migrating in the pelagic environment for up to several months after nesting. Comparisons of behavior patterns during such very different activities can help us better protect sea turtles, which can be extremely vulnerable both in nesting areas and while traveling over great distances, sometimes along narrow migration corridors. Futhermore, such detailed information on diving, submergence, and surface patterns can be critical for assessing habitat use and estimating population size.

IMPLEMENTATION OF THE TURTLE EXCLUDER DEVICE (TED) BY THE SHRIMP FLEET OF PACIFIC CENTRAL AMERICA

Randall Arauz
Sea Turtle Restoration Project, Earth Island Institute, Central American Office, Apdo. 1203-1100, Tibas, Costa Rica
rarauz@cariari.ucr.ac.cr

Commercial shrimp fishery activities have been identified by the world scientific authorities as the human induced factor that causes the greatest mortality of adult sea turtles. During the 80s, the Turtle Excluder Device (TED) was developed in the United States, which consists of a simple grid that is installed in the shrimp trawl net, which guides the turtles out a trap door, avoiding their capture and eventual death. Since 1991, the use of TEDs is mandatory in the shrimp fleet of the United States. Additionally, and as a measure to avoid the imminent extinction of these species, the Government of the U.S. imposes an embargo on shrimp imported from countries that do not protect sea turtles through the use of TEDs in their shrimp fleets.

As a condition to certify the Central American countries and allow their exports to the U.S. market, as of May 1 of 1996 they must have laws which mandate the use of TEDs in their local shrimp fleets. All Central American countries complied with these measures, and thus they export shrimp on a regular basis.

However: Has the implementation of TEDs been efficient in Central America after the imposition of the embargo?

Information from several Central American newspapers show a clear debate between conservationists on one side, and shrimpers and fishery sector officials on the other, caused by the stranded turtles that constantly wash up on the Central American Pacific coastline. While conservationists blame this situation on shrimpers for not using TEDs, they defend themselves claiming that all shrimp vessels comply with current regulations, which according to them and fishery officials alike, happen to be strictly enforced.

In order to definitely and directly determine if TEDs are being used by the Pacific shrimp fleet of Nicaragua, an "at dock" inspection was carried out in the South Pacific port of San Juan del Sur, on September 26 of 1997. Of three vessels inspected, none passed the inspection. One vessel had the TEDs improperly installed and without escape holes (however, they did have flaps). Another vessel only had one TED installed, while the other had both TEDs installed, but they were is such poor conditions that they can hardly be considered functional at all.

The situation in Costa Rica is even more critical. On October 27 of 1997, the U.S. Embassy carried out an official inspection in the port of Puntarenas, during which 12 vessels were checked. All passed the inspection, and the efforts of the government sector were applauded. However, during this same month, 5 vessels were captured by the Navy Police of Golfito fishing without TEDs, and all were released the following day. The official INCOPESCA TED LAW sanctions violators with the suspension of their license for one month the first infraction, three months the second infraction, and indefinitely the third. Obviously, this law was not applied. To make matters even worse, one of the vessels was prosecuted by the Mayor's Office in Golfito (the legal jurisdiction), but the Regional INCOPESCA office decided to apply the Wildlife Conservation Law, and the infracted only cancelled a small fine (about U.S.$70). It must be mentioned that the Wildlife Conservation Law is not applicable at sea, where INCOPESCA laws are in effect.

Thus, the embargo is not only irritating to countries that export shrimp to the U.S., it is inefficient. No doubt, the use of TEDs must be implemented with the greatest urgency, for the general well being of the marine ecosystem. Nevertheless, the embargo must be accompanied by a series of elements to guarantee an efficient implementation.

1. RESEARCH. Each country must have reliable and verifiable data on sea turtle catch rates, as well as research on the efficiency of TEDs and modifications designed to improved performance. In Costa Rica we have identified the "problem" areas, the origin of the problem, and we have modified the technology in order to satisfy the requirements of the Costa Rican shrimpers. For instance, in the South Pacific region of the country, up to 38% of the shrimp (by weight) may be lost when using TEDs, mainly due to the high amount of logs and organic debris on the ocean floor, which jam the TED and impair fishing efficiency. After this experience, we proceeded to evaluate the efficiency of different TED models and several modifications. As a result, it was determined that in these problem areas, the use of Seymour TEDs (which are square), with 6 and 8 inch deflector bar spacing, and a 42 inch escape hole rather than an official 32 inch, recorded a loss of shrimp by weight of 4% to 12%. On the other hand, the authorities of the NMFS expressed their concern regarding the wider spacing than the official spacing allowed (4 inches), as this may cause smaller sized sea turtles (such as juveniles) to be captured. In response, we submitted reports with data on more than 300 turtles captured incidentally by the Costa Rican shrimp fleet, which concluded that all sea turtles captured in these waters are adults. During the juvenile stage, the olive ridley sea turtle (*Lepidochelys olivacea*) in captured incidentally by the pelagic long line fisheries. This information is being used to solicit the approval of these modifications (wider bar spacing) for Costa Rica.

2. TECHNOLOGY TRANSFER. After the most efficient modifications for certain fishing conditions are determined, this information must be transferred to the shrimp fishery sector. It is important to work directly with the fish-

ery sector, and submit detailed and periodic reports on the status and results of the research.

3. COOPERATION. The efforts of shrimpers who are responsible and who openly want to be part of the solution, must be acknowledged. This is the case of the Georgia shrimpers in the U.S. The Sea Turtle Restoration Project of Earth Island Institute (STRP) has signed contracts with over 125 Georgia shrimpers, who commit to using TEDs in a responsible way, and to allow unannounced inspections by our representatives. On the other hand, the STRP seeks to sell this product in the "green" market. The program is currently in the capacity of providing up to 3,000,000 pounds of Turtle Safe Shrimp. Through campaigns, public consumers around the world are being reached and educated to acquire awareness of the problem and of their own responsibility as consumers of products that jeopardize the marine environment, as well as the fact that they may actively participate help save an endangered species by demanding the implementation of the TED. By the way, do you eat shrimp?

4. Effective implementation of the laws!

AFTER TEDS: WHAT'S NEXT??

Deborah Crouse
Center for Marine Conservation, 1725 DeSales St., NW, #600, Washington, DC 20036, U.S.A. d_crouse@cenmarine.com

By the late 1970's, drowning in shrimp trawls had been identified as a significant source of mortality for sea turtles in many parts of the world. By the early 1980's, the Turtle Excluder Device (TED) provided a technology by which shrimp trawling could continue virtually unimpeded while protecting most turtles entrained. There followed a protracted, at times pitched, battle first to achieve voluntary use, and when that failed, to require TEDs in shrimp trawls in U.S. waters. While the Center for Marine Conservation played a key role in this battle (Weber *et al.,* 1995), it enjoined many forces from throughout the sea turtle scientific and conservation communities, as well as staff in two federal agencies. Still, it took more than a decade before TEDs were required in most shrimp trawls. Since late 1989, TEDs have been required in some, since December, 1994, most shrimp trawls in southeastern U.S. waters. TEDs are now being required in 18 nations around the world and TED requirements are being considered in 15-20 more.

In the early 1990's, concurrent with TED implementation, sea turtle strandings on southeastern U.S. beaches declined significantly, however stranding numbers began increasing again beginning in 1994. Use of inefficient or improperly installed TEDs and intentional noncompliance were originally identified as the primary sources of the increased strandings. As each of these issues has been addressed in turn (not to 100% satisfaction, but significantly reduced), other possible explanations have warranted consideration, including other compensatory sources of mortality and increases in turtle populations resulting in more dead animals even if the rate of mortality is reduced. While little has been done to reduce multiple recaptures of turtles, at this point it seems increasingly likely that other mortality sources and increasing populations are both contributing to the increases in strandings. This complicates things, as it is difficult to separate mortalities due to noncompliance and/or problems with TEDs from these other factors. These will remain continuing problems that require vigilance and attention, as well as the current challenge before the World Trade Organization of U.S. laws that encourage TED use in countries importing shrimp to the U.S. But there is reason to believe that the worst is over as we hear of increased compliance, a more accepting attitude among many shrimpers, and evidence of increasing abundance of certain turtle populations.

But, though we were right to put such a heaving emphasis on reducing trawling mortalities first, even if TEDs are having an effect and some populations are beginning to increase, we cannot declare victory and go home. Population increases may turn out to be fleeting, if we do not start paying more attention to other problems. There are a whole host of other problems that need attention. Indeed, we may have done two of the easiest fights so far. With directed takes for international trade, it was relatively easy to document the takes, and to rally support against a mostly luxury market. With shrimp trawlers there was an obvious culprit, a fair amount of hard data indicated this was the largest source of mortality by far in the U.S. and a problem of global importance, we had a technological solution, and there were lots of stinking bodies on public beaches to organize campaigns around. And still it took most of 20 years, and the war is not over. But, even as we try to ferret out how many of those increased strandings are due to the ironic good news of increases in some populations, other threats loom: longline fisheries; coastal gillnet fisheries; habitat destruction as highlighted by the recent furor over the sale of the beach at X'cacel, Quintana Roo for a hotel, but we must also be concerned about in-water habitat loss as well (alarms have been raised about global degradation of coral reefs, seagrass beds, etc.). And, sad to say, these threats may be harder to address.

For several years now we have heard reports of large numbers of turtles taken in long line fisheries. In 1990, Nishemura and Nakahigashi an estimated 40,000 sea turtles of three species were caught (16,000 dead) in the Japanese tuna longline fleet in the Pacific in 1978. We know longlining fishing effort has increased dramatically since then. Now Sarti *et al.* (1996) and Spotila *et al.* (1996) tell us about the collapse of the primary remaining Pacific leatherback nesting rookeries, in Mexico and Costa Rica. Those declines probably started with other threats, but global longlining fishing effort is now increasing dramatically, and we know it takes leatherbacks, as well as loggerheads, greens, olive ridleys, etc. Longlining may well finish the job for Pacific leatherbacks.

Aguilar *et al.* (1992) reported an estimate of >20,000 juvenile loggerheads captured (as many as 10,700 killed) annually in the Spanish swordfish longlining fleet in the Mediterranean alone. We now know from genetic evidence (Bowen *et al.*, 1993) that about half (57%) of the juvenile loggerheads in the Mediterranean were hatched on southeastern U.S. beaches. Bolten *et al.* (1994) have reported that significant numbers of these same loggerhead juveniles are being taken in the Azorean longline fleet, and Witzell and Cramer (1995) have compiled data on loggerhead and leatherback captures in the U.S. longline fleet in the Caribbean and northwest Atlantic. In 1987, Crouse *et al.*, pointed to reducing mortality of benthic juveniles (the most common turtles drowning in shrimp trawls) as likely most important to effecting recovery of the Atlantic loggerhead model population. However, the same model also pointed to pelagic juvenile survival as the next most important stage. It would be a shame to save these loggerheads from shrimp trawlers in the U.S., only to have the same populations succumb to longline takes as they travel around the North Atlantic gyre.

After a brief furor, recently, an FAO consultation to reduce seabird takes in longline fisheries globally was initiated, and tragically sea turtles were not even mentioned in the terms of reference. Even worse, some of the solutions (fishing at night) that have been proposed to reduce seabird bycatch may actually increase turtle takes (turtles may be attracted to light sticks (Witzell and Cramer, 1995)).

The focus here has been on longlines because CMC has been working on them for a while and we believe they are a global-level threat. However, last year and again this year, I understand that members at the Latin meeting have started to compile numbers for coastal gill net fisheries, newer and equally disturbing numbers for Spanish longlines, and for other fisheries. Many of these may appear localized, but as the situation with longlines, loggerheads and the North Atlantic gyre illustrates, the cumulative impacts on highly migratory sea turtle populations may be quite significant. It would be a shame to have made such headway on shrimp trawling, just to lose what we gained to longlines, or gill nets.

Finally, habitat degradation and destruction, may well be the most difficult to address hazard sea turtles face. Not only does it happen incrementally, there are no body counts for rallying the troops. Loss of nesting beach habitat may be most obvious, and very hard to mitigate, but degradation of developmental and foraging habitats is of equal concern and may be harder to arouse interest in. One recent study reported 70% of the world's coral reefs (critical hawksbill foraging grounds) were imminently threatened, critical, or already lost (Wilkinson, 1992). Be it coral reef and sea grass feeding grounds, tar balls and plastic in ocean convergences, or nesting beaches, sea turtle habitat degradation is of increasing concern.

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INCIDENTAL CAPTURE OF SEA TURTLES BY THE INDUSTRIAL SHRIMPING FLEET OFF NORTHEASTERN VENEZUELA

Luis A. Marcano and José J. Alió M.
Laboratorio de Pesca Demersal FONAIAP-CIAE/Sucre-Nueva Esparta. Cumaná, Sucre 6101, Venezuela
104721.3234@compuserve.com

Incidental capture of sea turtles by industrial shrimp trawl fleet in the northeastern region of Venezuela was estimated from Feb.-91 to Dec. 93, performing 155 trips. The data were gathered by observers on board of Florida type vesseles, from 13,600 trawls (35.118 h. trawl net-1). In total, 48 turtles were captured : 11 *Eretmochelys imbricata*, 16 *Chelonia mydas*, 15 *Caretta caretta* and 6 *Dermochelys coriacea*. All species had a wide distribution, between the central North coast and the Atlantic zone of Venezuela, but always were caught in areas close to shore and not deeper than 60 m. *Dermochelys coriacea* is more concentrated towards the Atlantic zone. The estimated CPUE was 0,00137 turtles h net-1, equivalent to 1 turt./732 h red-1. Mortality rate, estimated from those turtles that could not be reanimated on board, reached 19%. Size structure information for each species (CCL length of 50% percentile, interval CCL and % adults) was: 68 cm (46-120) and 13% for *C. mydas*; 60 cm. (26-150) and 46% for *E. imbricata*; 64 cm (46-120) and 13% for *C. caretta*; and 145 cm (96-200) and 29% for *D. coriacea*. It is evident that most individuals found in Venezuelan coasts are juveniles which most probably use the zone as feeding grounds. Considering that the Venezuelan trawl fleet performs approximately 1 million h net-1 yr-1, an estimated general capture would be 1370 turtles per year, with an associated mortality of 260 turtles. Until now, the capture rate estimated in Venezuela is the lowest among the countries where similar evaluations have been performed

IMPACT ON CAPTURES BY THE USE OF THE TURTLE EXCLUDER DEVICE (TED) IN THE INDUSTRIAL SHRIMP FISHERY IN VENEZUELA

Luis A. Marcano[1], J. J. Alió[1], and M. R. Lozada[2]
[1]Min. Agric.-FONAIAP Sucre-Nva. Esparta, Aptdo. 236 Cumaná 6101,
[2]Min. Agric. - SARPA, Caracas, Venezuela. 104721.3234@compuserve.com

To prevent the retention and demise of sea turtles in industrial shrimp trawl nets, the Venezuelan government required that all vessels use the turtle excluder device (TED) in the nets since 1994. Compliance to this requirement has been a problem. We examine here the measured impact of the Georgia Jumper TED utilization on catches of the fleet. Using observers on board, 17 trips (950 trawls of 3 h average duration) were performed in the Gulf of Venezuela and 53 trips (1411 trawls of similar duration) in the northern part of Margarita Island, between 1994-97. The TED was installed in one of the nets of the Florida type vessels (indistinctly at board or starboard). The catch in each net was weighted by species. Results were consistent in both regions, but the percent losses could change for the the same species or group of species. In general, shrimp, crabs, octopus, squid and "robust" fish species were significantly lost through the TED, in amounts that varied from 9 to 85%. Losses of "slender" species of fish (*e.g.* Vomer sp.) were either non significant or not consistent between regions. The catch of scallops was significantly affected in the Gulf, but was reduced by 45% in Margarita Island. The use of the TED, with 10 cm separation in the bars, induces severe catch losses, that force a non-compliance behavior in the fleet. This losses could be prevented with a wider bar separation.

IMPACT OF REGULATORY MEASURES ON CUBAN MARINE TURTLE FISHERIES

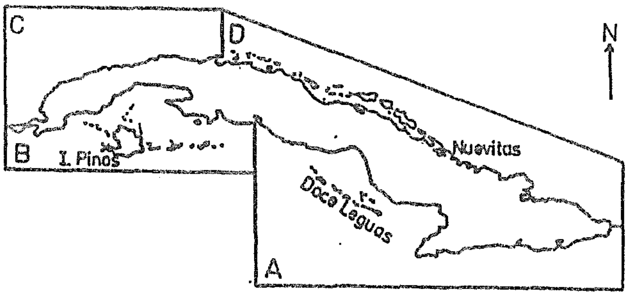
Felix Moncada Gavilan
Centro de Investigaciones Pesqueras, 5ta Ave y 248 Santa Fè, Ciudad de la Habana, Ministerio de la Industria Pesquera, Cuba. Fax: (537) 249827 cubacip@ceniae.inf.cu

INTRODUCTION

Marine turtle fisheries in Cuba have operated in recent years in with detailed biological and fishery studies. A set of regulatory measures have been established for the conservation and management of the species, including closed seasons, minimum sizes and catch quotas. This paper presents the evolution of the fisheries in Cuba, and the effect of the closed seasons which have been established.

MATERIALS AND METHODS

Data on marine turtle catches within the Cuban Shelf, for the period 1968-1996, were used. These were analysed on the basis of the total National catch, and for individual fisheries (Zones A-D), for each species.



Map 1. Cuban fishries zones: A (southeastern); B (southwestern); C (northwestern); D (northesatern).

RESULTS AND DISCUSSION

Trends in the national catch

The variation in annual catches from 1968 shows four well differentiated stages, closely related to the established closed seasons (Figure 1). The first, between 1968 and 1975, when there were no practical regulations, and annual catches reached the highest levels with a growing trend, oscillating between 800 and 1000 t and reaching 1300 t in 1975. The average annual total catch was 1136 t (means of 491 t, 441 t and 232 t for *C. caretta*, *C. mydas* and *E. imbricata* respectively).

The second period spans 1976-87, when a reproductive closed season was established for the three species, from June to August. This meant that the reproductive period was avoided, and consequently catches were reduced. The decrease in total catches was about 40%, equivalent to 500 t less (decreases of 40% for *C. mydas* and *C. caretta*, and 32% for *E. imbricata*). From 1983 to 1987 on, new fishing gears were generally introduced generalized (bottom nets) and the catches increased again.

The third period is from 1988-94, when the closed season was modified and protection increased. This closed season took into account the main reproductive months for each species in every fishery ground, starting from the effectiveness of the previous closed season (Moncada *et al.*, 1986).The new regulation included May to July in zones B (SW), C (NW) and D (NE), and September to November in zone A (SE), further protecting breeding animals. As a result of these modifications, catches decreased between 150 and 200 t.

Finally, the current period (1995-present) is characterized by a new concept in fishery management, with turtle fisheries limited to two traditional sites (Isle of Pines and Nuevitas), by means of catch quotas.

Seasonal trends

Between 1968 and 1975 the highest catches were obtained from May to July for *C. mydas* in the whole shelf; from April to June for *C. caretta* in the four zones, and from April to July for *E. imbricata* in zones C, D and B, and from September to November in zone A. When the closed season was established in 1976 those catches were no longer reached in the above mentioned periods and therefore the seasonal trends changed; two peak periods were observed for the three species: one in May and one in September, although in the case of *E. imbricata* it extended to October. Analysis of samplings carried out in commercial catches provided more detailed data on reproduction for each species in each zone (Moncada *et al.*, 1986, 1987). These data indicated that for *E. imbricata* and *C. caretta*, some important reproductive months were out of the closed season. The hawksbill turtle reproduces in the Cuban Archipelago practically throughout the whole year, with the main reproductive months varying between between zones: in zone A it occurs in the last four months of the year, while in zone B it occurs from April to August, in zone D from April to July, and in zone C from March to September.

With *C. caretta* it was observed that the reproductive period is mainly from April to June, with a peak in May throughout the shelf. That is, the 1976 closed season did not uniformly protect the main reproductive months for the three species all over the archipelago. As a result, gravid *C. caretta* and *E. imbricata* were caught before the closed season and gravid *E. imbricata* were caught after the closed season, demonstrating that the reproduction period of these species did not coincide with the reproductive months of the three species from April to June. Howwever, in zone A, this did not occur, showing the *E. imbricata* has its reproductive peak once that of the other two species has finished.

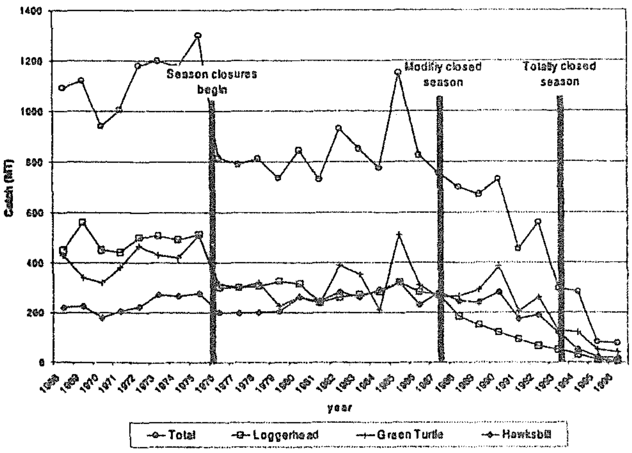


Figure 1. National catch records by species.

With the new regulation, in the three first zones (B, C, D), the closed season continued to protect *C. mydas* and increased the protection of *E. imbricata* and *C. caretta*. With May included in those zones, an annual average decrease of 185 t was noted, principally *C. caretta*. In zone A, when the closed season was moved to September-November, a decrease of 75 t was noted. Therefore, the trends of the seasonal catch changed, increasing protection with this modification in the closed seasons.

Trends in fishery grounds

These regulations influenced the catches for each per species per fishery ground. From 1968-75, the highest rates were observed in zones A and B, in the period 1976-87 in zone C, and from 1988-94 in zone A, C and D. For *C. mydas*, in the period 1968-75 the higher catches were recorded in zones A, B and D; for *C. caretta* it was in zone C, and for *E. imbricata* zones A and D. For the period 1976-87 the highest catches were reached in zone C for *C. mydas* and *C. caretta*, and in zones D and A for *E. imbricata*. From 1988-94, catches were highest in zones C and D for *C. mydas*, zones A and C for *C. caretta*, and zone A for *E. imbricata*.

CONCLUSIONS

The annual variation in catches from 1968 on shows four well differentiated stages, related to the established regulations. Seasonal catches for all species varied with the introduction of closed seasons. Maximum catches, for the whole period, were recorded from zones A (SE) and C (NW), and for species, zones A and D (*E. imbricata*), C (*C. caretta*) and C and D (*C. mydas*).

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TED TECHNOLOGY TRANSFER PUBLIC LAW 101-162

Wilber Seidel[1], Charles Oravetz[2], and John Mitchell[3]
[1]National Marine Fisheries Service, Mississippi Laboratory, 3209 Frederic Street, Pascagoula, Mississippi, 39567 U.S.A.
[2]National Marine Fisheries Service, Southeast Region, 9721 Executive Center Drive, N. St. Petersburg, Florida, 33702 U.S.A.
[3]National Marine Fisheries Service, Mississippi Laboratory, 3209 Frederic Street, Pascagoula, Mississippi, 39567 U.S.A. wseidel@triton.pas.nmfs.gov

Countries with commercial shrimp trawl fisheries are subject to Section 609 of Public Law 101-162. This law bans imports of wild harvested shrimp unless by May 1 of each year the U.S. Department of State certifies that a country has (1) a program to reduce incidental capture of sea turtles in its commercial shrimp trawl fishery; or (2) its shrimp fishing environment does not pose a risk to sea turtles.

Implemented in 1989, the law was interpreted to apply to the Gulf of Mexico, Caribbean and western Atlantic Ocean, which was challenged by Earth Island Institute. The United States Court of International Trade (CIT) ruled on December 29, 1995, that the geographic scope of the law had been improperly limited. Curently, all shrimp-harvesting nations must receive annual certification that their shrimp are harvested without adversely affecting species of sea turtles protected under U.S. law.

Approximately 72 countries have exported shrimp to the United States. Twenty-five countries are certified because they harvest shrimp from cold water, deepwater, or use fishing gear not threatening to sea turtles. Eighteen countries have passed a law that requires TEDs be used in their commercial shrimp fisheries. These countries are Mexico, Guatemala, Honduras, Belize, Nicaragua, El Salvador, Costa Rica, Panama, Trinidad Tobago, Venezuela, Ecuador, Columbia, Guyana, Suriname, Brazil, Thailand, Indonesia, and Nigeria.

The Department of Commerce, National Marine Fisheries Service provides technical assistance to the Department of State. Training workshops have been conducted in each country that adopted a TED program, and to 9 additional countries considering TEDs. Over 5000 vessels are required to use TEDs in the 18 countries with a TED program. Effective use of TEDs, however, depends on enforcement conducted be each country including both at-sea and dockside inspections.

INCIDENCE OF MARINE TURTLES IN THE MEXICAN LONG-LINE TUNA FISHERY IN THE GULF OF MEXICO

Pedro A. Ulloa Ramírez and Luis Vicente Gonzâlez Ania
Instituto Nacional de la Pesca/SEMARNAP, Pitágoras 1320, Col. Sta. Cruz Atoyac, 03310 México, D.F., México
ulloarpa@servidor.unam.mx

The National Fisheries Institute (INP) monitors the longline fishery in the Gulf of Mexico by means of scientific observers on board the fleet. In 1994 and 1995 the INP assigned observers in 435 fishing trips (1994: 38.9%; 1995: 61.1%), achieving a sampling coverage beyond 90%.

As a part of their regular duties, the observers record detailed information about sightings of marine turtles and their possible interactions with the fishing gear. This paper shows results of 2,398 fishing sets (1994: 37.2%; 1995: 62.8%) carried out during the 2 year period.

There were a total of 51 sightings of marine turtles (54 animals) in 37 fishing trips (8.5%). Species composition in these sightings was: 43 leatherback turtles (*Dermochelys coriacea*, 79.6%), 4 hawksbill turtles (*Eretmochelys imbricata*, 7.4%), 2 loggerhead turtles (*Caretta caretta*, 3.7%), 1 kemp's ridley turtle (*Lepidochelys kempii*, 1.9%) and 4 unidentified turtles (7.4%).

A total of 21 marine turtles were accidentally caught in 16 trips, most as a consequence of entangling with monofilament fishing line: 18 leatherbacks (85.7%), 2 hawksbills (9.5%) and 1 loggerhead (4.8%). In 13 trips, 14 turtles were released alive without any damage: 13 leatherbacks (92.9%) and 1 hawksbill (7.1%), standing for a releasing rate of 66.7% in survival conditions.

The average rate of interaction between marine turtles and fishing gear (entangling and/or hooking) turned out to be of 5 turtles per 100 trips and the rate of incidental mortality (bycatch) is even lower, with 1.6 turtles/100 trips, which probably represents a low impact effect for these populations.

A DIAGNOSIS OF SEA TURTLES INTERNAL TRADE AND LEGAL EXPORT OF TORTOISES IN NICARAGUA

Sandra del Socorro Vivas Castro
Sociedad para la Conservacion de la Vida Silvestres en Nicaragua; ONG-Biofaunic; De donde fue el Cine 2 c. al Norte, 1 c. al Oeste y 1/2 c. al Norte; Casa # 47; Residencial Las Mercedes, Managua, Nicaragua. nicam@sdnnic.org.ni

The main information to know the internal trade of sea turtles are the fishermantowns, the main markets of the cities in the 'departamentos' and the national borders with Costa Rica, Honduras and El Salvador.

The exportation of tortoises is registered by The Center for Transaction of Exportation or 'Centro de Tramites de las Exportaciones' more knew as Unique Window of the Exporter or 'Ventanilla Unica del Exportador' of the Central Bank Nicaraguas.

The other not less important source of information are the private Wildlife Exportation Enterprises or Companies which are register by CITES-Ni.

The main objective of this diagnostic is to alert the human population of the American continent about the problems of all Turtles and Tortoises than are being exported without deeply investigations of their real populations.

FIBROPAPILLOMATOSIS IN OLIVE RIDLEY TURTLES IN COSTA RICA

A. Alonso Aguirre[1], Terry R. Spraker[2], Anny Chaves[3], Leslie du Toit[3], Whitney Eure[4], and George H. Balazs[5]

[1] Joint Institute for Marine and Atmospheric Research, University of Hawaii, 2570 Dole St., Honolulu HI 96822-2396, U.S.A. Alonso.Agurirre@noaa.gov

[2] State Veterinary Diagnostic Laboratory, Colorado State University, Fort Collins, CO 80523, U.S.A.

[3] Douglas Robinson Marine Turtle Research Center, Ostional, Costa Rica.

[4] 220 Pinecrest Drive, Athens, GA 30605-1422, U.S.A.

[5] National Marine Fisheries Service, Southwest Fisheries Science Center, Honolulu Laboratory, 2570 Dole St., Honolulu, HI 96822-2396, U.S.A.

Fibropapillomatosis (FP) is a neoplastic disease that primarily affects green turtles (*Chelonia mydas*) in epidemic proportions. Although several infectious agents (herpesvirus, retrovirus and papillomavirus) have been associated with the condition, the etiologic agent has not been isolated or characterized. FP has been reported worldwide in green turtles and it has been recently reported in other turtle species, including loggerheads (*Caretta caretta*) in Florida and olive ridleys (*Lepidochelys olivacea*) from the Pacific coasts of Mexico and Costa Rica. Normal skin (6) and tumor (41) biopsies were collected from 25 adult female olive ridleys in Ostional, Costa Rica, between July and September 1997. Grossly, biopsies were small, white to grey, smooth to verruciform, raised masses on the integument of the neck and flippers. All 41 masses were 25 mm or less in diameter and histologically, 8/41 masses were small foci of chronic active dermatis and not tumors; and 33/41 were diagnosed as fibropapillomas. Twelve of 33 tumors were regressing and 9 of the remaining 21 tumors had early histological changes that suggested degeneration within the tumor. During field surveys based on gross lesions, prevalences of 1-10% have been reported in this nesting population. This is considered the first diagnostic confirmation of FP in olive ridley turtles.

RESCUE, REHABILITATION AND RELEASE OF MARINE TURTLES WITH FIBROPAPILLOMATOSIS: AN EPIDEMIOLOGIC PERSPECTIVE

A. Alonso Aguirre

Joint Institute for Marine and Atmospheric Research, University of Hawaii, 2570 Dole Street, Honolulu, HI 96822-2396, U.S.A. Alonso.Aguirre@noaa.gov

A perspective on wildlife epidemiology will be given regarding the rescue, rehabilitation and release of stranded turtles affected with fibropapillomatosis (FP). An objective overview will be provided to outline the pros and cons of rehabilitation of endangered species and their reintroduction into the wild. How rehabilitation provides for the 'welfare' of individuals is questioned as we determine if release programs for turtles with FP are in the best interest of the wild population.

There is no doubt that rehabilitation techniques in endangered species have provided a wealth of biomedical information that otherwise would not be collected. The data obtained in those settings have lead to the development of diagnostic techniques, baseline physiologic information, and experimental procedures that have contributed to the identification of possible causes and treatments of disease. Rehabilitation of wild animals is definitely an educational experience for both veterinarians/biologists and the general public.

If we are to release treated turtles known to be exposed to an infectious agent we should consider the risks that may be avoided by this reintroduction, including veterinary practices which favor reintroduction of FP and other diseases and their transmission to wild turtles. Based on recent research findings, we are dealing with more than one infectious agent of viral nature (*i.e.* herpesvirus, retrovirus, papillomavirus). All these viruses are known to spread by direct contact or shed intermittently for long periods of time in other species. Etiologic agent(s) need to be identified and characterized and their epidemiology understood before attempting to release turtles with FP back into the wild. In addition, these research efforts will provide better management tools for the control and treatment of this disfiguring disease.

MANIFESTATION OF FIBROPAPILLOMATOSIS AND RATES OF GROWTH OF GREEN TURTLES AT KANEOHE BAY IN THE HAWAIIAN ISLANDS

George H. Balazs[1], Shawn K. K. Murakawa[2], Denise M. Ellis[2], and A. Alonso Aguirre[2]
[1]National Marine Fisheries Service, Southwest Fisheries Science Center, Honolulu Laboratory, 2570 Dole Street, Honolulu, Hawaii 96822-2396, U.S.A. gbalazs@honlab.nmfs.hawaii.edu
[2]Joint Institute for Marine and Atmospheric Research, 2570 Dole Street, Honolulu, Hawaii 96822-2396, U.S.A.

Kaneohe Bay, located at 21°31'N, 158°51'W on the island of Oahu, is the largest bay in the Hawaiian Islands encompassing 13 km of warm (24-27°C) coastal waters <10 m in depth protected 4 km seaward by a barrier reef. All size-classes of green turtles (honu), *Chelonia mydas*, presently occur here in abundance, ranging from post-pelagic juveniles 35 cm in straight carapace length (SCL) to adults >85 cm. Foraging takes place on several kinds of benthic algae (Acanthophora, Hypnea, Codium, Amansia) as well as Halophila hawaiiana, the sole sea grass in the Hawaiian Islands. Green turtles in Kaneohe Bay rest underwater in muddy channel bottoms and in crevices associated with patch-reef pinnacles and other calcareous habitats (Brill *et al.*, 1995). Numerous smooth depressions and undercuts have been created in the coral from repeated use by resting turtles. Buoyant fecal pellets from turtles inhabiting Kaneohe Bay regularly wash ashore, occasionally in great numbers (Balazs *et al.*, 1993).

Over the past 50 years Kaneohe Bay has been subjected to an array of impacts including dredging, sewage discharge, siltation, increased vessel traffic, and elevated nutrients in freshwater runoff associated with human use and habitation of the surrounding landscape. As elsewhere in the main Hawaiian Islands, green turtles in Kaneohe Bay were legally hunted until 1978 when full protection was provided under the U.S. Endangered Species Act. Since that time there have been encouraging signs of population recovery as shown by systematic annual counts of adult females at the Hawaiian nesting colony of French Frigate Shoals (Figure 1).

Fibropapillomatosis (FP), a tumor-forming and debilitating transmissible disease of sea turtles, has emerged in recent years as a serious threat in the Hawaiian Islands, Australia, Florida, and the Caribbean. A herpes virus and retrovirus have been identified in association with FP, but the etiology of the disease, the environmental co-factors required for its occurrence, and modes of transmission in the wild have not been determined. The earliest verifiable case of FP from the Hawaiian Islands involved a green turtle in Kaneohe Bay killed by fishermen in 1958 (Balazs, 1991). However, the disease has been known from Florida since at least the 1930's when it was first reported in the scientific literature as a rare occurrence. The manifestation of FP at high prevalence in both Hawaii and Florida occurred almost simultaneously during the mid-1980's.

METHODS

Study techniques used in Kaneohe Bay since 1989 have included the harmless hand-capture of turtles by diving from a slow moving boat in shallows where foraging occurs, and by snorkeling or scuba diving with stealth to hand-capture turtles resting in bottom habitats. Capture efforts have been focused mainly in areas of the bay used by immature turtles during the daylight hours. Turtles were held for a short time to record morphometrics, apply external Inconel flipper tags and/or injectable internal PIT tags, to conduct FP health screening including oral exams and assignment of a subjective FP affliction category (0=no external tumors, 1=light, 2=moderate, 3=heavy), and to collect blood and biopsies. In addition, a comprehensive Hawaiian sea turtle stranding and salvage research program has been conducted since 1983 that includes collection of dead or FP-debilitated animals bordering Kaneohe Bay. Turtles derived from this effort have been utilized by veterinary and other collaborators to achieve maximum benefit for research (including viral screening and tissue banking), diet determinations, DNA stock identification, and age estimates by skeletochronology. Kaneohe Bay constitutes one of several important long term in-water research sites that have been established in the Hawaiian Islands to monitor FP prevalence and obtain baseline data on the biology, ecology and life history of green turtles (*e.g.*, see Balazs *et al.*, 1994; Aguirre *et al.*, 1994). A goal of this work is to gain insight into habitat-related and other environmental co-factors possibly associated with and responsible for the distribution and prevalence of FP.

RESULTS

As of October 1997, 581 green turtles ranging from 36.1 to 96.0 cm SCL have been captured and tagged in Kaneohe Bay during 87 daily visits since 1989. The recapture of tagged turtles over this nine year period resulted in a total of 777 turtle-capture events. For the 581 individuals identified, 43.9% had FP. The degree of affliction among three assigned FP categories was 1=30%, 2=31%, 3=39%. The annual prevalence of FP ranged from 33 to 60% with no apparent trend exhibited, although occurrence of the most severe cases (category 3) appears to have declined slightly during recent years. Similar findings were made when annual prevalence was examined for all 777 of the turtle-capture events. A significant finding was that 40% of the FP turtles had oral tumors, often associated with and adversely impacting the glottis. This life-threatening manifestation of FP has been documented in 61% of the FP turtles (N=222) necropsied after stranding in the Hawaiian Islands during recent years. No cases of oral tumors have been reported from Florida or elsewhere except for a few in Australia. The detection of changes in FP affliction in individuals over time (mean 2.3 ± 1.8 years) was possible for 89 of the turtles tagged and recaptured in Kaneohe Bay. Only four turtles (4.5%) exhibited a decrease in FP category, while 61 (68.5%) increased in severity and 24 (27.0%) showed no apparent change. Remarkable cases included the FP regression from category 3 to 1 in 16 months of a 58 cm turtle with a concomitant SCL growth of 4.5 cm/yr; and the FP progression from category 1 to 3 in 11 months of a 47 cm turtle with no measurable increase in SCL.

Tumors were often found growing in the axillary of the flippers in addition to the eyes, neck, tail and mouth. Flipper tags were only attached at sites free of tumors after the application of betadine or alcohol. The examination of some tagged and recaptured turtles suggested that tumor growth had been enhanced at the piercing site of the tag. Similar observations were made by Wood and Wood (1993) in green turtles released from the Cayman Turtle Farm. To eliminate this confounding factor, the use of flipper tags has been discontinued in the Hawaiian Islands and replaced exclusively with PIT tags.

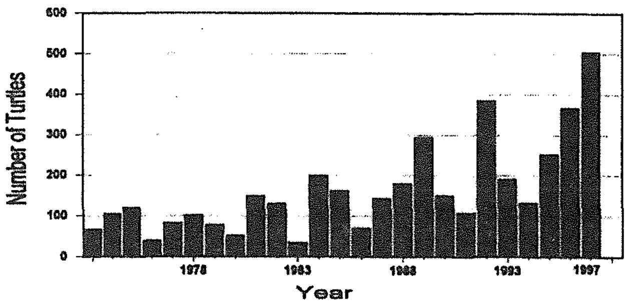

Figure 1.Historical trend for 25 seasons (1973-97) of green turtle nesting at East Island, French Frigate Shoals, in the Northwestern Hawaiian Islands. East Island accounts for 50% or more of all green turtle nesting in the Hawaiian Islands.

Of the 581 turtles tagged, 150 turtles (25.8%) ranging from 36.6 to 73.6 cm yielded SCL recapture data useful for determining rates of growth. A single growth increment was used for each turtle (*i.e.* increase between initial and most recent capture) resulting in an overall mean growth rate of 2.0 ± 1.5 cm/yr. The growth rates of tumored turtles (1.9 ± 1.5 cm/yr, N=89) and non-tumored turtles (2.2 ± 1.4 cm/yr, N=61) were not significantly different ($P< 0.05$). However, a significant difference was found when growth rates in the four FP categories were examined by ANOVA. Duncan-Waller analysis revealed significantly slower growth in FP category 3 (0.9 ± 1.2 cm/yr) in contrast to categories 0, 1 and 2 which were not significantly different from one another (Figure 2). The annual strandings of turtles along the shoreline of Kaneohe Bay from 1989 to 1997 accounted for 21% (range 17-25%) of all cases recorded each year throughout the Hawaiian Islands. The latter has ranged from 122 cases in 1989 to 251 cases in 1996, with an almost consistent annual upward trend. However, no trend has been displayed in the annual percentage of FP cases among these strandings (mean 59%, range 46-69%). The percentage of annual FP cases among the Kaneohe Bay strandings has been

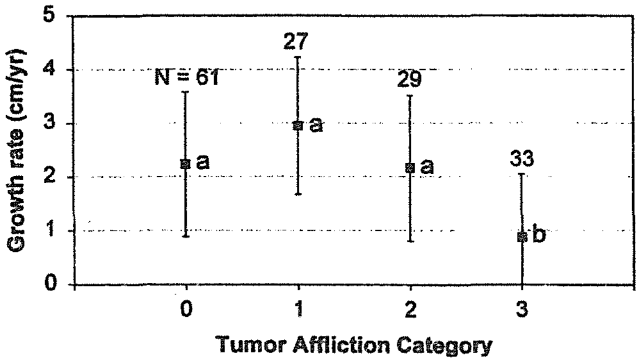

Figure 2.Mean and standard deviation for SCL rates of growth exhibited by four groups of green turtles tagged and recaptured in Kaneohe Bay. 0 = no external tumors, 1 = lightly tumored, 2 = moderately tumored, and 3 = heavily tumored. Means bearing the same alphabet letter (a, b) are not significantly different. No significant interactions were found between SCL 5-cm size classes (35 - 75 cm) and FP categories, hence growth rates shown for FP categories were not significantly influenced by SCL.

consistently higher (mean 73%, FP range 52-92%), but again no trend has been exhibited.

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FIBROPAPILLOMA IN THE OSTIONAL OLIVE RIDLEY (*Lepidochelys olivacea*) POPULATION

Anny Chaves Quiros, Leslie A. du Toit, and Guillermo Marin Whitney Eure
Douglas Robinson Marine Turtle Research Center, Ostional, Costa Rica. turtles@gema.com

At the last workshop on Marine Turtle Fibropapilloma seven years ago, almost all attention to the disease was concentrated on the green turtle, *Chelonia mydas*. Now we are faced with an exaggerated increase in the incidence of fibropapillomatosis in all other marine turtle species other than the Australian flatback (Natator depressa) and the Leatherback (*Dermochelys coriacea*).

The first confirmed report of fibropapilloma in the Ostional Olive Ridley population was a single specimen in 1987. That turtle showed examples of advanced disease with the largest of the tumors measuring 30mm in diameter. Since then, there have been an increased number of observations as well as an increase in size of the individual tumors.

By 1992 the problem had become so apparent that we presented a paper on the subject at the 12th Symposium on Sea Turtle Biology and Conservation. (Chaves, A. and Marin, G., 1992) While we do not know the exact number of diseased turtles, we may safely say that the number affected is rising rapidly.

There is also evidence that the size of the tumors is increasing exponentially to the number of tumors on the individual turtle. Between 1991 and 1993, the average size of tumors found were 10mm in diameter with an average 3 lesions per turtle. In 1997, the average size of the tumors observed was 25mm in diameter, the largest being 140mm, and the number of tumors per turtle upwards of 20. Most of the growths observed were of the "cauliflower" type but the "smooth, golfball" type are also regularly seen.

While most of the observed lesions were on the neck and around the eyes and mouth, there has also been an increase in the number of turtles with tumors appearing on the dorsal carapace margin and between the scoots. These lesions are varied in size with a maximum observed diameter of 20mm.

An intense survey was undertaken in Ostional between July and September of 1997. During this time, blood and tissue samples were taken from seventy two severely affected animals. The turtles were treated during the arribadas occurring in those months and in some cases were re- observed in the following arribadas. In al cases the small biopsy wounds had healed successfully.

From our observations, we have conservatively calculated that approximately 10% of the turtles nesting at Ostional are affected, with 1% being affected severely. While these statistics might appear low, it should be understood that an average of 300 000 turtles nest at Ostional each month. Therefore, the number of affected nesting turtles at Ostional may be more than 30 000. As George Balazs mentioned, it is the severence rather than the number of tumors that is important. This is concurrent with the Ostional data.

It is important to note that there have been no reports of fibropapilomas on stranded, dead turtles at Ostional.

Considering the high number of potential study subjects and the relative ease of access to the site, Ostional should be considered an important location to conduct investigation of fibropapillomatosis. It is critical that funds be secured to initiate long-term funding for this important research.

We gratefully acknowledge the invaluable cooperation of George Balazs of the Southwest Fisheries Science Center Honolulu Laboratory and the World Wildlife Fund, Central America Regional Office.

ADVANCES IN THE DETERMINATION OF DIETARY PROTEIN REQUIREMENTS FOR *AD LIBITUM* FED *LEPIDOCHELYS OLIVACEA* HATCHLINGS

[1]**Martha Harfush[1], Carlos Antonio Martinez-Palacios[2], Elpidio López Reyes[1], and Carlos Rojas[1],**
[1]Centro Mexicano de la Tortuga, Instituto Nacional de la Pesca, P. O. Box 16, Puerto Angel, Oaxaca, 70902 México. cmtharfu@angel.umar.mx
[2]Unidad Mazatlán, en Acuicultura y Manejo Ambiental del Centro de Investigación en Alimentación y Desarrollo A. C. P. O. Box 711, Mazatlán, Sinaloa, 82000, México

INTRODUCTION

The management of an important number of species in captivity is offering unique opportunities in order to achieve different studies helping to better understand some relevant aspects of the cycle of its life; turtles are not the exception, for their raising has been developed in several parts and practically in all the states of development.

In spite of that only recently the raising of marine turtles has allowed us to obtain experiences thanks to which it has been possible to improve the conditions of captivity, we have also been able to study, among other aspects, the quality and temperature of water, some diseases, clinical treatment including surgery, and aspects of feeding, too. On this respect we might mention the works realised with white turtle *Chelonia mydas* in Great Caiman Island and in Isla de la Juventud, Cuba, where they have been working with hawksbill turtle *Eretmochelys imbricata* (Pelegrin *et al.*, 1994). One of the most important aspects in the management of any type of animal is nutrition (Tacon and Cowey, 1985, Tacon 1987), for it is what the health of the biological organism depends on. Consequently, it is obvious to expect that a good feeding, based on each species nutrition requirements will result in strong and healthy organisms.

One of the main reasons to know the best nutrition requirements for marine turtles (and by this to be able to obtain better results from their culture) is its research for conservation. However, we should not avoid other benefits which might be obtained, such as the optimisation of resources in order to save any unnecessary supply of food products (Martínez *et al.*, 1996), reducing captivity maintenance costs, standardising diets, as well as the improvement of sanitary conditions and therefore the reduction in costs of medicine healing treatments.

OBJECTIVES

To determine the optimum protein requirements within the diet provided *ad libitum* during the early culture of olive ridley hatchlings *Lepidochelys olivacea.*

To evaluate the level of protein on above mentioned status where it be obtained the best individual weight gain, the specific growth rate (SGR), food conversion ratio (FCR), survival and protein/energy rate (P:E).

METHODS

Experimental animals: Lepidochelys olivacea hatchlings were taken from "La Escobilla Beach" these were immediately fed with a 38% protein diet; then, when they reached a mean weight of 19,080 mg they were transferred to the Centre experimental system and stocked in a number of 10 turtles per tank.

Experimental diets: Seven experimental diets were formulated with different levels of protein, these variations levels were achieved by replacement of fish, head shrimp and meat meal with dextrin in order to produce isocaloric diets (Table 1). Ingredients were mixed and prepared as described in Martínez *et al.*, 1988.

Experiment protocol: Turtles were fed ad libitum three to four times a day. Feed intake was recorded daily. Each diet was tested in triplicate for 49 days. At the start of the experiment and at subsequent fortnightly intervals, turtles were batch weighted to the nearest two decimal places using and Ohaus balance. At the end of the experiments, turtles were batch weighed.

Statistics methods: Statistical comparisons were made using a one-way analysis of variance. Mean differences between treatments were tested for significance ($P<0.05$) by Duncan's Multiple Range Test. Standard errors (s.e) of means were calculated from the mean-square for error.

RESULTS

The growth response and fortnightly weight increase of *Lepidochelys olivacea* over the experimental period at different protein levels is shown in Figure 1 and Table 2. The best growth response in terms of final body weight was observed with the turtles consuming diet D40 although no significant difference ($P<0.05$) was found with de diet D50, diets D45, D35 and D30, was found no significant difference and the diets D25 and D20 (Table 2), are significant different ($P<0.05$) each other. A similar response was also observed with the weight gain (%) (Table 2).

After realizing the average weight gain broken line analysis against protein level as shown in Figure 2 (Zeitoung *et al*, 1976) a 43% protein requirement value was obtained with a optimum P:E. of 118.48 g protein/Kcal (45%, 7% lipids and 3.79 Kcal/g.

Table 1. Formulation and nutrient content of the experimental diets. All figures quoted except energy are in g kg -1

	Diet						
Formula *	D50	D45	D40	D35	D30	D25	D20
Fish meal	28.57	24.29	20.00	17.14	14.29	10.00	7.14
Head shrimp meal	5.48	7.30	9.13	7.30	5.48	5.48	3.65
Meat meal	25.75	21.88	18.02	15.45	12.87	9.01	6.44
Wheat meal	6.35	6.35	6.35	6.35	6.35	12.69	12.69
Fish oil	1.80	2.11	2.42	2.93	3.43	3.92	4.43
Corn oil	0.90	0.90	0.90	0.90	0.90	0.81	0.81
Dextrin	4.20	10.21	16.23	22.98	29.73	31.14	37.89
Nutrients contents							
Protein	50.00	45.00	40.00	35.00	30.00	25.00	20.00
Lipids	7.00	7.00	7.00	7.00	7.00	7.00	7.00
Fibre	2.62	2.78	2.94	2.65	2.35	2.42	2.13
Ash	8.22	7.52	6.82	5.82	4.83	3.81	2.81
NFE	23.91	23.44	22.96	22.50	22.04	26.58	26.12
ME(Kcal/100g)	382.89	379.78	376.67	376.18	375.70	374.01	373.52
Protein**	49.87	43.19	39.57	34.92	27.73	23.89	18.15

* Fixed ingredients present in all diets were 8.96 g kg^{-1} Soya meal, 3.38 g kg^{-1} Spinach meal, 10.57 g kg^{-1} Corn meal, 0.01 g kg^{-1} BHT, 1 g kg^{-1} Lecithin, 0.10 g kg^{-1} Vitamins prepared mixture, 0.20 g kg^{-1} Minerals prepared mixture, 0.12 g kg^{-1} Vitamin C, 0.02 g kg^{-1} Coline, 0.02 g kg^{-1}, $CaCO_3$ 0.50 g kg^{-1}, $CaHPO_4$ 0.10 g kg^{-1} y Carboximetil cellulose 2g kg^{-1}.

** From proximate analysis (A.O.A.C. 1984).

Table 2: Mean Growth performance of Lepidochelys olivacea fed to satiation

	Diet						
	50	45	40	35	30	25	20
Survival (%)	96.67	80.00	100.00	90.00	96.67	93.33	80
Initial weight (mg)	19,080	19,077	19,077	19,067	19,083	19,043	19,073
Average initial weight (mg)	1,908	1,908	1,908	1,907	1,908	1,904	1,907
Final weight (mg)	52,807	39,843	51,480	38,438	39,160	32,970	23,313
Average final weight (mg)	5,470	5,002	5,148	4,252	4,048	3,536	2,902
Weight gain (%)	186.69	162.19	169.86	123.03	112.14	85.66	52.14
Individual weight gain (mg/day)	42.41	36.83	38.58	27.93	25.48	19.42	11.84
Ind. fd cons. (mg/day)	359.30	374.70	352.34	332.15	307.21	292.54	286.1
S.G.R. (%/day)	1.25	1.15	1.18	0.95	0.90	0.74	0.5
FCR	0.856	1.017	0.914	1.196	1.207	1.509	2.474

DISCUSSION AND CONCLUSION

As it was already mentioned, the works carried out about nutrition in marine turtles are still few, but coincides about pointing out a high requirement protein for those species of carnivorous preferences like the carried out with hawksbill turtle (*Eretmochelys imbricata*) by Pelegrin and collaborators (1994) who compared two diets with 40-45% protein against meal fish.

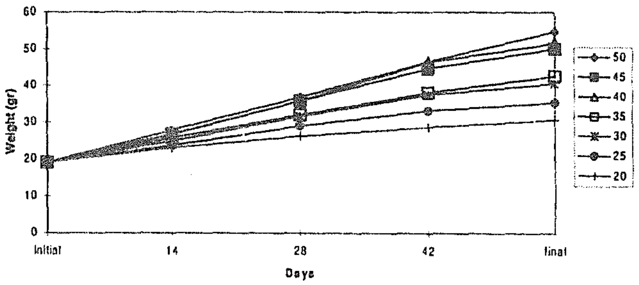

Figure 1: Average individual growth in grams observed in olive ridley hatchlings fed with different levels of protein during the experiment.

In the wilderness numerous studies have also been done in order to know more about the feeding of the turtles, such as the one carried out by Bjorndal (1995) and Balazs (1995). It has also been observed that some hatchlings eat plankton organisms (Mortimer, 1995). However, at any experiment level there is still a lot of work to do with different species in order to make a comparison between carnivorous/herbivorous resulting in a high quality food.

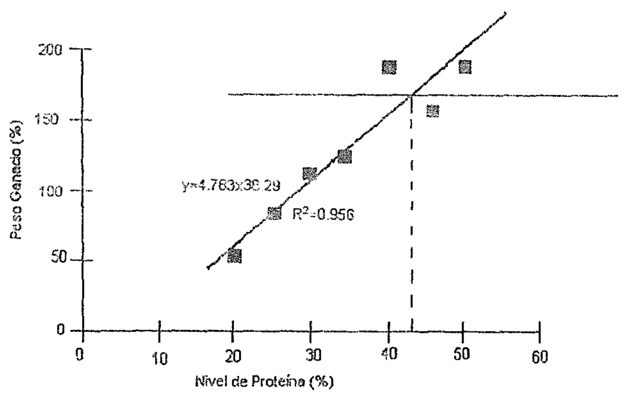

Figure 2. Average weight gain broken-line analysis (%) for L. olivacea hatchlings against percentage of dietary protein level.

Under the *ad libitum* feeding an optimum growth was obtained in *Lepidochelys olivacea* hatchlings with a 43% protein level (Figure 2). This protein level was also providing a maximum efficiency in the consumption of food. From a 45% protein diet, which was the more convenient for the maximum requirement found, a P:E value obtained was 118.18 g of protein/Kcal. Other researchers have suggested that the *Lepidochelys olivacea* is requiring a higher contents of protein due to the fact that it is considered preferentially carnivorous (Márquez, *et al.*, 1976; Mortimer, 1995), in comparison with other species of marine turtles such as green or black turtles which are preferentially considered as herbivorous (Bjorndal, 1995; Balazs, 1979; Mortimer 1995).

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VOLVULUS IN THE DUODENUM FROM FREE LIVING GREEN SEA TURTLES (*CHELONIA MYDAS*) AS A PROBABLE CONSEQUENCE OF HERBIVORY

Carlos R. Hasbún[1,2], Jaime H. Samour[1], Saif Al-Ghais[1], and Andrew J. Lawrence[2]

[1] Environmental Research and Wildlife Development Agency, P. O. Box 45553, Abu Dhabi, United Arab Emirates. c.hasbun@biosci.hull.ac.uk

[2] Department of Biological Sciences, University of Hull, Hull, HU6 7RX, U.K.

The recently created Environmental Research and Wildlife Development Agency of the United Arab Emirates performed during May and August of 1977, post-mortem examinations on stranded green sea turtles found in Ras Al Khaimah. From ten carcasses found fresh enough to permit adequate analyses of mortality, three died of an apparent natural cause, findings which are here presented. Full stomachs on all individuals were observed, being composed of fresh seagrass (99%) and presenting a clear duodenal volvulus extending over an area of approximately 100 cm. Duodenum appeared empty and necrotic with diffuse purple-black mucous. No apparent signs of acute endoparasitisim, obstruction by foreign objects, or other disorders were observed.

In all cases, duodenal volvulus was diagnosed, the cause of which may have been dietary in origin. The rise in water temperature, with an associated rise in the temperature of seagrass, thus enhancing the over-fermentation of ingests with the subsequent liberation of excessive amounts of gas is discussed as the probable cause of volvulus formation.

LESIONS, PATHOGENS AND TOXINS IDENTIFIED IN 13 STRANDED MARINE TURTLES IN FLORIDA

Bruce L. Homer[1], Allen Foley[2], Kristin J. Fick[3], Matilde C. Lores[3], Anthony E. Redlow[2], and Elliott R. Jacobson[4]

[1]College of Veterinary Medicine, University of Florida, PO Box 100145, Gainesville, FL, 32610-0145 U.S.A. homerb@mail.vetmed.ufl.edu

[2]Florida Marine Research Institute, St. Petersburg, FL, U.S.A.

[3]Florida Marine Research Institute, Tequesta, FL, U.S.A.

[4]College of Veterinary Medicine, Gainesville, FL, U.S.A.

Thirteen marine turtles (8 *Caretta caretta* and 5 *Chelonia mydas*) stranding along the east coast and southwest coast of Florida were necropsied and evaluated for potential pathogens and toxins. Sizes of the necropsied turtles ranged from 27 to 104 cm (straight carapace length).

Representative sections of all identified organs were collected and evaluated by light microscopy. Swabs of the choanae and distal bowel, and grossly abnormal organs were analyzed for bacteria and fungi. Sections of liver and kidney were frozen and then analyzed for concentrations of 22 metals. The primary lesions in five turtles were mainly associated with trauma that included boat-related injuries (n=3), penetration of the larynx by a fish hook (n=1) and strangulation by the buoy rope of a lobster pot (n=1). The primary lesions in four turtles were mainly associated with gastroenteritis. The pathogens identified in intestinal isolates from these turtles were *Listonella damsela*, *Shewanella putrefaciens*, and/or *Morganella morganii*. The primary lesions in the remaining four turtles were mainly associated with systemic fungal infections by *Paecilomyces* sp. (n=2) or with shell (n=1) or cutaneous (n=1) necrosis and inflammation. The causes of death were determined to be septicemia (n=9), severe enteritis (n=3), and acute renal necrosis and renal failure (n=1). Concentrations of eight metals were considered to be elevated in one or more turtles, including (ranges reported in ppm): aluminum (1.2-22 in liver; 0.97-2.5 in kidney); arsenic (1.0-18 in liver; <1.0-23 in kidney); cadmium (0.89-29 in liver; 0.97-73 in kidney); copper (2.9-60 in liver; <0.10-2.0 in kidney); iron (97-7600 in liver; 11-120 in kidney); mercury (0.12-2.9 in liver; <0.02-4.3 in kidney); selenium (0.13-21 in liver; 0.06-13 in kidney); and zinc (18-56 in liver; 10-51 in kidney). Metal toxicity may have been a factor in the demise of several turtles.

CONTAMINATION BY PHTHALATE ESTER PLASTICIZERS IN TWO MARINE TURTLE SPECIES

J. Arturo Juárez Cerón[1], Ana R. Barragán Rocha[1], and Humberto Gómez Ruiz[2]
[1] Laboratorio de Tortugas Marinas, Facultad de Ciencias, UNAM. México. mcart@rocketmail.com
[2] Laboratorio de Espectrometría de Masas, Facultad de Química, UNAM, México

It is well known how man has affected the survival of all sea turtle species because of egg poaching, incidental capture of adults in fisheries, loss of nesting habitat, etc. Nevertheless, researchers have not paid a lot of attention to the possible effects of pollutants on sea turtle biology.

Until very recently, plastics were considered little more than physical pollutants with isolated importance in certain areas. However, their role as chemical sources of pollution is beginning to be understood. Phthalates and hydroquinones are anthropogenic molecules widely used in the plastic industry, and are easily released in any medium. Experiments showed that phthalates are highly toxic, with important effects on the reproductive biology of organisms and have been considered estrogenic, cancerogenic, orchidotoxic and mutagenic (Giam, *et al.*, 1978; Jobling, *et al.*, 1995). Reports on phthalate concentrations in the Atlantic Ocean, regard them as higher than those of DDT's or PCB's (Giam *et al.*, 1978).

For several nesting beaches in countries like Costa Rica (Hirth, 1987) and Mexico (Sarti *et al.*, 1994), the most common debris found are plastics. Carr (1986, 1987a and 1987b) explained how juvenile turtles behave as passive migrants, converging in the great oceanic currents with their food source, and unfortunately also with a large variety of debris which increase the possibility of ingestion of plastics. There is a large amount of reports of adult sea turtles ingesting plastics (Mrosovsky, 1981; Den Hartog and Van Nierop, 1984; Barragán *et al.*, 1992 among others), and all of them conclude that plastic may have a detrimental effect in the health of the animals. However, there is almost no information on the exact effect of plastics on the turtle's physiology.

In this study, we analyzed samples of egg yolk of two sea turtle species, leatherback turtle (*Dermochelys coriacea*) and olive ridley (*Lepidochelys olivacea*), in search of potentially harmful substances stored among the lipid contents.

METHODS

We sampled one egg from each of 11 clutches of *L. olivacea* and one egg from each of 14 clutches of *D. coriacea*. After extraction of lipids with hexane and saponification, the samples were analyzed in a gas chromatograph coupled to a mass spectrometer. The details of this method are described in Juárez (1998).

RESULTS

We found several chemical pollutants that came from plastic ingestion in 42.8% of the leatherback samples and in 27.3% of the ridley samples. Such molecules are noteworthy not only because of their presence, but also because they were found in the egg, which means that they found their way through the lipid physiology of the mother and through vitellogenesis.

The substances were divided in two categories:

a) Phthalates, which include Dimethyl-phthalate, Dibutyl-phthalate and Dioctyl-phthalate in 21.4% of the leatherback samples, and Dioctyl-phthalate in 9.1% of the ridley samples. All this substances are used in the manufacture of plastics, as plasticizer molecules.

b) Antioxidants (AO), compounds derived from naftoquinones such as Terbutyl-toluene and Butyl-toluene. These molecules are used in industry to prevent the oxidation of a polymer and polymerization of its precursors. We found six antioxidants, with as much as four different kinds in each species.

The relative percentage of the pollutants, represented by the size of their chromatographic peaks (Figure 1), show proportions similar or higher than the ones for the rest of the compounds in the non-saponifiable fraction. This could indicate that sea turtles act as "biomagnifiers", accumulating toxic molecules in their tissues.

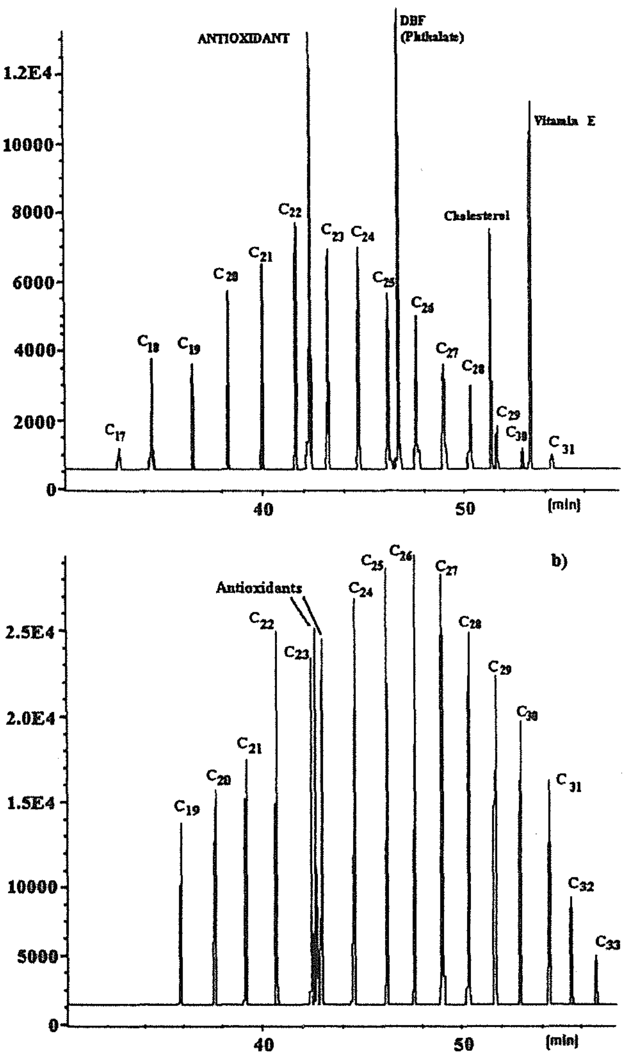

Figure 1. Reconstruction of chromatograms of the non-saponifiable fraction in the yolk of two sea turtle species a) Dermochelys coriacea and b) Lepidochelys olivacea. Observe the size of the peaks that correspond to pollutants (AO y DBF) in comparison to the rest of the molecules.

CONCLUSIONS

The presence of plastic chemical pollutants in the yolk of sea turtle eggs shows that these molecules are capable of being transported from the gut to all the system responsible of processing lipids, and permeate through vitellogenesis. Since this is a vital process in reproductive biology, these findings alert about a kind of impact of pollutants in sea turtle biology that is poorly understood.

It is evident that the consequences of plastic ingestion for sea turtles may go beyond the mere blocking of the gut. Plastic pollutants could affect the fitness of populations by altering the reproductive functions and have a possible cumulative effect for generations, as reported for other vertebrates. More research is essential to reveal the true effect of phthalates and hydroquinones on the embryo development and reproductive physiology of sea turtles. It is also important to determine the minimum concentrations of these pollutants that can have a detrimental effect in a living organism.

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MERCURY CONCENTRATION IN SCUTE SCRAPINGS OF SEA TURTLES IN THE GULF OF MEXICO

Stephanie M. Presti[1], Andre M. Landry[2], and Albert E. Sollod[1]
[1]Dept. of Environmental and Population Health, Tufts University School of Veterinary Medicine, 200 Westboro Rd. N. Grafton, MA 01519. spresti@opal.tufts.edu
[2]Sea Turtle and Fisheries Ecology, Texas A&M University at Galveston Galveston, TX 77551

Phlebotomy has been the only technique used in the past for detecting the accumulation of mercury, a toxic environmental contaminant, in live sea turtles. This study was undertaken to demonstrate whether sufficient levels of mercury could be detected in the keratinized scutes of the carapace to be useful as a non-invasive test for this, and possibly other heavy metals. Eighty-two sea turtles, caught at Sabine Pass on the Gulf coast of Texas and Louisiana, were sampled by phlebotomy and scute scraping. The species sampled included seventy-six Kemp's Ridleys (*Lepidochelys kempi*), three Loggerheads (*Caretta caretta*), two Hawksbills (*Eretmochelys imbricata*) and one Green sea turtle (*Chelonia mydas*). Differences in mercury concentrations were noted between the different species which may be due to differences in foraging ecology. Differences were also noted between different size classes. In the larger turtles sampled, the concentrations of mercury in the keratin tended to increase with the size of the carapace. It was demonstrated that mercury concentration in the keratin was up to 7,486 ppb, and on average 36 times higher than in the blood. Scute mercury levels were also 5.2 times higher than previously reported in kidney, and 2.4 times higher than in liver. It was concluded that scute scraping could be a highly sensitive, non-invasive technique for monitoring mercury in live sea turtles.

MORPHOLOGIC AND CYTOCHEMICAL CHARACTERISTICS OF BLOOD CELLS FROM THE GREEN TURTLE, *CHELONIA MYDAS*, IN THE HAWAIIAN ISLANDS

Thierry M. Work[1], Rose E. Raskin[2], George H. Balazs[3], and Scott Whittaker[4]
[1]U.S. Geological Survey, Biological Resource Division, National Wildlife Health Center, Honolulu Field Station, PO Box 50167, Honolulu, HI 96850, U.S.A.
[2]University of Florida, Department of Physiological Sciences, College of Veterinary Medicine, Gainesville, FL 32610, U.S.A.
[3]National Marine Fisheries Service, Southwest Fisheries Science Center, Honolulu Laboratory, 2570 Dole St., Honolulu, HI 96822, U.S.A.
[4]University of Florida, Electron Microscopy Core Laboratory, Interdisciplinary Center for Biotechnology Research, Gainesville, FL 32611, U.S.A. thierry_work@usgs.gov

We tried to identify and characterize blood cells from free-ranging Hawaiian green turtles, *Chelonia mydas*, in order to standardize nomenclature. To do this, we examined blood from a total of 26 green turtles from Puako on the island of Hawaii and Kaneohe Bay on the island of Oahu. Blood was examined using a combination of light and electron microscopy and cytochemical stains including benzidine peroxidase (PER), chloroacetate esterase (CAE), alpha naphthyl butyrate esterase (NBE), acid phosphatase (ACP), Sudan black B (SBB), periodic acid-Schiff (PAS), and toluidine blue (TB). We recognized 6 types of leukocytes including lymphocytes, monocytes, thrombocytes, heterophils, basophils, and small and large eosinophils. Cell morphology of mononuclears and most granulocytes were similar to that of other reptiles except that green turtles have both large and small eosinophils. Our classification of green turtle blood cells clarifies improper nomenclature reported previously and provides a standard base of reference for future hematologic studies in this species and allows for hematologic comparison of healthy and unhealthy aggregations.

SEX RATIOS OF FORAGING SEA TURTLES IN THE PAMLICO-ALBEMARLE ESTUARINE COMPLEX, NORTH CAROLINA, U.S.A.

Joanne Braun-McNeill[1], Sheryan P. Epperly[1], David W. Owens[2], and Rhonda W. Patterson[2]
[1]NOAA, National Marine Fisheries Service, Southeast Fisheries Science Center, Beaufort, NC 26516, U.S.A. jbraun@hatteras.bea.nmfs.gov
[2]Department of Biology, Texas A&M University, College Station, TX 77843, U.S.A.

INTRODUCTION

The natural sex ratios of sea turtles have been of interest since the discovery of temperature-dependent sex determination (TSD) in sea turtles (Owens and Hendrickson, 1978). It is possible that the sex ratio within a management unit is dynamic, varying among cohorts. Studies have shown that adult populations are difficult to evaluate for sex ratios due to various sex-determined behaviors (Wibbels *et al.*, 1987). Likewise, the sex ratios of hatchling populations can vary depending upon the geographic location or the time of year (*i.e.*, incubation temperature) the eggs are laid. In theory, an immature stage of a sea turtle population has not developed such behavior biases and is thus more likely to reveal the actual sex ratio for that population. In addition, the benthic immature life stage represents a condensation of many years of hatchling production (Wibbels *et al.*, 1987). Interestingly, most sex ratios of sea turtle populations described to date have been fairly close to 1:1, or up to a bias of about 1.9:1 (Owens, 1996).

The purpose of this poster is to report on the sex ratio results of the foraging populations in Pamlico and Core Sounds, N. C., 1995-1997. These data were collected while sampling the catches of pound nets set in these sounds.

METHODS

Blood samples were drawn from the dorsocervical sinus or from the jugular vein, and were analyzed to determine testosterone titers of the individual. In 1995 and 1996, one 4 cc sample of blood was drawn within 30 minutes of possession of the turtle. In 1997, two 4 cc samples of blood were drawn from each turtle (N=139) - one immediately upon possession of the turtle (sample A), the second within 30 minutes of possession (sample B) - to determine affects of stress on testosterone levels and sexing results. A serum androgen sexing technique was used to sex the sea turtles following a testosterone radioimmunoassay procedure (Wibbels *et al.*, 1987; Owens, 1996; Valverde, 1996).

The sex ratios for both loggerhead and green sea turtles in 1995 and 1996 (Bass *et al., in press*) were the most skewed sex ratios yet published for a foraging population (Owens, 1996). In order to confirm serum androgen sexing technique results, surgical observation of the gonad was performed in November 1997 on 47 loggerheads, 7 greens and one Kemp's ridley via a laparoscopic entry into the peritoneum (Wood *et al.*, 1983). Visual differentiation of the ovary and testis was based on the ovaries lumpy appearance with underlying primordial follicles in contrast to the seminiferous tubules underlying the smoother stroma of the testis. Only in the very small green sea turtles was this distinction a problem.

RESULTS AND DISCUSSION

We confirmed the sex of 47 loggerheads, 6 greens (the sex of one very small (SCL=24.8 cm) green could not be determined) and one Kemp's ridley through laparoscopic examination of the gonads. The testosterone titers of all 32 female loggerheads were < 20 pg/ml, but 9 of the 15 male loggerheads had testosterone titers < 30 pg/ml. Based on green sea turtle testosterone titers, the 1 male (> 20 pg/ml) and 5 females (< 10 pg/ml) would have been classified correctly. The Kemp's ridley was a female. Although serum testosterone titer has been determined to be an accurate indicator of the sex of immature sea turtles, testosterone levels in immature turtles vary directly with ambient temperature (Owens, 1996). Cooler temperatures depress testosterone titers, thus biasing results against males (towards unknowns and females). We believe the cold water temperatures at which the lap'd turtles were captured (<20°C) depressed testosterone titers. As water temperatures decreased throughout the season, the testosterone levels of all turtles captured likewise decreased (Figures 1-2), as evidenced by the misclassification of 9 male loggerheads.

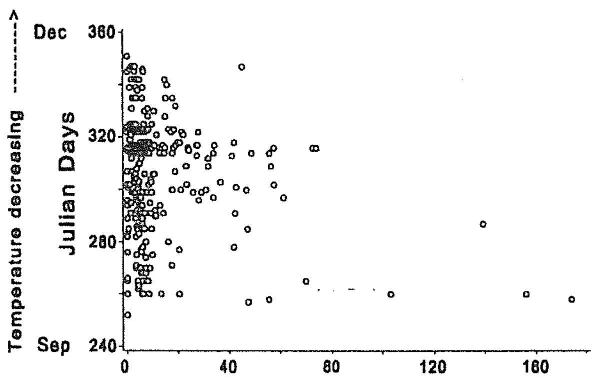

Figure 1. Testosterone titers of loggerhead (Caretta caretta) sea turtles captured 1995-1997.

To determine whether testosterone titers were being depressed by cold water temperatures (<20°C - temperature minima of previous sex ratio studies typically were 15-18°C), we used the lowest testosterone level of a confirmed (lap'd)

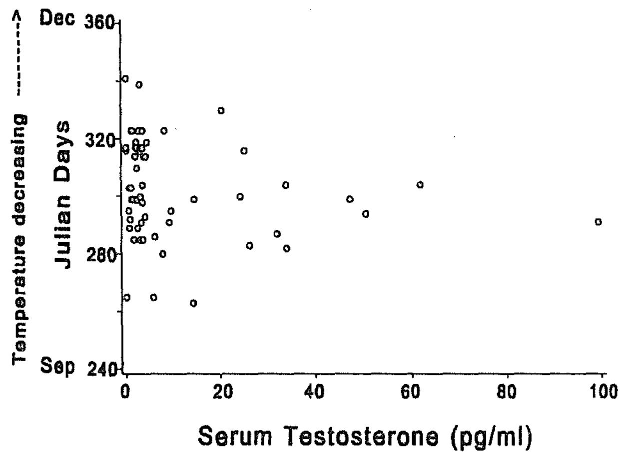

Figure 2. Testosterone titers of green (Chelonia mydas) sea turtles captured 1995-1997.

male loggerhead (6.1 pg/ml) as the threshold for determining females (0-6.0 pg/ml) and the highest testosterone level of a confirmed (lap'd) female loggerhead (14.7 pg/ml) as the threshold for determining males (14.8 pg/ml and higher). We determined that 21 of 25 lap'd loggerheads that could not be categorized based on testosterone titer were female and that 4 of the 25 were male. We applied these ratios to all uncategorized loggerheads caught in cold water during 1997, resulting in a total of 69% female. For loggerheads caught in warm water (>20°C) (n=26), we applied the testosterone thresholds of Owens (1996). The results indicated 69% were female (with only one unknown). By eliminating loggerheads captured when water temperatures were <20°C, we saw similar sex ratiosfor 1995 and 1996, and across all 3 years (Table 1).

Table 1. Predicted sex of loggerhead and green turtles foraging in the Pamlico-Albemarle Estuarine Complex, North Carolina.*

Year/Sex	Species: Loggerhead	Green
1995 N	18	8
%Female	61.1	87.5
%Male	22.2	12.5
%Unknown	16.7	0.0
1996 N	18	0
%Female	83.3	-
%Male	16.7	-
%Unknown	0.0	-
1997 N	26	4
%Female	69.2	50.0
%Male	26.9	25.0
%Unknown	3.8	25.0
1995-1997 N	62	12
%Female	71.0	75.0
%Male	22.6	16.7
%Unknown	6.5	8.3

** Sea turtles captured in water temperatures > 20°C*

Since we confirmed the sex of only 6 green turtles and their corresponding testosterone titers did not overlap, we did not apply a cold water correction to green sea turtles. However, testosterone levels of green sea turtles also decreased as water temperatures decreased (Figure 2). Thus we conclude that the sex determination of immature sea turtles caught in warm waters may be accurate, but caution should be used when applying this technique to loggerhead and green turtles caught in cold water (<20°C).

No significant changes in testosterone titer occurred between blood samples taken immediately upon possession of the turtle and those taken within 30 minutes (N=139, P=0.16). Wibbels *et al.* (1985) had similar results with immature loggerheads captured via trawler or pound net in Florida and Virginia, and suggested that the titers of samples taken near the time of capture should not be influenced by the stress associated with capture.

Pound nets are not set in abundance until the fall when the sounds' fauna begin emigrating due to decreasing water temperatures. Thus, most of the turtles were captured in water < 20°C. We plan to increase the number of sea turtles captured and lap'd when waters are > 20°C to determine if a female bias holds true.

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PRIMARY EVIDENCE OF SPERM STORAGE IN THE OVARIES OF THE OLIVE RIDLEY MARINE TURTLE (LEPIDOCHELYS OLIVACEA)

Anny Chaves[1], Margarita Arana[2], and Leslie du Toit[1]
[1]Douglas Robinson Marine Turtle Research Center. Ostional, Costa Rica.
[2]Biology Dpt., Universidad Peruana Cayetano Heredia. Lima, Perú. turtles@gema.com

The possibility that marine turtles are able to store sperm and later fertilize the eggs, has been proposed by various authors (Ehrhart, 1982, Owens, 1980). However, it has not been possible find a storage structure in the female (Fox, 1977) although there have been observations of sperm in the oviduct (Owens, 1980, Solomon and Baird, 1979, Chaves and Jaen,1986). Neither has it been possible to clarify the temporal relationship between the moment of fertilization to ovulation and the migration of the ovules to the oviduct.

Samples of the ovary and oviduct were taken from a recently deceased turtle found on the beach after an arribada. The samples were fixed in formalin (10%) and, 24 hours later, were processed and ready for the scanning electron microscope (SEM).

The oviducts contained 107 fully developed eggs (with shells) ready to be deposited (50 and 57 eggs in each oviduct). Also observed in the ovaries were developing ovules which were between 15 and 20 mm in diameter, recent scars 15 mm in diameter and numerous "corpus albicans".

Once analysed under the SEM, the ovary showed a multi-folded wall covered with different sized folicules. Attached to the walls were eggs of various sizes, many of which were in a state of calcification.

Observed at this point of the ovary were a number of spermatozoids of which the flagella, head and neck could be clearly identified.

The early calcification of the eggs indicates that by necessity they should be fertilized before their migration to the oviduct. The samples of oviduct wall show it to be completely ciliated, which indicates the function of facilitating the transport of the spermatazoids to the ovary.

The presence of spermatazoids in the oviduct might be the first evidence to support the hypothesis of sperm storage and retarded

The poster will present SEM photos of the spermatazoids in the ovary and the ultra structure of the ovary and oviduct.

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COMPARISON OF TECHNIQUES USED TO SEX LEATHERBACK HATCHLINGS

Leticia Gámez[1], Cristina Ordóñez[1], and Miriam Benabib[2]
[1] Programa de Tortugas Marinas, Facultad de Ciencias, UNAM, México D. F. 04510. lsm@hp.fciencias.unam.mx
[2] Instituto de Ecología, UNAM. Apdo. Postal 70-275, México D. F. 04510

INTRODUCTION

Identifying the sex of hatchlings and juveniles is an important limiting factor in the studies of sex determination of sea turtles. Because secondary sexual characters are not yet developed, sex has to be identified by anatomical and histological studies of the gonads. Basically, there are two techniques most widely used to sex hatchlings that depend on the processing of the gonads:

a) *Histology*: involves embedding the tissue either in paraffin or in epon to obtain sections of the gonads for their observation in the microscope; b) *Tissue clearing*: it consists in rendering the gonad transparent with a solution of glycerin and formalin, for its observation in the stereoscopic microscope. There are several criteria for the identification of sex with this technique.

The clearing technique has several advantages over the histological technique, mainly that it is faster and cheaper. However, questions have been raised repeatedly about the validity of the results obtained with the clearing technique.

Problems seem to arise in particular when working with the leatherback turtle (*Dermochelys coriacea*), whose hatchlings seem to have very undifferentiated gonads. Due to the diversity of sexing criteria, it is important to compare the histological and the clearing techniques in gonads of the same individuals, to define which technique would be advisable to sex gonads of hatchlings of the leatherback turtle.

OBJECTIVE

To evaluate the equivalency of the histological and the clearing techniques for the identification of sex of leatherback hatchlings.

STUDY AREA

Field work was done in Playón de Mexiquillo, Municipio de Aquila, in the state of Michoacán, México. It is found in the central part of the coast of Michoacán, 80 km NW of Ciudad Lázaro Cárdenas. The beach is approximately 18 km long, running from the rocky shore named "La Punta", up the creek "La Manzanilla. " The study area included approximately 6.6 km, from the SE end of the beach (La Punta), up the estero named "La Majahua", to the NW. A base camp was located in the site known as "El Farito".

METHODS

During the nesting season of the leatherback turtle (October to February) of the years 1992-1993, nests were collected in the beach as part of a permanent conservation program, and kept in a protected corral at "el Farito. " After 55 to 60 days of incubation, once emerged from the nests, 79 hatchlings were collected at random from 31 different nests. Twenty six of those hatchlings were sacrificed by decapitation, and dissected immediately to take out the gonads attached to the kidneys. One gonad of each hatchling was put in Karnovsky's fixative, and later embedded in epon in the laboratory. Transversal histological sections of 1 to 2 microns were obtained of the anterior and median part of the gonad, and stained with Toluidine blue 0.5%. The other gonad was fixed in 10% formalin in phosphate buffer 1 M, and cleared with glycerin according to the technique described by Van der Heiden *et al.* (1985), using a 5% glycerin solution in 4% formalin in phosphate buffer 1 M. The remaining 53 hatchlings were sacrificed with an injection of 0.1 ml sodium pentobarbital (Anestesal) in the spinal cord. These hatchlings were then fixed in 10% formalin in phosphate buffer 1 m. The animals were dissected in the laboratory: one gonad was embedded in paraffin, and 6-7 microns sections obtained, which were stained either with hematoxylin-eosine, or with Pas+; the other gonad was cleared with glycerin. The cleared gonads were observed using a stereoscopic dissection microscope, and the sectioned gonads were observed with a light transmission microscope.

The histological characteristics taken into account to sex the gonads were those proposed by Yntema and Mrosovsky (1980). The characteristics used to sex the cleared gonads were those described by Benabib (1984), Van der Heiden *et al.* (1985), and Briseño (pers. comm.). Three types of gonads were distinguished among the histological sections: immature ovary, immature testis, and ovotestis. The characteristics used to identify each were the following: **Immature ovary**. - The external surface of the gonad (germinal epithelium or cortex) is markedly thickened. The germinal cells, if any, are located in the superficial epithelium. The medulla starts to look fragmented to form medullar cords, and the blood vessels are distributed mainly in the central region of the gonad. The epithelium is separated from the medulla by a tunica albuginea. **Immature testis**. - The germinal epithelium is formed by a single row of cells, therefore being thinner than in the ovary. It has been reported that the testis presents medullar cords that appear continuous with the external epithelium of the gonad, and that a few germinal cells may be observed in those cords, but most germinal cells are in the superficial epithelium. However, in our samples we observed these characteristics only in one ovotestis; in most gonads classified as male, we found a dense medulla and a simple epithelium surrounding it. The blood vessels were located mainly in the periphery of the gonad. **Ovotestis**. - Presents characteristics of both sexes in different combinations.

The criteria of Benabib (1984) used to sex the cleared gonads were: **Immature ovary**. - The gonad is completely transparent, with no evident internal structures. **Immature testis**. - The gonad has tubular internal structures, that may be colored (red or brown), or not. **Ovotestis**. - The gonad has a combination of characteristics of the female and the male gonads, with completely transparent areas, areas with tubular structures, and/or with areas were the tubular structures are very loosely and incompletely distributed.

The criteria of Van der Heiden *et al.* (1985) to sex the cleared gonads were the following: **Ovary**. - The lateral edges of the gonad are serrated, the central part of the gonad is less opaque than the borders, and no internal structures are evident. **Testis**. - The surface of the gonad is smooth, and presents different patterns of granulation.

The third set of criteria (Briseño, pers. comm.) used to sex the cleared gonads included the following: **Ovary**. - The gonad presents numerous foldings in its edges, and the central area is less opaque than the rest of the gonad. **Testis**. - The edge of the gonad is smooth.

The morphological characteristics used by Rimblot *et al.* (1985) to sex the gonads were: **Ovary**. - The gonad is relatively long and thin, and its edge is smooth. **Testis**. - The gonad is relatively thick, the surface is irregular, with transversal grooves.

Table 1. Sexing results obtained

Species	Immature testis	Immature ovaries	Ovotestis	Total
D. coriacea	20	42	7	69

Table 2. Sexing results obtained with the different criteria using the glycerin clearing technique

Criteria	Immature testis	Immature ovaries	Ovotestis	Ambiguous	Total
Benabib	12	57	6	0	75
Briseño	10	14	2	0	26
Van der Heiden *et al.*	6	15	0	54	75
Rimblot *et al.*	2	10	0	37	49

sex ratio of 5:6, thus, having a bias toward the production of more females. We observed a high proportion of ovotestis (9.86%; Table 1). Each criteria used to sex the glycerin cleared gonads, rendered different sex ratios (Table 2). All of these criteria tended to underestimate the number of male gonads as compared to the histological technique. The only criteria that detected ovotestis were those of Benabib (1984) and Briseño. The criteria reported by Van der Heiden *et al.* (1985), and Rimblot *et al.* (1985), were not reliable in the sense that a large proportion of gonads from the sample could not be sexed because they did not present the combination of characters that supposedly describes each sex, and therefore, were classified as ambiguous.

The sex of the gonads identified with histological sections, was compared, one by one, with the sex obtained for those specimens using the different criteria used to sex the cleared gonads. In the best case, only 66.6% of the sex of the gonads in a sub-sample of 21 gonads sexed by R. Briseño, coincided with their sex identified with histology (Table 3). However, the criteria used by R. Briseño could not be reproduced by us to give us the same sex in each gonad. Using a sample of 70 gonads, the best approximation to the results obtained with histology, was a 40% coincidence with the criteria used by Benabib (1984).

DISCUSSION

The histological sections of the gonads showed the characteristics of the epithelium commonly used to distinguish each sex (*i.e.* a pseudostratified, thick epithelium in females, and a simple, thin epithelium in males). However, we could not identify seminiferous tubules as reported in males of other species, and only in a few cases, differences in the structure of the medulla of each sex could be detected. Therefore, the identification of the sex of the gonads processed histologically was based mainly on the epithelium. It is still a problem the interpretation of the characteristics observed in gonads classified as ovotestis, mainly because of the little differentiation shown by gonads of recently hatched leatherback turtles. Therefore, we use the terms immature ovary, immature testis, and ovotestis.

Until now, it had not been described the high amount of vascularization present in the gonads at this stage of differentiation. The general observation was that immature ovaries have a central vascularization, and that blood vessels in immature testes tend to be in the periphery. Probably, this vascularization corresponds to the internal tubular structures, interpreted as characteristic of the glycerin cleared testes.

There was a high discrepancy in the criteria, and therefore the results obtained, when sexing the glycerin cleared gonads. Therefore, we suggest to keep using histology to identify the sex of recently hatched leatherback turtles, at least until more accurate criteria for the identification of sex in cleared gonads are described.

Table 3. Comparison of the results obtained when sexing with histology versus the different criteria used for sexing cleared gonads

Compared criteria	# of gonads whose sex coincide	# of gonads whose sex do not coincide
Histology vs. Benabib	28	42
Histology vs. Van der Heiden *et al.*	10	60
Histology vs. Rimblot *et al.*	11	38
Histology vs. Briseño	14	7
Van der Heiden *et al.* vs. Briseño	8	13
Benabib vs. Van der Heiden *et al.*	14	56
Benabib vs. Rimblot *et al.*	10	39
Benabib vs. Briseño	8	13

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CORNEAL STRUCTURES AND DENTIGENOUS LAMINA IN THE MOUTH OF THE MARINE TURTLE *CARETTA CARETTA* (LINNAEUS,1758)

C. Mendoza[1], Ma. Abaurrea[2], and L. Gállego[1]
[1]Zoology Laboratory, Department of Animal Biology, The Balearic Island University, 07071 Palma de Mallorca, Spain
[2]Department of Cellular Biology, Granada University, 18071- Granada, Spain. *dbalgc0@ps.uib.es*

From the dissections of various examples of *Caretta caretta* frozen post-mortum, we describe the arrangement of the corneal cover which forms the beak of the turtle and covers the bones of both mandibles. The differences in thickness in the distinct regions of the mouth permit the animal to grind-up very hard foods, such as the shells of notably sized mollusks.

Although the corneal cover does wear with use, it maintains a size proportional to that of the animal; the older the individual, the greater size the cover. This indicates that the rate of cover growth is superior to the rate of wear, and can be attributed to the function of the dentigenous lamina, a fine epithelial tissue with non-mineralized teeth, located between the corneal structure and the mandibular bones.

The dentigenous lamina is described from data obtained by scanning microscopy studies, and its evolutionary state is discussed. The aforementioned structure is considered primitive, as bones such as the vomer and the palate still maintain the capacity to bear teeth, a trait that occurs in *C. caretta*'s ancestors as well as some of the current day *Ophidea.*

COMPOSICION QUIMICA DEL HUEVO DE LA TORTUGA LORA (*LEPIDOCHELYS OLIVACEA*)

Randall Mora[1], Carlos Herrera[2], and Anny Chaves[3]
[1]Escuela de Tecnología de Alimentos, Costa Rica
[2]Escuela de Química. UCR, Costa Rica
[3]Programa Tortugas Marinas. UCR Actualmente: Centro para la Investigación de las Tortugas Marinas Douglas Robinson; Ostional Guanacastle, San Pablo Heredia, Costa Rica, *turtles@gema.com*

Con el objeto de conocer la composición química del huevo de la tortuga Lora, se tomó una muestra de 50 huevos de playa Ostional, Guanacaste, Costa Rica. Se realizó una separación de las cáscaras, claras y yemas, tomando las masas individuales de cada uno de dichos componentes. Se realizaron determinaciones de humedad, proteínas, lípidos, cenizas y carbohidratos a cada uno de los componentes. A la grasa extraída de la yema se le determinó el contenido de colesterol y se le realizó un perfil lipídico mediante cromatografía de gases. Los huevos de la tortuga lora tienen un peso promedio de 27.9 g. Están constituidos por un 57.4% de yema, un 38.4% de clara y un 4.14% de cáscara. Estos presentan un contenido de humedad más alto de los correspondientes componentes en el huevo de gallina, por lo que son más susceptibles al ataque microbiano. La cáscara del huevo de tortuga tiene un alto contenido de proteínas que le confieren flexibilidad. La parte comestible del huevo de tortuga contiene aproximadamente la mitad los lípidos y proteínas del huevo de gallina y el mismo porcentaje de carbohidratos, además contiene 2.3 veces menos colesterol que la parte comestible del huevo de gallina. Los huevos de tortuga lora contienen ácidos grasos esenciales. Además tiene los ácidos C25:5 y C22:5 y algunos con número de carbono impar, que son característicos de las grasas de origen marino. Presentaron un índice de aterogenicidad más alto que los huevos de gallina, pero similar al de la carne de res y menor que el de los quesos.

PORCENTUAL COUNTS OF BLOOD CELLS IN LEATHERBACK HATCHLINGS

Ofelia Margarita Silva Peña[1], Adriana Laura Sarti Martínez[1], and Concepción Rugerio Vargas[2]
[1]Laboratorio de Torgtugas Marinas, Fac. de Ciencias, UNAM., México
[2]Depto. de Biología Celular y Tisular, Fac. de Medicina UNAM, México. lsm@hp.fciencias.unam.mx

Blood samples taken from hatchlings incubated in hatchery (n= 14) and poliestirene boxes (n=15), were analyzed. The technique used was cardiac puncture using EDTA sodium as anticoagulant. Percentages of different types of red and white cells were done using blood smears which were stained with Wright's stain. Five stages described of the Erythropoiesis process were observed, these were higher in hatchlings from hatchery. It is important the presence of mitotic figures in circulating blood. Different types of Leucocytes were not founded in all the observed smears. Eosinophils, Basophils, Lynphocytes, Monocytes and Azupholis were higher in hatchlings coming from hatchery, on the other hand, Thrombocytes were more numerous in hatchlings incubated in boxes.

ESTIMATING AGE IN HAWAIIAN GREEN SEA TURTLES BY SKELETOCHRONOLOGY

George R. Zug[1] and George H. Balazs[2]
[1]Department of Vertebrate Zoology, National Museum of Natural History, Smithsonian Institution, Washington, DC, 20560, U.S.A. zug.george@nmnh.si.edu
[2]National Marine Fisheries Service, Southwest Fisheries Science Center, Honolulu Laboratory, 2570 Dole St., Honolulu, HI, 96822-2396, U.S.A.

Green sea turtles, *Chelonia mydas*, in Hawaiian coastal waters range from 35 cm SCL juveniles to 106 cm SCL adults (Balazs *et al.*, 1987). An earlier skeletochronological analysis (Zug and Balazs, 1985) of a small sample suggested that in Hawaii, large juveniles to adults might be as old as 43-81 years. A larger sample salvaged since 1991 to examine the effects and onset of fibropapillomas also permits us to use skeletochronology to estimate the ages of these turtles. Skeletochronology is based on the reptilian aspect of skeletal growth by appositional deposition of new bone on old. This periosteal growth is cyclic, producing discrete bony layers in response to environmental and/or physiological cycles. The number of layers serves as an age index, and we assume that each layer represents one year of growth, i.*e*., the number of layers equals the estimated age of the turtle in years.

For skeletochronological analysis, we use 0.6-0.8 mm cross-sections of the humerus from the middle of the shaft. Although analogous to dendrochronology in determining the number of years of growth, bone is a dynamic tissue. Resorption and remodeling in the core of the humerus destroys the earlier periosteal growth layers, and a protocol must be developed to estimate the number of lost layers. We use the correction-factor protocol (Parham and Zug, 1998) which estimates the number of lost layers by determining the average growth vector of increasing humerus diameter in the youngest/smallest turtle in the sample. This vector via a regression equation provides an estimate of the lost/resorbed layers. The total number of layers (also the estimated age in years) is the sum of the number of estimated lost layers and the number of remaining periosteal layers.

Age estimates range from 4.8 to 34.6 yr (Figure 1). The smallest turtle in the sample has the lowest age estimate and the two largest individuals the oldest estimates. Are the age estimates strictly the function of size and the mechanics of the age-estimation protocol? Because the correction-factor protocol and, for that matter, any other technique rely on the observed (remaining) growth layer and resorption-core diameters, a component of the estimates is likely always protocol-linked, because the diameter of the humerus enlarges with increasing age and size. This link of age and size is a physiological and evolutionary component of the growth pattern of every animal. Why is there such a difference between these and the 1985 estimates? The 1985 estimates derive from an average growth width protocol that was noted then to provide overestimates in large turtles with large resorption cores in the humerus.

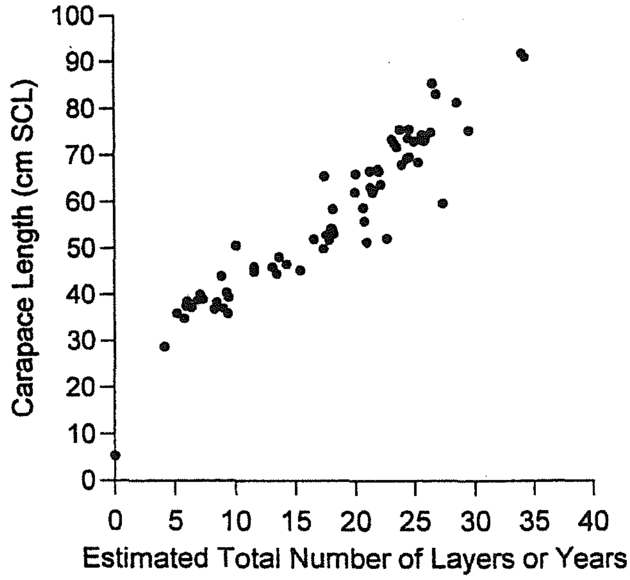

Figure 1. The association of age estimates and size in the Hawaiian green sea turtle sample. The 29 cm turtle was captured in the pelagic habitat in a commercial highseas driftnet fishery.

Linear regression of the age estimates yields a positive and strong association of age (X) and size (Y) [$Y = 22.8 + 1.91\,X$, $r^2 = 0.90$]. Because of the strong linearity of these data, exponential growth models do not fit these data. Examining the data for local growth trends with a smoothing function, *e.g.*, LOWESS, suggests different growth rates at different life stages, as in an Australian population of *C. mydas* (Limpus and Chaloupka 1997).

Skeletochronology yields age estimates, not actual ages, of sea turtles, because resorption destroys the earlier layers. Another limitation of the skeletochronological data is that age estimates are not equally extractable from the different age classes. Skeletochronology relies on a pattern of distinct layering within the bony elements. Such patterns are most evident in the smaller turtle, and their occurrence becomes less frequent in the larger individuals. Age can be estimated for 89% of the 30-69 cm SCL turtles, 72% for 70-79 cm, 18% for 80-89 cm, and 29% for >89 cm turtles. Another aspect of bone layering in Hawaiian *C. mydas* is the predominance of "annuli" to "lines of arrested growth." This observation suggests continuous growth in most individuals in this population, although retaining a cycle of rapid versus slow growth, and thus producing layers and permitting skeletochronological analysis.

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TRACKING OF THE TAGS (T AND J) APPLIED ON KEMP'S RIDLEY IN RANCHO NUEVO, TAMAULIPAS

Refugio G. Castro M., Alma S. Leo P., Enrique Conde G, and Rolando Orta N.
Centro Regional de Investigaciones Pesqueras Tampico-Tamps, Calle Altamira S/N, Col. Isleta Perez, Apdo. Postal: 197 Tampico, Tamps., México. criptam@tamnet.com.mx

The Kemp's ridley is considered to be the most endangered of sea turtles and an endemic species to the Gulf of Mexico (Márquez, 1994), since its only zone of reproduction in the world is exclusive to the beach of Rancho Nuevo, Tamaulipas. A way of keeping track of each of the nesting turtles is through the recording of the tagging and recapturing that was begun in 1966. The data gathered through the recording of traditional steel tags, used to this day by Instituto Nacional de la Pesca and satellite tracking (Richard Byles) with the help of the U.S. Fish and Wildlife Service, indicate that the zones between their nesting and reproduction areas are shallow waters (Marquez, 1996). The field work is as follows: beach patrols (recorridos"), three or more times a day depending on the weather conditions appropriate for a possible "arribada" (arrival), tagging specimens, collecting, moving and transplanting the egg clutches to a protective corral, and the releasing of hatchlings.

We present the tracking of those turtles tagged in the eighties with the T and J series, in respect of the last four seasons (1994-1997), checking for the increment in carapace length, preference in the incidence zones, number of times it was recorded each season and finally if it was retagged with another series

EMERGENCE PERIOD OF TRANSPLANTED NESTINGS AND THE EFFECT OF AIR AND SAND SURFACE TEMPERATURE ON THE HATCHLINGS OF THE TURTLE LEPIDOCHELYS KEMPI IN RANCHO NUEVO TAMAULIPAS, MEXICO

A.L Cruz Flores[1], R. Sánchez Trejo[2], R. Márquez-Millan[3], and R. Castro Melendez[1]
[1]CRIP- Tampico Tamaulipas, C.P. 89090, México
[2]Lab. Ecología Costera y Pesquerías, UAM-X, A.P. 23182, C.P. 04960, México, D.F., México
[3]CRIP- Manzanillo, A.P. 591, Colima, C.P. 28200, México. rtrejo@cueyatl.uam.mx

The are several studies which deal with the hatchling emergence period at natural and artificial nest of several turtle species. Nevertheless, no precise data on the importance of air and sand surface temperature or their effect on the emergence period of Lepidochelis kempi have been reported. This species has its main anidation site on the shores of Rancho Nuevo Tamaulipas, Mexico. In the present study the preemergence period (when the nest mouth collapses) and emergence (when more than ten hatchlings appear at the nest mouth), as well as the on set and gradual decrease of this phenomenon were registred, so as to determine the association between temperature records obtained at two-hour intervals. The relation between these factors and hatchling emergence was determined through statistical analysis. Preemergence period was observed since the 40th day of incubation when the average air temperature was 27.1 °C and sand surface temperature was 35.4 °C; hatchling emergence occurred mainly from 1:30 to 6:30 hours when the air temperature ranged from 25.5 °C to 31.5 °C and the surface ranged from 29.2 °C to 34.5 °C. The maximum emergence was detected from the 41 to the 43rd day of incubation and at the 46th day. Air and sand surface temperatures were highly correlated and both influenced hatchling emergence, this was inhibited when temperature increased 1-2 °C above 26.0 °C. Thus we conclude that preemergence and emergence are regulated by air temperature in trasplanted nestlings which is the governing factor of the emergence period and the hours of hatchling emergence for this species.

CONSERVACION DE LAS TORTUGAS MARINAS EN EL SALVADOR SINOPSIS Y PERSPECTIVAS.

Celina Dueñas[1], Mauricio Vásquez[1], and Carlos Hasbún[2]
[1]Dirección General de Recursos Naturales Renovables, Servicio de Parques Nacionales y Vida Silvestre Calle y Cantón El Matazano, Soyapango, El Salvador. dgmr@es.com.sv
[2] University of Hull, United Kinddon U.K.

INTRODUCCION

En El Salvador se encuentran y anidan cuatro especies de Tortugas Marinas; "golfina" (*Lepidochelys olivacea)*; "prieta" (*Chelonia agassizi*); "baule" (*Dermochelys coreacea*) y la tortuga "carey" (*Eretmochelys imbricata*).

El recurso tortuga marina ha constituido tradicionalmente una fuente de generación de ingresos para la comunidad de tortugueros e intermediarios que comercian sus productos y subproductos.

Actualmente a nivel nacional todas las especies se encuentran en peligro de extinción, debido principalmente a la captura incidental de adultos y subadultos reproductores por efecto de las diferentes artes de pesca, sobreexplotación de huevos y utilización de algunos subproductos, como el caso de artesanías de concha de carey.

Es urgente establecer y desarrollar una estrategia de conservación de tortugas marinas, que sea congruente con la necesidades de recuperación del recurso y la satisfacción de las necesidades socioeconómicas de las comunidades de usuarias que se benefician de los mismos.

Para que los esfuerzos de conservación sean efectivos y sostenibles se deberá promover la participación integrada de los sectores políticos, ONG´s, usuarios, planificadores del desarrollo turístico, Camara de la Industria Pesquera y acuacultura, otras instiruciones gubernamentales.

ANTECEDENTES

Los esfuerzos de conservación de tortugas marinas en El Salvador habían sido aislados, realizados por diferentes instituciones sin responder a metodologías estandarizadas y en la mayoría de los casos sin el debido seguimiento e integración institucional.

En la tabla 1, se puede apreciar la cronología de proyectos realizados y los resultados obtenidos antes de 1997.

Entre 1974-1978 el Servicio de Recursos Pesqueros (Ministerio de Agricultura y Ganadería) liberó 1420 crías de la especie ***Lepidochelys olivacea***, empleando corrales de incubación bajo un sistema abierto de total radiación solar.

En el período 1979-1986 el Servicio de Parques Nacionales y Vida Silvestre (Ministerio de Agricultura y Ganadería) centró sus esfuerzos en las playas El Icacal e Isla San Sebastían (en el oriente del país) y Barra de Santiago y Garita Palmera en la zona occidental de El Salvador, logrando liberar 193,000 crías y trabajando con las especies *Lepidochelys olivacea y Chelonia agassizi*

En 1990, la región II del Ministerio de Agricultura y Ganadería,. en Playa Cangrejera, libero 8,000 crías de *Lepidochelys olivacea*, desconociendo por completo su metodología de trabajo.

Durante 1986, la Dirección de Patrimonio Natural (Ministerio de Educación), trabajó en playa San Diego, incorporando el componente de educación ambiental.

El período 1989-1996 La asociación ambientalista AMAR, combinadamente con PANAVIS y comunidades desarrollaron toda una metodología de trabajo, con la incorporación de la comunidad en el proceso de conservación de las tortugas marinas en Barra de Santiago, logrando incorporar 41,291 neonatos de *Lepidochelys olivacea.*

Durante estos ocho años se involucró a las comunidades en el manejo comunitario a traves de canje de huevos frescos por enseres y artículos de primera necesidad (1989-1993); veda parcial de playa, en esta se prohibía la extracción de huevos durante tres días a la semana (1994-1995) y entrega voluntaria de dos docenas huevos por cada nidada encontrada (1996-1997). La obtención de huevos fue mas eficiente con esta ultima metodología.

Tabla 1. Instituciones involucradas en la Conservación de Tortugas Marinas en El Salvador (1974-1996)

AÑO	INSTITUCION	SITIO O PLAYA	# CRIAS	ESPECIE	METODOLOGIA
1974-78	Servicio Recursos Pesqueros MAG	El Tamarindo Isla Madresal Isla San Sebastian Playa Hermosa San Diego Barra de Santiago	1420 /año	L. olivacea C. agassizi	100% luz solar
1979-86	PANAVIS MAG	El Icacal Isla San Sebastian Barra de Santiago Garita Palmera	193,000	L. olivacea C. agassizi	Se desconoce
1987	Dirección de Patrimonio Cultural (MINED)	San Diego	....	....	Se incorpora la educación ambiental
1989-96	Asociación AMAR	Barra de.Santiago	41,291	L. olivacea	
1990	Region II MAG	Cangrejera	8,000	L. olivacea	Se desconoce
	Comunidad Bola de Monte	Bola de Monte	6,500	L. olivacea C. agassizi E. imbricta	A media sombra
	ONGVision Mundial	playa Puntilla	7,104	L. olivacea D.coriaceae	A media sombra
	Fuerza Naval	playa San Diego. playa Cangrejera. Pla. San Juan. Golfo de Fonseca Playa El Flor	9,500	L. olivaceae C. agassizi E. imbricata	A media sombra A sol total

MATERIALES Y METODOS

En noviembre de 1997, el Servicio de Parques Nacionales y Vida Silvestre, emitió la Veda al aprovechamiento de huevos, manejo de neonatos y productos derivados de las tortugas marinas en El Salvador. Una buena parte de los fundamentos de esta veda los dio la experiencia que se obtuvo en años anteriores, especialmente en la Barra de Santiago, por parte de la Asociación ambientalista AMAR.

La base legal que da la pauta para la emisión de esta Veda fue la Ley para la Conservación de Vida Silvestre. Esta Veda regula el comercio de huevos de las especies *Lepidochelys olivacea, Chelonia agassizi y Eretmochelys imbricata;* además regula el establecimiento y manejo de corrales de incubación, manejo de neonatos y prohibe el comercio y consumo de huevos de *Dermochelys coriacea* y el comercio de productos de carey y subproductos de cualquier tipo.

La base técnica del sistema de aprovechamiento emitido en Octubre de 1997 fue la metodología empleada en los años anteriores, pero principalmente la generada en Barra de Santiago. La base legal fue la Ley de Conservación de Vida Silvestre, emitiéndose una Resolución que regula el consumo y comercialización de los huevos de Tortugas y además prohibe el comercio de otros productos y subproductos de las mismas.

En 1997 por primera vez se logra realizar un esfuerzo integral entre PANAVIS/ ONGS/ comunidades, logrando establecer 10 campamentos a lo largo de toda la costa salvadoreña. Con este esfuerzo se liberaron 25,296 crías de las especies: *Lepidochelys olivacea; Chelonia agassizi; Dermochelys coriacea* y *Eretmochelys imbricata.*

Para poder aplicar la Resolución de Veda, se realizaron visitas periódicas a las diferentes comunidades para explicarles el proceso técnico y legal, así como brindar capacitaciones al personal encargado de los corrales de incubación, se emitieron licencias a los tortugueros, para garantizar que el aprovechamiento lo realizaran unicamente las comunidades de la costa y llevar un control de las personas que se dedican a esta activadad; se repartieron boletas de control de los huevos que se permitió comerciar y se distribuyo una guía para el establecimiento y manejo de corrales de incubación.

Table 2. Resumen de los resultados obtenidos por la aplicacion de veda en 1997.

PLAYA	DEPARTAMENTO	EJECUCION	TORTUGAS LIBERADAS
Bola de Monte	Ahuachapan	Comunitario	5.000
Barra de Santiago	Ahuachapan	AMAR-PANAVIS	3.500
Playa El Flor	Sonsonate	Fuerza Naval	3.790
San Diego	La Libertad	F. Naval-Comunidad	6.000
Toluca	La Libertad	CESIA (ong)	6.500
Amatecampo	La Paz	Comunitario	sin datos
El Pimental	La Paz	Comunitario	sin datos
La Zunganera	La Paz	Comunitario	sin datos
Punta San Juan	Usulatan	PNC-Fuerza Naval	306
La Union	La Union	Fuerza Naval	200
		Total	25.296

PERSPECTIVA PARA LA CONSERVACIÓN DE LAS TORTUGAS MARINAS EN EL SALVADOR

El Servicio de Parques Nacionales y Vida Silvestre considera que para implementar adecuadas medidas de conservación se deberá elaborar e implementar una Estrategia Nacional de conservación de las tortugas marinas.

En la elaboración y aplicación de esta Estrategia se deberá involucrar a los diferentes sectores estatales, ONG´s de desarrollo y ambientalistas, lideres religiosos, comunales y usuarios.

En la Estrategia se considerarían aspectos como: la protección del habitat, manejo, control de explotación, investigación, participación comunitaria, educación ambiental, procedimientos de pesca que disminuyan el impacto sobre los adultos, determinación de los sitios de mayor anidación, fortalecimiento legal, técnico y financiero de las instituciones y de las áreas naturales que incluyen ecosistemas costeros.

PROTECCIÓN DEL HÁBITAT

La conservación del hábitat conlleva una variedad de formas y técnicas de manejo desde la creación o consolidación de áreas costero marinas protegidas bajo diferentes categorías de manejo, esfuerzos a limitar el acceso o actividades en áreas claves como sitios de anidación específicos o protección a congregaciones de aguas, tratando de simular las condiciones naturales lo más preciso posible.

Se deberá dar prioridad a la determinación de los sitios de mayor anidación de tortugas, determinación de playas donde se presenten anidaciones dispersas, determinación de areas de interanidación y de rutas migratorias y areas de concentración y forrajeo.

MANEJO

El aprovechamiento de los huevos actualmente se regula a traves de la Resolución de Veda, pero a corto se ha incluido además en el reglamento de la Ley de Conservación de la Vida Silvestre, el cual se espera sea aprobado en 1998.

Se considerará además la no intervención y nula traslocación de huevos.

Dentro de la realidad salvadoreña son pocos los sitios en donde se puede implementar la veda total al aprovechamiento de los huevos; uno de estos lugares es la Isla Martín Pérez, ubicada en el Golfo de Fonseca, el cual es un importante sitio de anidación para *Chelonia mydas.*

En casos de hacer transplantes de nidos, éstos son supervisados por el Servicio de Parques Nacionales y Vida Silvestre y a través de un proyecto y un Convenio firmado por las partes interesadas. En dichos corrales se trata de crear las condiciones lo mas naturales posibles y empleando materiales rusticos y de bajo costo.

En el caso de los neonatos, actualmente se regula el manejo a través de la Veda en la cual se permite tener un maximo de 30 individuos de *L. olivacea* o *C. Agassizi,* unicamente para fines educativos o de interpretación, así mismo se exige que las crías que emergen de corrales de incubación deberán ser liberadas inmediatamente.

CONTROL DE EXPLOTACIÓN COMERCIALIZACIÓN

La comercialización de huevos de tortugas actualmente ésta siendo regulada y controlada por el Servicio de Parques Nacionales y Vida Silvestre, a través de una Resolución de Veda.

Actualmente se permite comercializar el 70 % de los huevos y el resto se debe destinar a corrales de incubación; el control se ejerce por medio de la emisión de boletas y licencias para los tortugueros.

Tradicionalmente en nuestro país no existe una cultura para el consumo de carne, aceites, cremas y grasas. Ni tampoco una utilización muy arraigada de carapacho, escamas, garras, osamentas, huesos, cráneos y vértebras de tortuga. Con la nueva Resolusion queda totalmente prohibido este tipo de comercio.

En El Salvador, aún no se ha dado una experiencia de establecimiento de una granja comercial. La experiencia mundial y sobretodo bajo la realidad y contexto salvadoreño, no se recomienda una operación de este tipo. Cualquier iniciativa de exportación deberá cumplir con las estipulaciones técnicas exigidas por CITES.

INVESTIGACIÓN

Se deberán realizar estudios sobre sitios de anidación, estimación del número de hembras anidantes, condiciones físicas en nidos naturales y en corrales de incubación, uso y comercio ilícito de huevos y otros subproductos, hábitats empleados para alimentación y establecer un programa de marcaje.

PARTICIPACIÓN COMUNITARIA

Se deberán abrir más espacios para que las comunidades de tortugueros tengan una participación activa en las acciones de conservación de las tortugas marinas debiendo participar en la elaboración de proyectos, ejecución y evaluación, así como en los programas de educación no formal; para ello se buscará el apoyo de Cooperativas, Asociáciones de Desarrollo Comunitario, Ministerio de Educación y de Salud, Iglesias, etc.

EMPLEO DE TECNICAS PESQUERAS QUE DISMINUYAN EL IMPACTO SOBRE LAS POBLACIONES DE ADULTOS.

Para esto se contará con la participación de Cooperativas de pescadores de la Cámara de pesca y acuacultura y el Centro de Desarrollo para la Pesca.

Se exploráran alternativas que puedan ser empleadas para disminur el impacto sobre los adultos y se propondrá un efectivo mecanismo de verificación del uso del mecanismo TED.

LEGISLACIÓN NACIONAL

Actualmente existe una legislación dispersa que ampara la protección del recurso tortuga en tierra y mar. La actual Ley de Conservación de Vida Silvestre y la Resolución de Veda al aprovechamiento de huevos, manejo de neonatos y productos derivados de las tortugas marinas, es administrada por El Servicio de Parques Nacionales y Vida Silvestre.

Es prioridad la aprobación de los Reglamentos de dicha ley, lo cual proveería de un soporte muy eficiente al recurso.

DISCUSION Y RESULTADOS

Al comparar el número de crías liberadas en los proyectos ejecutados antes de 1997, con los de este año, se observa que en este último año la cantidad de individuos es relativamente mayor.

Pero si comparamos la calidad de la información generada en 1997, con la producida en Barra de Santiago en el periodo 1989-1996, la primera no es significativa, esto se debe a que no se dispone de suficiente personal y recursos como para dar la asesoría y realizar la toma de datos en el sitio. Se pone de manifiesto que para poder coordinar una acción de tal magnitud, se requiere de un fuerte apoyo financiero institucional que podría ser a través de ONG's o volver sostenible económicamente los proyectos de Conservación de Tortugas Marinas.

En este proceso de conservación de las Tortugas Marinas desde sus inicios en los años 70´s, hasta ahora 23 años despues, se ha contado con una experiencia propia de recolección con apoyo de voluntarios, trueques y prohibiciones, logrando una participación comunal de avanzada; igualmente se ha pasado de metodologías dispersas, hasta una estandarización de éstas y de iniciativas locales de difusión hasta el involucramiento de los medios de comunicación y de la implementación de programas de educación ambiental para llegar a diversos sectores de la población.

Igualmente oportuno ha sido contar en toda esta experiencia técnica, con la existencia de una Ley de Conservación de Vida Silvestre que permite que esta sea aplicable a fin de lograr cumplir con sus objetivos de Protección, Uso, Aprovechamiento y Manejo de la Vida Silvestre y en nuestro particular de las Tortugas Marinas.

THE SEA TURTLE CONSERVATION PROJECT IN BARRA DE SANTIAGO, EL SALVADOR EVALUATED FROM A POLICY PERSPECTIVE: IMPLICATIONS FOR CONSERVATION AND MANAGEMENT.

Angela Formia[1], Carlos Roberto Hasbun[2], Mauricio Vasquez[3], and Emilio Leon[4]
[1]Institute of Zoology- The Zoological Society of London, Regent's Park, London NW1 4RY, U.K. margarida.fernandes@ucl.ac.uk
[2]Dept. of Biological Sciences, University of Hull, Hull HU6 7RX, U.K.
[3]Servicio de Parques Nacionales y Vida Silvestre, Ctn. El Matasano, Soyanpango, El Salvador
[4]Asociacion Ambientalista A. M. A. R., Reparto Palomo No. 1314, Col. Layco, San Salvador, El Salvador

The Sea Turtle Conservation Project in Barra de Santiago, El Salvador was established in 1989 as an attempt to protect the dwindling population of olive ridleys (*Lepidochelys olivacea*) nesting in the area. We will present an in-depth assessment of this project, its context, key players and driving forces, as a means to illustrate the use of the policy orientation in conservation, a method described back in 1943 by Harold Lasswell. Small-scale sea turtle conservation projects worldwide share several common characteristics: they struggle to survive on limited resources, tiny budgets and huge odds. It is time to evaluate whether many of these efforts are misdirected, whether projects are based on an accurate definition of the real problem and its context, and whether the limited available resources are appropriately utilized. Many projects fail to evaluate trends and outcomes of past management strategies, and conservation activities remain unchanged from year to year due to the absence of a holistic and adaptive approach to examining the measures of their success. For instance, should an organization expand the scope of its action, at the risk of losing effectiveness at the small scale of operations? Or, are many conservation programs covering a big hole with a patch that is pitifully inadequate, and curing the symptoms of an epidemic rather than preventing it from spreading? The policy orientation is necessarily problem-oriented rather than solution-oriented, it transcends the biases of narrow disciplinary approaches, stimulates new insight and creativity in search for ideas and alternatives, it seeks to understand goals, trends and expectations, as well as causal relationships and sources of uncertainty. We hope it will provide a stimulus for "self-analysis and re-assessment" of many conservation efforts worldwide.

WHAT IS THE POLICY ORIENTATION?

Harold Lasswell, the creator of the policy sciences, elegantly describes the decision-making process with a policy orientation as "an integration of morals, science and policy" (Lasswell 1943).

1) Contextual Problem Orientation. In order to design a rational problem definition, it is important to understand the historical context, driving forces and observed scientific and social trends. Awareness of the context and of goals and expectations leads to a better problem definition, which, in turn points to alternatives and creative insights into potential solutions. The problem definition also contains measures of success and indicators to determine how realistic and justifiable is the proposed course of action. Finally, the scope of the problem should be bounded to a manageable size to be feasibly handled in the policy process.

2) The Social Process. Each key player places demands on the system and its values, each has expectations and employs different strategies (i. e. diplomatic, ideological, economic and military) to achieve goals. One of the fundamental difficulties in the resolution of conflicts, including the contrasting values placed on natural resources, is the clashing of base values, and the fact that everyone's behavior is aimed at maximizing these base values. The various actors normally approach a problem with different epistemologies, different standpoints and biases, different ways to conceptualize a process or a conflict, they all perceive their roles as being different, governed by different interests and perspectives. A successful outcome is able to reconcile all factions, redistributing and organizing beliefs and perceptions into a unified picture. The policy scientist identifies the differences in resource valuation and attempts to find common grounds. It is in this common ground that one can find loci for intervention and stimulation of positive change.

3) The Decision Process. In the analysis of the six stages of the decision process (Table 1), we will attempt to distinguish 'knowledge of' substantive biology and 'knowledge in' the policy and management process. Although both of these factors are essential to successful conservation, 'knowledge of' the policy process is normally neglected in favor of determining more and more about the endangered species and its habitat. Contrary to the belief of many conservation organizations, such knowledge, once complete, does not automatically point to the elimination of threatening processes.

4) Organizational Analysis. Clark and Cragun (1991) write that "understanding organizations and knowing how to make them work for species recovery can make the difference between a program that succeeds and one that fails."

Too often, when a project does not attain its goals, the failure is attributed to technical problems and insufficient resources. Instead, the structure of the organization should be re-examined, the flow of information within it and the systems of decision-making through the hierarchy should be questioned. The policy analyst should be able to know the system and manipulate around obstacles that arise within it, pushing for innovation and inquiry. An ideal conservation organization should be entirely structured toward problem-solving, it should be flexible and quick in appraising situa-

Table 1. The Six Stages of the Decision Process Applied to Sea Turtle Conservation in Barra de Santiago, El Salvador

PHASE DEFINITION	DESCRIPTION	CRITIQUE
Initiation: A concern comes to the surface and is identified as requiring attention and action. It is a problem for whom? Why does it matter that it be resolved? Does it matter enough to justify attention? What are possible solutions?	Population decline Anecdotal evidence Individual initiative	Not nationally recognized problem
Estimation: Perception of a problem is the result of an imposed frame of reference, accepted assumptions, dominant epistemologies. The problem definition develops from evidence, communication and information gathering. Are there alternative definitions? What lessons can be learned from precedents and experiences? Is there an in-built appraisal function as a basis for learning and to integrate knowledge and experience? Do participants' expectations match or conflict?	Economic and demographic pressure Unsustainable use of natural resources Lack of conservation awareness High hatchling mortality	Oversimplification of problem definition Inattention to alternatives, different sources of mortality, context and key players Inadequate assessment of population status
Selection: Debate on the issues allows for multiple views, values and compromises. Feasibility assessments are performed to choose among program designs and uncertainty on options is reduced.	Education, headstarting, beach patrols, in-situ hatchery National awareness campaigns NGO involvement	Maintenance not task orientation No TEDs enforcement No outcome assessment No indicators of success
Implementation: Should include a formal assessment of the adequacy and equity of implemented objectives, and work efficiency and effectiveness should constantly be questioned. Mechanisms should be in place to deal with common obstacles and errors and to enforce performance standards.	Children's ecology group, annual turtle release festival, hatchery activities, partial beach protection, hiring of local beach patrollers, display of juvenile turtles, local natural resource museum, establishment of regional reserve, media campaigns, fund-raising activities	No performance standards Ineffective leadership Inadequate scientific information and resources Inconsistent methodology Lack of enforcement power No structured response to obstacles (local resentment and resistance to change) Inattention to market demands
Evaluation: Pitfalls include insensitivity to criticism and limited learning from experience. Expected and realized performance should be compared. Double loop learning mechanisms should, on the basis of experimentation and reflection, arrive at insights on project premises and priorities. The flow can be envisioned as going from governing values to strategies to consequences and back to governing values, allowing constant molding of the problem definition.	No formal evaluation Single-loop learning No trend data	No double-loop learning Insufficient measures of success Lack of re-evaluation of premises and priorities Lack of problem definition
Termination: Have long or short-term goals been attained? Is the problem solvable as currently defined? The validity of goals must be re-assessed and information generated about new problems. Institutional rigidity, political and local pressure, a blocked learning cycle and small-scale parochial vision may be obstacles preventing smooth transitions.	None	No goal attainment (long/short-term) mechanism and guidelines No project replacement plans (TEDs)

tions and in responding to change and challenges. Information should be transferred effectively and efficiently within sectors and learning mechanisms should be 'double-looped', whereby premises and priorities are frequently re-evaluated and fed back into the cycle.

WHAT ARE THE OBSTACLES?

This analysis will conclude by making a few recommendations (Table 2) and suggesting possible reasons why conservation practices with wider scopes and better long-term effects are not being implemented at the local scale in Barra de Santiago and in many other conservation projects worldwide. Both types of conservation should be carried out, both have invaluable advantages and one should not be stressed at the expense of the other. Running a hatchery, beach patrols and educational activities is much simpler and clearly defined than attempting to address a large-scale unmanageable problem such as resource over-exploitation or poverty. Aside from scale, financial restrictions and logistical difficulties become paramount for small organizations. However, the required changes are usually so long-term that they normally outlast funding sources and they may not have identifiable measures of success. Finally, changes such as the implementation of TED's or the establishment of protected areas appear to be political and lobbying problems which become removed from the local community and preclude many opportunities for environmental education.

Table 2

- Identify key leverage point within system
- Improve science
- Improve interagency coordination
  - * Communication - designated liaison
  - * Well defined project headquarters
  - * Consistent methodology
- Create central information bank
  - * National and local level
  - * National habitat survey and population census (update regularly/create)
- Create evaluation mechanisms
  - * Periodic evaluation workshops
    - a) reasses premises, goals, priorities
    - b) encourage public participation
    - c) evaluate progress toward goals
  - * Logistical meetings
- Designate leadership roles
  - * Well defined, stable, reliable, respected authority
- Improve enforcement
  - * Consistent presence of authority
  - * Incentives and funding
- Obtain partnerships with outside funding sources
- Global and national dissemination of successful project outcomes
- Implement and/or enforce TEDs

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A MULTIMEDIA PROJECT ON THE ENVIRONMENTAL EDUCATION OF THE POPULATION ABOUT THE SEA TURTLES OF THE ISLAND OF MARGARITA, VENEZUELA, AND AN INTEGRATION OF DATA BASE FOR HATCHING CONTROL

Angel Gómez Bonive
Fundación OIKOS, VenezuelaUrbanización Nuevo Juan Griego. Qta Salitre. Juan Griego, Estado Nueva Esparta, Isla de Margarita, Venezuela

Due the evolution of new technologies in the field of computer science and bearing in mind the interest that all the layers of the population are taking in this area, it is necessary to integrate something as important as Environmental Education with its systems and programs worked out especially for this purpose. In this respect, an attempt has been made to develop a multimedia project (images and sounds) to be implemented during the first stage of the educational system in different areas of Margarita Island. The program could let the people get acquainted, in an easy and didactical way, with the most important aspects of the biology and conservation of sea turtles, including such aspects as: taxonomy, life cycle, factors affecting survival and a brief reviev of the current situation of sea turtles on the Island of Margarita, Venezuela.

In the same way, due to the great amount of information about the hatching of sea turtles on the beaches of the island, it is important to have a computerized data base that could process this information, work out statistical reports and save it to be used later as background for research projects that could be developed around this aspect. The Data Base of the Sea Turtles is a program, developed to save information pertaining to general data about the beaches, hatching specific data about the beaches and, additionally, to show reports about the distribution of nest per moths, years and beaches.

SEA TURTLES IN THE CENTRAL COAST OF VENEZUELA

Hedelvy J. Guada[1], Vicente J. Vera[2], and Marco García[3]
[1]WIDECAST/Universidad Simón Bolívar. Apdo. 50.789. Caracas 1050-A. Venezuela. 95-79050@usb.ve
[2]PROFAUNA. Edif. Camejo. Mezzanina. El Silencio. Caracas 1010. Venezuela
[3]Universidad Central de Venezuela. Facultad de Ciencias. Escuela de Biología. Caracas. Venezuela

Since the ends of 1987, when it was prepared the national report for the II Western Atlantic Turtle Symposium (WATS II) under the coordination of FUDENA (Foundation for the Defense of Nature) (Medina *et al.,* 1987; Vernet, 1987), it has not been done again any survey about the status of the sea turtles in the beaches close to the capital city of Caracas. The fishermen and people living in coastal localities indicated that the four species of marine turtles nesting in Venezuela are found in these beaches: *Chelonia mydas, Eretmochelys imbricata, Caretta caretta* and *Dermochelys coriacea.* Information from divers, tourists and local people indicates that the turtles are caught in the fishermen nets. Sometimes, we receive reports about that sea turtle meat it is sold in the littoral markets (Catia La Mar) or that eggs are sold to tourist in the beaches (Naiguatá).

The main goal of this preliminary work was to gather information to confirm sea turtle nesting beaches in the 1998 reproductive season and, to include the beaches reported in the inventory of the "Sea Turtle Recovery Action Plan for Venezuela" (Guada and Solé, in prep.). Moreover, we want to establish the most important nesting beaches in the area in order to initiate monitoring programs or environmental education activities focused to sea turtles.

METHODS

We have conducted interviews according to the Pritchard *et al.* (1984) guidelines in the following beaches: Chichiriviche de la Costa, Osma, Todasana and Caruao, between January and February of 1998. ". At the same time, we have evaluated these beaches as possible nesting areas.

RESULTS AND DISCUSSION

Ten interviews were conducted. According to the people we have found that the most common species in the area are the loggerhead turtle, *Caretta caretta* and the hawskbill turtle, *Eretmochelys imbricata*. The leatherback turtle, *Dermochelys coriacea*, is less frequent and always more than 2 miles from the coast. Nobody of the persons identified to *Chelonia mydas*. Besides the beaches indicated previously as nesting sites (Quebrada Seca, Mono Bravo, Mono Manso and Chuspa) (Medina *et al.*, 1987; Vernet, 1987), we have now several localities to be confirmed as nesting areas: Chichiriviche de la Costa, Cañaveral, Osma, Playa Grande (Todasana), Urama, El Fraile and Santa Clara (10° 36' - 10° 41 N, 66° 21" - 67 °14' W). The begining of the nesting season was indicated for May or June. Sometimes the eggs are stolen and sold. The fishermen told that if a turtle is death in the nets ("trenes"), it is eaten by them.

The information gathered, even in a same beach seemed contradictory some times: Chichiriviche de la Costa, as example, has been reported as nesting beach for some local people, while others comment that several years ago, they have not observed some nest. In a general way, it seems that the western area evaluated (Chichiriviche de la Costa), it may be used for nesting sea trtles, although scarcely. Several adjacent beaches to Chichiriviche de la Costa must be surveyed by boat. From Cañaeral to Chuspa, some localities could be relatively more important for nesting turtles, although nobody mentioned mre than two turtles per night in a same beach. In a general ay, the study area may be more important for foraging turles than for nesting turtles. Several fishermen told that the have found turtles with tags. Join with the interviews nd beach evaluation, we have distributed environmental ducational materials as the WIDECAST sea turtle identification sheets and posters on sea turtles.

This work needs to be completed. As the nesting season has not begun, the intervew process will continue to try to define the key informants and nesting sites to establish a monitoring program by May of 1998. Simultaneously we will be offering lectures with materials provided by the Columbus Zoo (Powell, Ohio) and to continue distributing environmental educational mterials. Fortunately, a NGO based in Caruao (Fundación oder a los Niños) have offered support for our sea turtle conservation efforts.

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USE OF MINIATURE TEMPERATURE DATA LOGGERS TO ESTIMATE SEX RATIOS OF HATCHLING LOGGERHEAD SEA TURTLES

JoAnne Hanson[1], Thane Wibbels[1], and R. Erik Martin[2]

[1]Department of Biology, University of Alabama at Birmingham, Birmingham, AL, 35294-1170, U.S.A.
bio009@uabdpo.dpo.uab.edu

[2]Ecological Associates, Inc., P. O. Box 405, Jensen Beach, FL 34958-0405, U.S.A.

Sea turtles possess temperature-dependent sex determination (TSD) in which the incubation temperature of the egg determines the sex of the hatchling (Yntema and Mrosovsky, 1980; Mrosovsky, 1994). During TSD, the temperature during the approximate middle third of the incubation period determines sex (Yntema and Mrosovsky, 1982). Previous studies indicate that TSD in sea turtles can produce a variety of hatchling sex ratios, including some which are highly biased (reviewed by Mrosovsky, 1994). Hatchling sex ratios are of conservational interest since they contribute to the population sex ratio and thus could alter the reproductive success in a population (Mrosovsky and Yntema, 1980; Morreale *et al.*, 1982). They are also of evolutionary interest since sex ratios produced from TSD do not always conform to sex ratios predicted by evolutionary theory (Bull and Charnov, 1988).

A variety of previous studies have used beach temperature data to estimate hatchling sex ratios (Mrosovsky *et al.*, 1984; Mrosovsky and Provancha, 1989; 1992; Mrosovsky *et al.*, 1992). These studies used temperature probes which were buried in the nesting beach. These probes were attached to manual or automatic recorders located above ground. The current availability of small and self-contained temperature data loggers, provides a means of avoiding many of the logistical difficulties associated with the repeated recording of beach or nest temperatures. The self-contained data loggers can be buried in the beach or placed directly into nests. They can be programmed to record temperatures at specific intervals for the entire incubation period or nesting season. Once retrieved from the nest or nesting beach, the temperature data can be downloaded to a personal computer.

During the current study, temperature data loggers were used to record incubation temperatures in loggerhead sea turtle, *Caretta caretta*, nests on Hutchinson Island, Florida. This area represents one of the densest nesting areas for *C. caretta* that inhabit the Atlantic coastal waters of the U.S.A previous study of *C. caretta* on a nesting beach approximately 140 km north of Hutchinson Island (*i.e.* Cape Canaveral; Mrosovsky and Provancha, 1992) indicated that highly female-biased sex ratios (estimates of 87 to 99 % females) were consistently produced over a 5 year period. Examination of sex ratios from Hutchinson Island can provide insight as to whether such biases might be a normal characteristic of *C. caretta* nesting on Florida beaches. The beaches of Hutchinson Island also provide a means of examining the effects of beach "nourishment" on nest temperatures. Beaches on the southern half of Hutchinson Island have been replenished with sand (*i.e.* nourished) in order to compensate for erosion, whereas the beaches on the northern half do not receive supplemental sand. Thus, Hutchinson Island contains both control and nourished beaches for examining the effects of beach nourishment on *C. caretta* nest temperatures.

"Hobo" temperature data loggers (Onset Computer Corporation, Pocasset, MA) were used to monitor nest temperatures. These units contain a thermistor probe and, at the temperatures common in sea turtle nests, are precise to approximately 0.4 C°. The data loggers were calibrated in custom incubators which maintain a constant internal temperature of +0.2 degrees C. Prior to use in the field, data loggers were programmed to record temperature at 1.2 hour intervals and were then double bagged in heat sealed plastic bags (Dazey Seal-A-Meal and Kapak/Scotchpack). Incubation temperatures were monitored in a total of 40 nests. These nests were laid during June and July, which is the period during which the majority of nesting occurs. To account for temperature variations during this period, 10 nests were monitored with data loggers early in the period, 20 were monitored toward the middle of the period, and 10 nests were monitored toward the end of this period. For each group, half of the data loggers were deployed on the control beach, the other half on the nourished beach. Nesting turtles were selected as they were just beginning to crawl up the beach to nest. No preference was given to turtles based on the location where they nested on a particular beach. In each of the nests, the data logger was placed in the approximate centre of the egg clutch.

Mean daily Incubation temperatures during the thermosensitive period were used to predict sex ratio based on previously published pivotal temperatures and transitional range of temperatures for *C. caretta* (Yntema and Mrosovsky, 1980; 1982; Limpus *et al.*, 1985; Mrosovsky, 1988; Mrosovsky and Provancha, 1989; 1992; Marcovaldi *et al.*, 1997). The great majority of the nests (92.5 %) were predicted to produce 100% females. Both control and nourished beaches were predicted to produce primarily female hatchlings.

The female biased sex ratios predicted for Hutchinson Island in the current study are consistent with those previously predicted for Cape Canaveral Seashore (Mrosovsky and Provancha, 1989; 1992). These data support the hypothesis that an overall female-biased hatchling sex ratio may be a standard feature of the *C. caretta* inhabiting the Atlantic coastal waters of the U.S.

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MORTALITY RATES OF NESTING HAWKSBILL TURTLES IN BARBADOS: A POSITIVE IMPACT OF TOURISM ON SEA TURTLES

Julia A. Horrocks[1], Steve Hertzlieb[2], and Vickie Copeman[2]
[1]Department of Biological and Chemical Sciences, University of the West Indies, Barbados. bcs@uwichill.edu.bb
[2]Bellairs Research Institute, St. James, Barbados

INTRODUCTION

In Barbados, it has been illegal to kill sea turtles nesting on the beach or within 100 yards of the shore since 1904. However, owing to a lack of enforcement personnel and an insufficient penalty, hawksbills, *Eretmochelys imbricata*, the primary species nesting in Barbados, continue to be killed during nesting, primarily for the consumption of meat and eggs.

Over the past two decades, Barbados has been extensively developed for tourism. Much of this development has occurred on the more leeward south and west coasts, with the north and east coasts still largely undeveloped. Most hawksbill nesting activity to date has been recorded on the developed leeward west and south south-west coasts (see Poponi *et al.*, Poster). The consequence of this is extensive negative impacts of tourism-associated developments on nesting beaches on these coasts. The impacts include loss of available nesting beach due to coastal armouring, inadequate setbacks to walls and buildings, light pollution (see Woody *et al.*, Poster), and destruction of indigenous vegetation.

Although there are many negative impacts of tourism-related developments on turtle nesting beaches, a potential positive impact is that there may be reduced poaching, since these beaches being more brightly lit and heavily traversed than undeveloped beaches. The objective of this paper is to investigate whether the presence of security personnel and tourists on hotel/restaurant beaches acts as a deterrent to potential poachers of nesting female turtles.

METHODS

All nesting attempts where the fate of females was known *i.e.* whether the female successfully re-entered the sea or not, were compiled from the hawksbill nesting activity database of the Barbados Sea Turtle Project for the ten year period (1987-97). The location of each nesting attempt was categorised according to whether the female emerged on a beach adjacent to a hotel or restaurant, or whether she emerged on a beach with no tourism-related development.

RESULTS

Since 1987, 1,003 nesting attempts by hawksbills have been recorded, where the fate of the female was known. Of the 1,003 activities, 597 (59.5%) occurred on beaches with adjacent hotels or restaurants and the remaining 406 (40.5%) on beaches with no tourism-associated development.

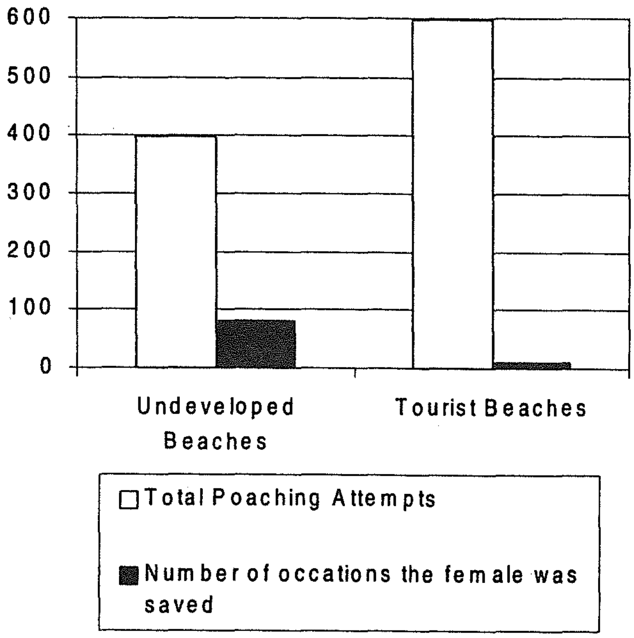

Figure 1. Chart showing the number of occasions on which a female turtle was killed during nesting attempts on undeveloped beaches and tourist beaches.

On 94 occasions (9.4%), the female was killed by poachers. Of these deaths, only eight occurred on hotel/restaurant beaches. A significantly higher proportion of females emerging on beaches with no tourism-associated development were killed (21.2%) than females emerging on hotel/restaurant beaches (1.3%; X^2 =109.7; P<0.001, Figure 1). This suggests that the possibility of being observed and/or confronted is a major deterrent to poachers on hotel/restaurant beaches.

That confrontation is more likely on hotel/restaurant beaches is supported by the fact that when poachers did target turtles on these beaches (N=14), on six (42.9%) occasions the turtles were physically taken away from them (by tourists on 3 occasions and by hotel security guards on 3 occasions) after the poachers had turned the turtles on their backs. When poachers targetted turtles emerging on beaches with no tourism-associated development, on only nine of 95 (9.5%) occasions were turtles physically taken from them (by tourists on 2 occasions and by local residents (sometimes with police support) on 7 occasions ($X^2 = 8.81$; $P<0.01$, Figure 2).

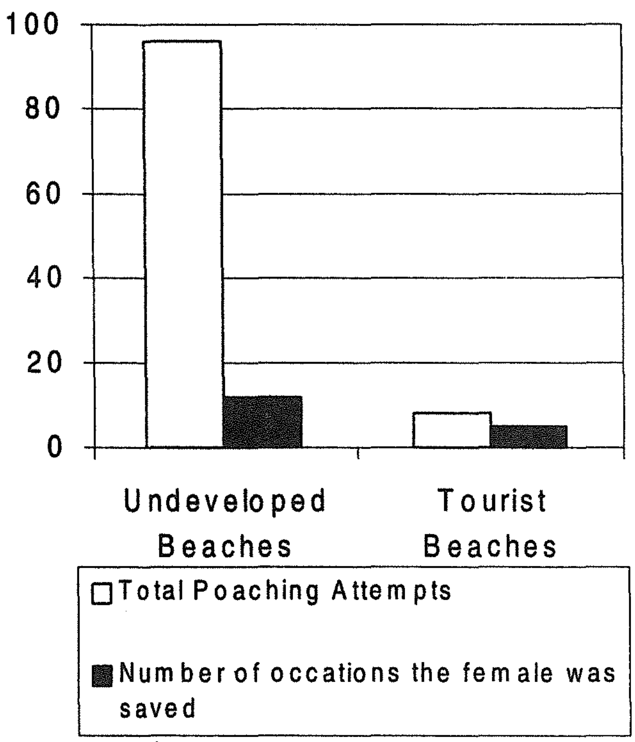

Figure 2. Chart showing the number of occasions on which a female was saved during poaching attempts on undeveloped beaches and tourist beaches.

DISCUSSION

Negative impacts of coastal developments on hawksbill nesting are well documented and remain a major constraint to species recovery. Potential positive effects of development have seldom been assessed. In Barbados, poaching of nesting females is less common on hotel/restaurant beaches than on undeveloped beaches, and poachers were more likely to be confronted on the former beaches. In the absence of effective legislation and enforcement, tourism-associated developments adjacent to nesting beaches may assist in protecting adult females from poaching and may therefore contribute to species recovery.

For this effect of tourism development to have a net positive benefit, the known negative impacts of development must be minimised. In particular, the lights that can contribute to the prevention of poaching can adversely affect hatchlings following their emergence causing significant levels of disorientation.

Large hotels are located on several important nesting beaches in Barbados and most have responded positively to the Barbados Sea Turtle Project to make beach lighting more 'turtle friendly'. They have shown willingness to reduce light intensity and reorient lighting. Discussions about the use of more 'turtle friendly' types of light fixtures are underway.

In conclusion, tourism-related development adjacent to nesting beaches can provide protection from poaching for nesting females. To realise the full benefits of this, it remains important to protect the nesting beach from adverse effects of development. In Barbados, this typically will require reduction of light intensity, reorientation of lights, use of more 'turtle friendly' light fixtures, adherence to appropriate setbacks above the high water mark, and protection of indigenous vegetation.

ACKNOWLEDGEMENTS

We would like to thank the Columbus Zoo, Ohio for financial support of the Barbados Sea Turtle Project in 1997.

ESTIMATION OF LEATHERBACK NESTING FEMALES IN MEXIQUILLO BEACH DURING 1995-1996 AND 1996-1997 NESTING SEASON USING PIT TAGS AND PHOTOIDENTIFICATION.

Patricia Huerta Rodríguez[1] and Laura Sarti Martínez[1 and 2]

[1]Lab. de Tortugas Marinas, Facultad de Ciencias, UNAM. Circuito Exterior, Ciudad Universitaria, México D. F. 04510. México. lsm@hp.fciecias.unam.mx

[2] Instituto Nacional de la Pesca. Pitágoras 1320, 5° Piso. México D. F. 03310. México

INTRODUCTION

The leatherback turtle (*Dermochelys coriacea*) in the Mexican Pacific was considered the most important in the world (Pritchard 1982). A drastic decline in the nesting numbers of this population has been observed in the past years

(Sarti *et al.*, 1996), enhancing the need of an accurate annual estimate of the number of recruit and remigrant females to this area.

In Playón de Mexiquillo, Mich., only monel tags were used for the identification of the nesting females until 1994; nevertheless, the high loss rate of this kind of tag avoids a proper evaluation of the number of females. Therefore, the use of alternative techniques for identification of turtles, using tags with a higher retention rate became a priority.

The use of PIT (*Passive Integrated Trasponder*) tags and photoidentification (PID) techniques using the pink spot responded to such priority (McDonald 1995, Dutton and McDonald 1994). Both techniques allow a longer-term monitoring of the individuals than the traditional tagging systems, since their permanence is higher, and the estimates calculated using a tag-recapture system are more accurate.

PIT tags are glass capsules that hold a microchip; they are injected in the muscle mass of the shoulder area in the leatherback turtle, and are detected by means of a portable reader (Dutton and McDonald 1994). Photoidentification of natural markings allows, using an image catalog, to have a record of turtles for identification; the "pink spot" in the head has been considered as a natural marking adequate for the characterization of each individual since its size and shape are different in every turtle (López *et al.*, 1992; McDonald 1995).

STUDY AREA

Playón de Mexiquillo is located in the south region of Michoacán State, Mexico, between the coordenates 18°09´46"N 102°52´07"W and 18°05´34"N 102°48´31"W. It has an extension of 18 km, from which 6.5 km were monitored and were the most important nesting area for *Dermochelys coriacea*.

METHODS

TRADITIONAL TAGGING

Monel Tags. Traditionally, nesting females are tagged by application of serial-numbered monel metal clamp, in the skin fold of the rear flippers, mainly on the left one.

ALTERNATIVE TAGGING

PHOTOIDENTIFICATION (PID). Photographs were taken from the pigmentation pattern seen in the dorsal surface of the head (pink spot and surrounding markings). For each photograph, a card was placed with the number of the monel tag for that female. A reflex camera was used, with a normal lens of 52 mm and black-and-white Kodak Plus-X-Pan film, 125 ISO and 2 flashes with a diffuser, one on each side of the camera to avoid glare and shadows in the images. The photographs were developed and printed manually in a dark room. The identification of turtles was made by visual comparison of the photographs, considering on first stance the shape, size and distribution of the pink spot, and as second criterion, the rest of the head pigmentation (McDonald, 1995).

PIT TAGS. As described by Dutton and McDonald (1994), PIT tags were placed in the left shoulder, previously disinfected, of each leatherback using AVID injectors and readers.

The alternative tagging systems were simultaneous to the application of traditional monel tags. PIT tagging and photographs were done while the turtle was laying eggs, monel tags were applied afterwards.

RESULTS

Table 1 shows the results of the tagging program in Mexiquillo beach for 2 nesting seasons

MONEL TAGS

Monel tags, although represent an easy and visible form of identifying a turtle, have some problems like low retention rate in the animal, possibly due to bad tagging technique or to being naturally rejected by the turtle's tissue (tags surrounded by necrotic tissue). Evidence of this is the high percentage of females bearing a tag scar each season.

PHOTOIDENTIFICATION

PID is a technique that allows the identification of individuals on the long term. The advantage of this technique is that it can detect recaptured individuals that have lost the regular monel tag, and that in other circumstances are considered like "new". However, this system doesn't allow immediate recognition of the turtle on sight, since it requires an extensive and detailed search on a catalog, aside the photographic process. This technique was used as a method parallel to the traditional monel tagging.

As part of the natural markings, the pink spot can be complemented with the rest of the pigmentation that surrounds it.

In order to obtain the best results is necessary to have an standardized method of shooting photographs, avoiding distortions of the image due to angle changing. It is also important to eliminate the excess of sand over the head markings or any other obstacle that spoils the adequate observation of the natural markings.

PIT TAGS

The application of PIT tags, is a system with a high retention rate for turtles (Dutton and McDonald 1994). As is the case of monel tagging, some experience is needed for preventing the loss of the PIT tag due to improper placement. The area of application must be disinfected as an infection-preventing measure. An important disadvantage is that, being internal tags, if no reader is available, the identification of the turtle is impossible.

Table 1. Results of tagging program in Mexiquillo, Beach during 1995-1996 and 1996-1997

Season	Total clutches (6.5 Km)	Nesting Females	Females Monel-tagged	Females Photoidentified	Females PIT- tagged
1995-1996	800	160-210*	162	92	-
1996-1997	60	14-16*	14	-	14

*Number of nesting females was estimated with clutch frequency and total number of clutches in the season.

DISCUSSION

Looking for new options of identification of individuals gets special importance in order to know the ecology and biology of the populations they form part of. Both PID and PIT tagging offer new alternatives for saturation tagging programs, since the loss rates are lower than the ones for traditional tagging. In the case of *Dermochelys coriacea* in Playón de Mexiquillo, the objective is to establish both systems as a complementary form, in order to follow in the long term the identified turtles and to estimate with a higher accuracy the number of nesting females.

The cost of monel tags and PITs, as well as the equipment, developing and printing process, and the time consumed in the analysis of the photographs, is compensated by the benefits obtained with the parallel use of the three techniques for the knowledge of the leatherback populations.

Our objective is to establish these identification methods in the five major nesting beaches for *Dermochelys coriacea* in the Mexican Pacific (Mexiquillo, Mich., Tierra Colorada, Gro., Llano Grande, Chacahua y Barra de la Cruz, Oax.), in order to gain a major knowledge of the population status of this species in the Mexican Pacific.

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DESIGN OF THE CENTER FOR INTERPRETATION, RESEARCH AND PROTECTION IN THE WILDLIFE REFUGE "CHOCOCENTE", SANTA TERESA, CARAZO, NICARAGUA

Carla Isabel Lopez Fernandez

Facultad de Arquitectura; Universidad Nacional de Ingenieria; Avenida Universitaria; Frente a la Escuela de Danza; Managua, Nicaragua. nicam@sdnnic.org.ni

The Wildlife Refuge "Chococente" is located on the Pacific coast, 130 Km from the capital, Managua. It is one of the eight priority areas that form part of The National System of Protected Areas and one of the two beaches on the Nicaraguan Pacific coast where masive nesting ("arribadas") of Paslama Turtles (*L. olivacea*) ocurr, as well as being an important nesting beach for Bull Turtles or Leatherbacks (*D. coriacea*). It also contains one of the last reducts of tropical dry forest with an extension of 4.800 has.

Due to the importance of Chacocente, this paper describes a proposed design for an ecotourism center inside of the area, dedicated to management activities, research and interpretation. It pursues the objective to provide this protected area with adequate infrastructure for such activities that could develop self-sufficiency in the future. At the same time viable alternatives of subsistence for the local population could be provided through participative ecotourism, research and interpretation.

ROLE OF THE MUNICIPALITY OF SANTA TERESA, NICARAGUA IN THE CONSERVATION OF SEA TURTLES IN CHOCOCENTE

José Antonio Martínez Narvaez
Del Centro de Salud 2 C. Al oeste, Santa Teresa, Carazo, Nicaragua. nicam@sdnnic.org.ni

As coordinator of The Environment and Natural Resources Commission of the municipality of Santa Teresa, Nicaragua, I have the responsibility of a major to protect the environment and the natural resources; it is a luck for this municipality to have 'arribadas' of olive ridley (*L. olivacea*) turtles and the visit of leatherbacks (*D. coriacea*) in only one mile of distance from each other, in recognition of our sea turtles potential we have with proud the symbol of a turtle in our shield of the municipality in Santa Teresa. the ancient experience we have with these sea turtles could give all the turtles specialists more knowledge of those they actually have

X´CACEL: PROPOSAL FOR THE ESTABLISHMENT AND MANAGEMENT OF A PROTECTED AREA

Benito Prezas Hernández, Roberto Herrera, and Julio C. Zurita.
El Colegio de la Frontera Sur. Unidad-Chetumal. A. P. 424. Chetumal, Quintana Roo, México, 77000. zurita@xaway.ciqro.conacyt.mx

INTRODUCTION

The state of Quintana Roo, has 14 areas legally protected, by state or federal official decree. Two belong to the continental zone and 12 to the coastal zone, in which are found important sea turtles nesting sites. Yum-balam, Isla Contoy and Sian Kaán Biosphere reserve are hawksbill *Eretmochelys imbricata*, nesting sites. Green *Chelonia mydas* and loggerhead *Caretta caretta* nest at these sites and also on the eastern part of Isla Cozumel and Tulum National Park. The studies made by Zurita *et al.* (1993) determined that the beaches with the greatest density of turtle nests are: Chemuyil, X'cacel and Aventuras DIF; in addition they recommended legal actions to be taken for their integral protection due to their biological characteristics, their biogeographic importance and their state of conservation, and the threat that prevails within the tourist corridor Cancún - Tulum.

The present state of the beach is fairly stable, despite the pressures of tourist development. The principle beaches of the area are owned by Fideicomiso Caleta de Xel-ha y del Caribe (FIDECARIBE), which was created to advance tourist development. X'cacel was owned by the federal government from 1972 to 1992, since 1993 it has been in the hands of the state.

In 1994 the Ecological group of the Mayab (GEMA) officially proposed incorporating X'cacel into the National System of Protected Areas (SINAP). The proposal includes the diagnosis asked for by the federal authorities, including the physical, biological, historical, cultural, investigation, legislation and socioeconomic aspects of the proposed area. The National Institute of Ecology has not answered GEMA's request. At the moment, the importance of X´cacel's beach is considered in the Management Plan of the tourist corridor Cancún - Tulum since it is in a zone of ecological protection (Gob. Est. 1994b). The same document indicates that the FIDECARIBE lands are subject to low density tourism developments, with up to 10 rooms per hectare. FIDECARIBE controls 1,800 hectares from Akumal to Xel-ha including the main nesting beaches of the marine turtles. In 1996 Prezas updated this proposal and established the category of appropriate handling.

The purpose of the present work is to provide a general panorama of the proposal to consider X´cacel as a protected area.

AREA

X´cacel is located along the eastern coast of the state of Quintana Roo, 112 km south of Cancún by way of the Puerto Juárez - Chetumal highway, in the tourist corridor Cancún - Tulum,. Xcacel is in the municipality of Solidarity. In the north it borders Chemuyil, in the south Xel-Ha, in the east the Caribbean Sea and in the west federal highway 307 (Figure 1). The total area is 311 hectares, of which 156 are in the terrestrial environment and 155 in the aquatic.

RESEARCH REVIEW

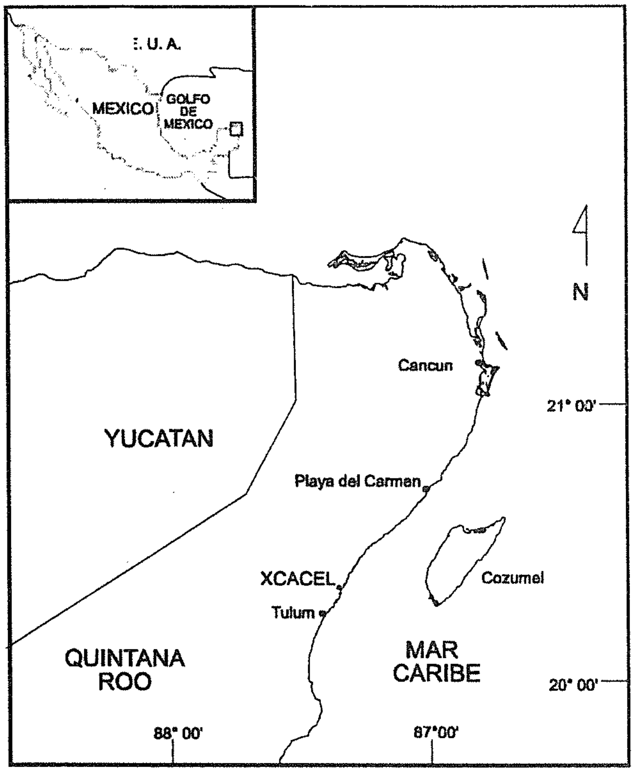
The relevant aspects of flora and fauna of the area are mentioned in the studies by GEMA (1994) and Prezas (1996). The aquatic habitat is represented by two cenotes and coral reefs. In the terrestrial area, it displays a disturbed zone, occuping extension of 2 hectares and represents 1.3 % of the total area; 15% corresponds to the secondary vegetation represented by an abandoned coconut plantation (*Cocos nucifera*), 83.7% of the area is made up of native vegetation in a good state of conservation in which subcaducifolia predominates the low forest. In the terrestrial habitat 137 plant species, 20 mammals, 11 amphibians, 24 reptiles and 44 birds were registered; in the aquatic habitat 23 species of algae, 23 corals and 109 fishes were registered.

Some of the species observed at X´cacel are considered under some kind of protection, either by the Mexican laws (Gob. Fed. 1994a) or by international norms (IUCN, 1988; 1989). For the species of plants: the palm kuka *Pseudophoenix sargentii*, Chit *Thrinax radiata*, Hoo´loop *Bravaisia tubiflora*, subi'n *Acacia dolichostach* and mangrove (*Rhizofora mangle*, *Avicennia germinans*, *Laguncularia racemosa* and *Conocarpus erecta*). Within the species of fauna: the marsh crocodile *Crocodylus moreleti*, the boa *Boa constrictor*, the marsh turtle *Kinosternon creaseri*, *Rhinoclemmys areolata*, and the loggerhead and green sea turtles.

Along the entire coast of Quintana Roo, Zurita *et al.* (1993) registered 1,331 to 2,166 loggerhead turtle nests and 481 to 2,296 green turtle nests, of these 60% of the loggerhead and 45% of the green turtle nests were found on the beaches in the central part of the state. In the sea turtle tagging program in the central part of Quintana Roo, Zurita *et al.* (1994, 1997) indicated that an average of 269 loggerhead and 120 green turtles were tagged. Preliminary data of the maximum efficiency intercepting nesting turtles on the main beaches is 75% for loggerheads and 89% for green turtles during the period of 1987 to 1995. Márquez (1976) estimated 500 nesting loggerhead turtles and, 283 to 420 green turtles nesting in Quintana Roo (Ogren, 1989).

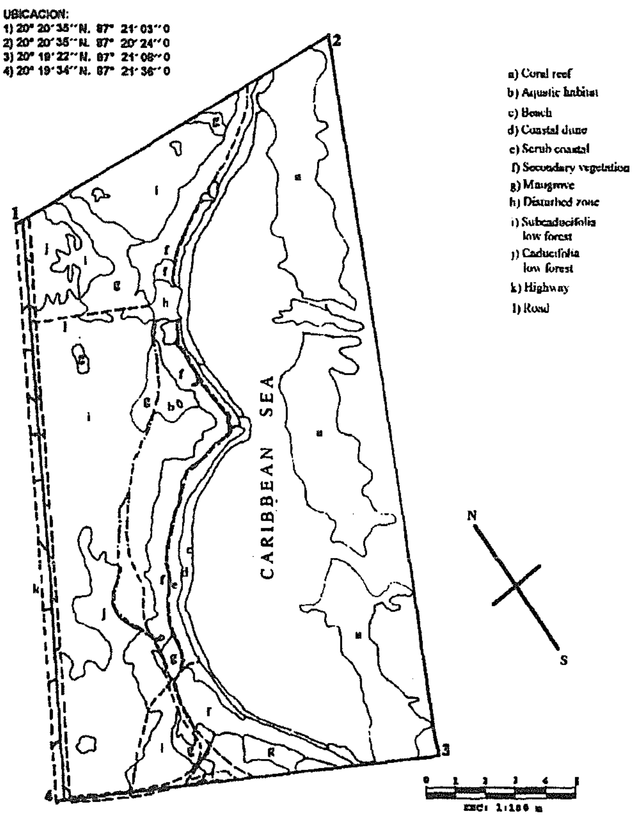
The relevance of conserving the main areas of these nesting colonies of loggerhead and green turtles, is based on: a) more than 10 years of investigation and conservation of these main nesting areas by the defunct Centro de Investigaciones de Quintana Roo, b) the investigations made by Dr. Brian Bowen and his team from the University of Florida, who indicate that a substantial portion of the diversity of mtDNA found among green turtles in the Atlantic resides in this population, and similar arguments can be made about the loggerhead turtles of this area c) eight years of environmental education activities have been carried out at this beach d) and finally X' cacel's present state of conservation.

Considering the ecological importance of the area X'cacel and the threat of tourist development the situation should be reviewed. The representatives of the three levels of government (Federal, State and Municipal), research centers, scientists with ecological knowledge and natural resource management experience, conservation groups, and the representatives from civil and private associations signed the document: Management Plan of the Tourist Corridor Cancun - Tulum (Gob. Fed. 1994a). This document indicates the following : « In the case of the realization of development projects or exploitation in the zone of X´cacel the following risks to the integrity of the ecosystem and the species in danger of, extinction that live there, such as marine turtles who depend on these beaches for their reproduction: a) erosion of dunes b) disturbance of the vegetation that controls the flow of water c) contamination and alterations of the physical, chemical and biological characteristics of the beaches d) disturbance of nesting female turtles and their nests e) disturbance caused by the artificial illumination of the beach and adjacent areas f) disturbance caused by noises generated by aquatic activities and g) disturbances in the reef and its platform, potentially able to alter the water flow. The viability study concludes that in the strip between the 60 m isobath and the Federal Highway Chetumal - Puerto Jua'rez, there should not exist any type of development. It is necessary to closely evaluate the proposal to include this coastal strip and its associated forest in the National System of Protected Areas. Finally, it is asked that in case the area is subject to sale, that conservationists groups who have promoted the protection of the area and sea turtles are given the right of first refusal». The UNEP/ACOPS report (1995) recommends permanent monitoring of the signed agreements, since there is a probability that this area will be sold for unsustainable tourist development which would cause ecological damage and is contrary to the above mentioned agreement.



Prezas (1996) analyzed the incidence of tourism in the area and evaluated alternatives such as a source of financing with controlled or low impact tourism, whose benefits would be utilized for the operation of the area and to support the activities of protection, investigation, conservation and environmental education. Following a simplified scheme to evaluate the suitable category of management for the protected area proposal by Mackinnon *et al.* (1990) and according to the natural values and suitable handling of the area. Prezas (1996) concludes that it should be considered as a Managed Natural Reserve, according to the proposed categorization by International Union Conservation Nature (IUCN), and that with respect to the National

System of Protected Areas (SINAP), it can be considered an area of protection of flora and wild fauna. GEMA (1994) proposes the creation of a local administration to manage X´cacel which would keep accounts available for public inspection and possibly giving greater stability to the project.



X´CACEL AND XCACELITO AREA

All the legal mechanisms that have been realized to protect the area are based within the structure of the Mexican Inter-ministerial Commission for Marine Turtle Protection and Conservation created in 1993, through the establishment of the National Committee for the Protection and Conservation of Marine Turtles (Gob. Fed. 1993b). This system of organization is reflected in the activities of the different institutions (SEMARNAP, INP, PRONATURA, Committee of Protection in Isla Cozumel, Ecological Group of Akumal, Amigos de Sian Ka´an, Xcaret and others) to protect the marine turtles in Quintana Roo (Isla Holbox, Isla Contoy, Cancun, Reserve of the Biosphere of Sian Ka´an, Xcaret Eco. archeological Park, Akumal, X´cacel and 10 beaches along the central coast, Mahahual and adjacent beaches) with the purpose of stabilizing these nesting colonies. Nevertheless, the sale of X´cacel was announced in February of 1998 by the state government of Quintana Roo for the development of a «Eco- tourist» project; similar to the ones on Aventuras-DIF and Chemuyil beaches in 1997. At the time of this writing the sale is pending.

CONCLUSIONS

There is increasing pressure to develop this area. All or part of the three of the critical beaches (Chemuyil, Aventuras-DIF and X'cacel) have recently been sold. If the state and federal authorities do not include the area of X´cacel in SINAP, then this risks the losing of one of the most important nesting sites for the green and loggerhead turtles. The recovery of these nesting colonies would be affected; therefore, it will be left in doubt the credibility of the actions made by the Mexican Inter-ministerial Commission for Marine Turtle Protection and Conservation. A substantial portion of the mtDNA diversity in Atlantic green turtles resides in this one nesting population, and similar arguments can be made for the loggerhead species. Consider the effects of the construction of tourist infrastructure in the nesting areas of Chemuyil and Aventuras DIF.

RECOMMENDATIONS

Therefore, we recommended an overhaul of the environmental impact studies and a permanent monitoring of development in these areas. That this area, X'cacel, vital to sea turtle reproduction be protected in a meaningful way.

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RESEARCH AND MANAGEMENT OF LOGGERHEAD SEA TURTLES, *CARETTA CARETTA*, AT THE CRIP SEA TURTLE RESEARCH STATION, BAHIA DE LOS ANGELES, BAJA CALIFORNIA, MEXICO

Antonio Resendiz S. Hidalgo[1 and 2], Beatris J. Resendiz[2], Jeffrey A. Seminoff[3], and Wallace J. Nichols[3]
[1]Centro Regional de Investigacion Pesquera, El Sauzal de Rodriguez, Ensenada, Baja California, México. bandaa@cicese.mx
[2]Sea Turtle Research Station, Apartado Postal 135, Ensenada, Baja California, México
[3]Wildlife and Fisheries Science, School of Renewable Natural Resources, University of Arizona, Tucson, Arizona 85721, U.S.A.

INTRODUCTION

The origin of loggerhead sea turtles (*Caretta caretta*) along the coast of Baja California has until recently been a mystery. Various authors have cited the abundance of subadult and adult individuals in this area (Shaw, 1947, Marquez,1969, Ramirez Cruz *et al.*, 1991, Bartlett, 1989), but no nesting areas along the eastern Pacific are known.

Sternberg (1981) speculated that *C. caretta* nested in Panama and Cornelius (1982) in Nicaragua, but these reports are unsubstantiated. Bartlett (1989) was the first to suggest that these animals originate in the western Pacific (Australia).

In 1993 a group of geneticists from the United States and Mexico investigated the genetic affinities between individuals captured as bycatch in the Pacific high-seas fishery and individuals along the Baja California peninsula (Bowen *et al.*,1995). They demonstrated that loggerheads found in the eastern Pacific had affinities with nesting populations in Japan (95%) and Australia (5%). Following this, two adult loggerhead sea turtles raised in the CRIP-Sea Turtle Research Station (STRS) and included in the Bowen *et al.*, survey were released along the Pacific coast of the Baja Peninsula in the summer of 1994. One of these two adults was later captured along the southeastern coast of Japan near Kyushu (Resendiz *et al.*, 1998). In the summer of 1996 an additional adult female raised at the CRIP-STRS was released with a satellite tag along the Pacific Coast of the Baja Peninsula. The trans-pacific migration of this turtle, "Adelita", has been followed by thousands of people over the Internet (Nichols, *et al.*, 1997) and she has recently completed the journey (Nichols *et al.*, in prep).

CRIP SEA TURTLE RESEARCH STATION

The CRIP Sea Turtle Research Station in Bahia de Los Angeles, Baja California, Mexico was founded in 1979. During times of a legal sea turtle fishery in Bahia de Los Angeles, the monitoring of this fishery was carried out by the local Canal de Las Ballenas fishing cooperative. Originally, all harvested turtles were inventoried at the Coronado Island lagoon north of town. In 1980 monitoring efforts were upgraded and a holding facility (later to become CRIP STRS) was constructed on the northern edge of Bahia de Los Angeles. The first studies of captive sea turtles at this facility occurred in 1981 when several juvenile loggerheads and black sea turtles were donated from the Canal de Las Ballenas fishing cooperative. The original goal was to house and rehabilitate turtles injured in fishing nets and keep undersized animals (< 75 cm) for studies and eventual release. In 1982, economic hardship in Mexico and declining sea turtle populations brought about the collapse of the fishing cooperative in Bahia de Los Angeles and marked the independence of the CRIP Sea Turtle Research Station.

METHODS

Loggerhead sea turtles (*Caretta caretta*) captured in the central province of the Gulf of California near Bahia de los Angeles, Baja California, Mexico (28 58 N,113 33 W) were held in outdoor circular concrete tanks (5 x 1.5 m). Turtles were fed a variable diet consisting of fish, shark, and ray in addition to seasonally available items such as the California sea hare (*Aplysia californica*), giant squid (*Dosidicus gigas*), mussels (*Modiolus capax*), blue swimming crabs (*Gallinectes arcuatus*), princely fiddler crabs (*Uca princeps*) and pelagic red crabs (*Pleuroncodes planipes*). Weight and straight carapace length were taken every month. Cleaning occurred every day. Tanks were shaded with plastic mesh. Turtles were identified with plastic tags placed on the front flippers. All loggerheads were released offshore from Santa Rosaliita, Baja California, Mexico (28°40' N, 114°12' W).

RESULTS

Loggerhead #1
ID# 309 and 39;
Origin: Donated from local Fish Coop. "Canal de Ballenas" BLA;
In Captivity: 1981-1994;
Released: July 19, 1994;
Growth: From 42.0 cm / 12.7 kg. to 79.8 cm /80.8 kg. (Female);
Comments: This loggerhead had the longest stay (13 yrs) at the STRS and was released with "Rosita" in 1994 (see Resendiz *et al.*, 1998).

Loggerhead #2
ID# 27 and 310;
Origin: Donated from a sport fisherman;
In Captivity: 1986-1994;
Released: July 19, 1994;
Growth: From 32.9 cm / 6 kg. to 85.6 cm / 97 kg. (Female);
Comments: 478 days after her release from Baja California waters, this turtle ("Rosita") was caught by a fisherman off-shore from Kyushu, Japan (Resendiz *et al.*,1998).

Loggerhead #3
ID# 38;
Origin: Donated by Canal de Las Ballenas Fish Coop.,BLA;
In Captivity: 1981-1991;
Released: Oct. 18,1991;
Growth: From: 46.7 cm. / 11.4 kg to 74.6 cm. / 69.9 kg. (Male);
Comments: Released with Loggerhead #4 (Resendiz *et al.*,1992).

Loggerhead #4
ID# 40;
Origin: Donated by Canal de Las Ballenas Fish Coop., BLA;
In Captivity: 1981-1991; Released: Oct. 18,1991;
Growth: From 36. 2 cm / 7.2 kg to 77.9 cm / 78.0 kg. (Female);
Comments: Released with loggerhead #3 (Resendiz *et al.*, 1992).

Loggerhead #5
ID# 37 and 333;
Origin: Donated by Canal de Las Ballenas Fish Coop., BLA;
In Captivity: 1982-1993;
Released: Donated to Museo*;
Growth: From 40.0 cm / 10.4 kg. to 65.4 cm / 48.12 kg. (Female);
Comments: This individual was donated to the Museo de La Tortuga, Mazunte, Oaxaca, Mexico for Pacific loggerhead exhibit (Nov. 1993).

Loggerhead #6
ID# 302;
Origin: Donated by local fishermen;
In Cap-tivity: 1986-1996;
Released: Aug. 10,1996;
Growth: From 29.9 cm / 4 kg. to 83 cm / 95.3 kg. (Female);
Comments: This turtle ("Adelita") was released with a Telonics ST-3 satellite transmitter supplied by the United States Fish and Wildlife Service. It has recently completed an east-west transpacific migration that was followed by many via the Internet (Nichols *et al.*, 1997).

Each of these six turtles was used in the initial genetic analysis of the Pacific loggerhead assemblage (Bowen *et al.*, 1995) and have been confirmed to have haplotypes consistent with those found on Japanese nesting beaches.

DISCUSSION

The migratory and genetic research that has been facilitated by this station has been important to our understanding of Pacific loggerhead ecology. The genetic analyses (Bowen *et al.*, 1995), the flipper tag recovery (Resendiz *et al.*, 1998), and the migratory route as demonstrated through satellite tagging efforts (Nichols, this symposium) all support the transpacific migratory nature of this endangered species. Movements that encompasses the entire North Pacific emphasize the importance of increasing the geographical scale of investigations and modifying our approach to sea turtle conservation to incorporate such vast migrations.

We suggest that efforts must continue to perform similar flipper-tagging and satellite tracking efforts with wild-caught individuals so that our findings may be supported. Regardless, the research efforts carried out at the CRIP-STRS illustrate the importance of an interdisciplinary approach to sea migratory studies and the benefit of cooperative multinational investigations of sea turtle biology.

ACKNOWLEDGEMENTS

We would like to thank the local community of Bahia de los Angeles (Ejido) and the hundreds of volunteers and fishermen who have been involved with this project. In addition, Dr. Grant Bartlett, One World WorkForce, Coastal Conservation Foundation were critical to the success of these projects. We would especially like to thank CRIP-PESCA, the Bartlett Lab, Foundation For Field Research, Sea Turtle Center, and University of Arizona for their generous financial assistance.

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TEMPORAL AND SPATIAL VARIATION OF THE HATCHING TEMPERATURE IN TRANSPLANTED LEPIDOCHELYS KEMPI NESTINGS AND THEIR INFLUENCE ON THE SEX RATIO, AND EGG SURVIVAL AND MORTALITY

G. Vázquez Luna[1], R. Sanchez Trejo[2], R. Márquez Millan[3], and R. Castro Melendez[1]
[1]CRIP- Tampico Tamaulipas, C.P. 89090, México.
[2]Lab. Ecología Costera y Pesquerías, UAM-X, A.P. 23182, C.P. 04960, México, D.F. México
[3]CRIP-Manzanillo, A.P. 591, Colima, C.P. 28200, México. rtrejo@cueyatl.uam.mx

The influence of temperature on the sex ratio has been studied for almost all the known species of marine turtles since the 1970's and in different parts of the world. Nevertheless, the influence of the thermal gradients which develop within the nests of *Lepidochelys kempii* on the determination of the sex ratio, and egg survival and mortality has scarcely been studied. The thermal gradients within the nests of this species were determined through temperature records obtained with thermocouple thermal sensors at different points and depths of the incubatory chamber during the months of maximums anidation of this turtle in Rancho Nuevo, Tamaulipas, México. The information thus obtained was further statistically studied in order to determine if significative thermal gradients ocurred, as well as, their relation to sex ratio, and egg survival and mortality. These results show significative differences in the temperature of the peripheral regions of the nest as compared to the core region which are due to the aggregation af the eggs at this latter and to the higher metabolic heat thus produced by the embryonic development. Nevertheless, these differences did not affect the sex ratio, as they ocurred after the critical period for the sex determination and did not exceed 0.4 °C. Egg mortality, which was 24 % could not be relatied to thermal defferences within the nest, as no correlation to temperature of the nest was statistically proven.

MARINE TURTLE PROJECT, TOLUCA BEACH - CESTA

Rafael Vela Nuila and Juan Carlos Sánchez.
Salvadoran Center for Appropriate Technology Kilometro 4, Carretera a San Marcos # 392, San Salvador, El Salvador. cesta@es.com.sv

The marine turtle is one of the many animal species important for the maintenance of the marine ecological environment and it also has historical importance. It is in danger of extinction and some of the principal reasons for this threat in El Salvador are:

1) THE OVER-EXPLOITATION OF EGGS.
2) PRAWN BOATS CAUSE OCCASIONAL DEATHS.
3) OCEANIC POLLUTION BY DOMESTIC AND INDUSTRIAL WASTES

As a result of this CESTA (Salvadoran Center for Appropriate Technology) started the MARINE TURTLE PROJECT at Toluca Beach, Department La Libertad, El Salvador in 1994. The aim of this project is the protection and conservation of marine turtles in order to maintain both the marine ecological balance as well as provide food for the people. The project has achieved one of these objectives by making possible the hatching of 30,000 small turtles of the species Olive Ridley (Lepydochelys olivacea). The success of this project is due to local families and their leaders living in the community. They have been involved in the construction of a hatchling nursery and two pools. An important part of this project was to strengthen community cooperation as well as develop relations with other institutions. One of our visions is to find an adequate alternative with the objective of benefiting local people as well as turtle egg collectors, with the idea to reduce the over-exploitation of turtle eggs as well as to improve the quality of life for the people and promoting in them the awareness of the threat to this turtle species. Hopefully, in the medium term we will achieve that the turtle egg collectors will not be totally dependent on turtle eggs for their income but will find other sources such as selling handicrafts, natural medicines and organic foods, nature walks for the public, etc. This would permit the reduction of egg collectors on the beach and the possibility to declare this a protected zone. This will allow the turtles to lay their eggs with less human intervention.

SEA TURTLES IN THE GULF OF VENEZUELA: A PRELIMINARY DIAGNOSIS

Tito Barros[1], Lenin Parra[2], Mayra Matos[2], and Lizbeth Caceres[2]
[1] Museo de Biologia, Facultad de Ciencias, Universidad del Zulia, Apdo. 526. Maracaibo 4011, Edo. Zulia, Venezuela lparra@solidos.ciens.luz.ve
[2] Departamento de Biologia, Facultad de Ciencias, Universidad del Zulia, Apdo. 526, Maracaibo 4011, Edo. Zulia, Venezuela

An inventory was made of all available reports concerning the presence of sea turtles in the Gulf of Venezuela, in order to start an evaluation of their current situation. The study area includes the coast of the Venezuelan Guajira, located at the northwestern extreme of Venezuela, as well as the shores of the Cienaga de los Olivitos Wildlife Refuge, at the northeast of the Gulf of Venezuela. In 1987, four species - *Chelonia mydas, Caretta caretta, Dermochelys coriacea* and *Eretmochelys imbricata* - were reported in this area. *C. mydas* is the most frequently reported species, and most of them have been individuals of immature size. This suggests that the Gulf is a foraging area for immatures. In 1995 a *Lepidochelys olivacea* was found on Caimare Chico beach. Several specimens of *Dermochelys coriacea* and *Eretmochelys imbricata* have been found stranded with portions of fishing nets around their bodies, which confirms the threat of incidental capture in fisheries. Several shells were also found along the coast. Sea turtles have traditionally been important as food in the diet of the Guajira people, and in recent years "Guajiros" have sold turtle products in Venezuelan towns and also Maicao, a nearby town in Colombia. We intend to update and complete information on the status of sea turtles in the Gulf of Venezuela by making an inventory of possible nesting sites, as well as documenting the effect of human activities on sea turtles in the area.

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OCCURRENCE, DISTRIBUTION AND ABUNDANCE OF GREEN TURTLES, *CHELONIA MYDAS*, IN LONG ISLAND, NEW YORK: 1986-1997

Kerin A. Berry[1], Marie E. Peixoto[1], and Samuel S. Sadove[1,2]
[1]Department of Natural Sciences, LIU Southampton College, Southampton, NY 11968, U.S.A.
[2]Puffin Consulting, P.O. Box 361, Jamesport, NY, 11947, U.S.A. bphysa1@pipeline.com

Loggerhead and kemp's ridley sea turtles have been studied extensively, but relatively little has been reported about the biology of juvenile green turtles in Long Island, New York. Tagging, morphology, and positional data was collected from 1986 through 1997 in cooperation with commercial fishermen.

A total of 81 individual green turtles was captured during the study period. The average number of turtles per year is 7.36±4.50 with a range of 0-19. Of the 81 turtles captured, 21%(n=17) were recaptured. In any one year the highest recapture rate was .75 during 1991.

The mean straight carapace length for all green turtles captured is 31.93±5.83cm (n=81); mean weight is 4.84±4.95kg (n=77). Growth rates were calculated for five turtles with recapture intervals of 25 days or greater. The mean growth rate for 30-40cm size class is 8.70±4.54kg/yr. The mean SCL growth rate is 6.33±1.87cm/yr

Green sea turtles generally arrive in Long Island during late July - early August and remain in the are until late October - early November with the highest abundance in late September and early October. Although green turtles were found throughout the Peconic Estuary there were clearly time dependent distributional trends. During arrival and departure periods turtles were found in eastern areas. During peak times green turtles were found in more western areas but widley distributed. Distributions were found to be highly correlated with submerged aquatic vegetation distributions.

Annual recapture rates indicate that more turtles are present in New York waters now than at the beginning of

TRACKING A SUBADULT *CARETTA CARETTA* THROUGH PUBERTY

Emma Hickerson and Dr. David Owens
Department of Biology, Texas A&M UniversityCollege Station, TX 77843, U.S.A. emmah@bio.tamu.edu

Sea turtles either residing at or passing through the Flower Garden Banks National Marine Sanctuary have been studied since fall 1995, Scientific divers captured a subadult male *Caretta caretta* in June, 1995, and on two subsequent occasions over a period of 19 months, Documentation of the development of secondary sex characteristics over this time period indicate that this Individual a going through puberty. Satellite and radio tracking data suggest strong site fidelity during this life history stage. Data suggest that the Flower Gardens may provide feeding habitat for *Caretta caretta* subadults.

SEA TURTLE FEEDING GROUNDS OF BRAZIL

Maria Ângela Marcovaldi[1], Augusto C. C. D. da Silva[2], Berenice M. G. Gallo[3], Cecília Baptistotte[3], Claudia F. Vieitas[3], Claudio Bellini[2], Eduardo H. S. M. Lima[3], Jaqueline C. de Castilhos[3], João C. A. Thomé[2], and Taisi M. Sanches[3]
[1] Fundação Pró-TAMAR National Coordination - CP2219, Salvador – BA, 40210-970, Brazil. protamar@e-net.com.br
[2] TAMAR-IBAMA/Fundação Pró-TAMAR Regional Coordinators
[3] TAMAR Technical Coordinators

The main sea turtle nesting sites in Brazil have been protected since 1980 by TAMAR (Brazilian Sea Turtle Conservation Program), a federal government initiative of IBAMA (Brazilian Institute for the Environment), co-managed by Fundação Pró-TAMAR, a non-governmental organization. Since then, TAMAR has also collected information on dead and stranded turtles found along the Brazilian coastline. Of the seven species of sea turtle existing in the world, five are found in Brazil: loggerhead (*Caretta caretta*), green (*Chelonia mydas*), leatherback (*Dermochelys coriacea*), hawksbill (*Eretmochelys imbricata*) and olive ridley (*Lepidochelys olivacea*) (Marcovaldi and Marcovaldi 1987). Following the establishment of conservation and research stations at the main nesting areas, TAMAR began in 1991 to work in the main feeding grounds, where the levels of incidental capture is high (Marcovaldi 1991). Initial efforts to increase at-sea protection of marine turtles found in feeding areas were at Ubatuba and afterwards in Almofala and Pontal do Peba (Figure 1). In addition, some of the nesting beaches also support regular numbers of turtles that feed, mate, and rest in the nearby coastal waters. All stations collect information on dead and stranded turtles found along the beaches.

As was done with data from nesting turtles, a database has been created to organize and standardize the collection of information in the feeding grounds. Date, time of occurrence, condition of turtle (alive, dead or drowned), curved carapace length and width, species, sex (when possible), tag

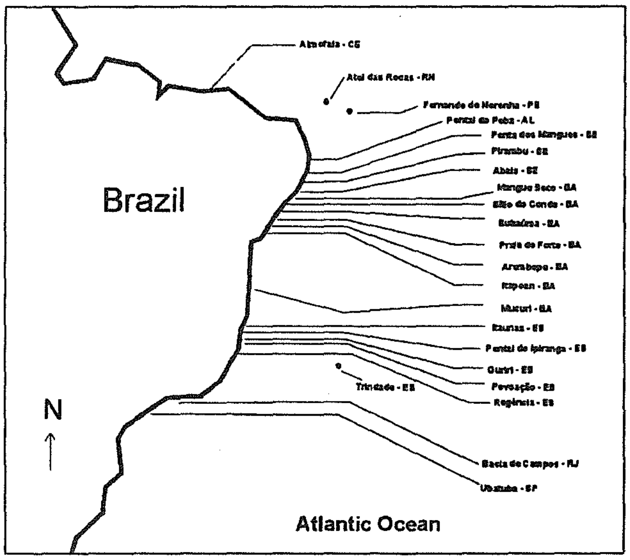

Figure 1. Location of TAMAR stations in Brazil

number and the final outcome (dead, released at sea, or held in recovery tanks) are all recorded. Important notes are also recorded through key words in a specific field of the database. Data recording goes through the following steps: a field notebook, a regional database and the national database where all the information is gathered and kept. Detailed information has been gathered on the fishing methods that most often capture marine turtles in Brazilian coastal waters where TAMAR is working, and is now being described and compiled in a manual (Fundação Pró-TAMAR, in prep.). Fishing methods are mostly artisanal, the most common being: floating weirs, set nets and fish traps. This census will help to identify the main threats to the turtles in their feeding grounds and also aid the development of appropriate management and conservation strategies necessary to address their impacts.

The overall results obtained so far reveal specific characteristics of each area, which enables TAMAR to apply specific methodologies for their management. Depending on the physical and cultural characteristics of the feeding grounds, the work is divided into two major strategies. First, environmental education is undertaken at sites with high levels of capture, with the aim to alert the local fishermen of the threats of some fishing techniques to sea turtles and the marine environment. Through the campaign "Not everything caught by the fishing net is fish," techniques of reviving captured turtles that are unconscious are taught to the fishermen and the coastal communities in general. The campaign involves informal conversation, video presentations (a special 5 minutes animation video was made for this purpose), and distribution of leaflets and posters. Hiring the people involved in fisheries activities to work for the protection of turtles checking the nets for turtles and orienting other fisherman about better spots for placing nets, as well as creating new ecologically sound economic alternatives are all part of the program. The TAMAR Program intends to revive and maintain the cultural identity of the coastal areas by employing techniques that directly involve the coastal communities, such as promoting festivals and parties with the sea turtle image as the theme. This strategy is used mainly at the Ubatuba and Almofala stations (Figure 1).

Table 1. Number of dead turtles recorded by TAMAR along the Brazilian coastline since 1980.

SPECIES	NUMBER
Chelonia mydas	953
Eretmochelys imbricata	45
Caretta caretta	154
Lepidochelys olivacea	202
Dermochelys coriacea	10
Non identified	1530
TOTAL	2894

The second strategy that began in 1987 is in water research studies on behavior and growth parameters of marine turtles, and takes place at sites with good diving conditions. Researchers capture sea turtles through free diving, tag the individuals, and take notes on weight and curved carapace length and width (Bellini and Sanches 1996). Tags used are Inconel (model # 681), and are placed one on each of the front flippers, at the trailing edge proximal to the first scale. After which, turtles are immediately released to the sea. As the capture of turtles using free diving is a specialized skill, currently TAMAR is undertaking to train its interns and permanent staff in these techniques. This occurs mainly in Fernando de Noronha and Atol das Rocas (Figure 1).

Of 6561 records, only 44.1% correspond to dead and stranded individuals. In the majority of the cases, the cause of death could not be identified, due to advanced decomposition, which could indicate that these deaths occurred off shore or in harbors away from TAMAR stations. Table 1 presents data on dead turtles found along the coast by species. In Alagoas State (Pontal do Peba- AL) (Figure 1), most turtles were already far too decomposed to enable the identification of the species or cause of death.

In Bahia (BA) and Espírito Santo (ES) States set nets are a common fishing device that capture sea turtles, and in Sergipe State (SE) semi-industrial shrimp trawlers are common.

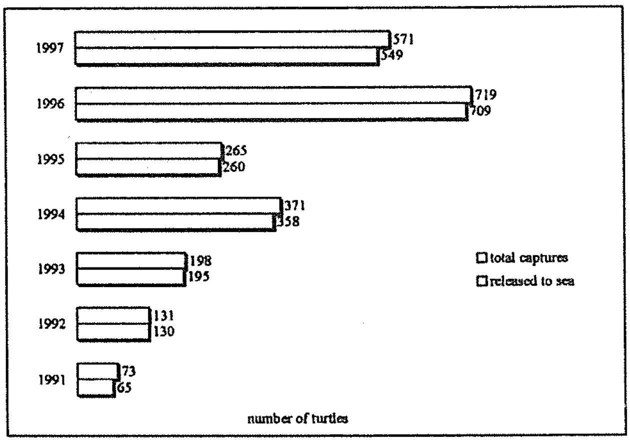

Figure 2. Number of turtles captured on fishing devices and safely released to the sea by TAMAR

The records of turtles captured in fishing devices are mainly from the fishing communities of Ubatuba (87.3%) and Almofala (6.7%), where most of the turtles were safely released to the sea (98.5% at Ubatuba and 98.7% at Almofala). In Ubatuba, most of the turtles captured (98.3%%) were *Chelonia mydas*, where carapace measurements suggest a population of juveniles and subadults (Table 2). Floating weirs are the fishing devices that more often capture sea turtles in the area (79.6%). At Almofala the greatest majority of individuals were also *Chelonia mydas* (92.5%), and carapace measurements suggest a population of juveniles to adults (Table 2). Fish traps are the fishing devices that more often capture sea turtles in this area

Table 2. Records of green turtle (Chelonia mydas) captures in Ubatuba and Almofala Stations; CCL = curved carapace length, CCW = curved carapace width, weight in kg.

Station	Max CCL (cm)	Min CCL (cm)	N	Max CCW (cm)	Min CCW (cm)	N	Max weight	Min weight	N
Ubatuba	96.0	27.0	2141	91.5	21.0	1944	2.4	83.0	2019
Almofala	120.0	27.0	170	113.0	21.0	170	-	-	-

(91.2%).

In Atol das Rocas and Fernando de Noronha (Figure 1), 1127 captures of sea turtles were recorded during underwater studies, being 770 captured at the first station and 357 at the latter one. The species most frequently captured were *Eretmochelys imbricata* and *Chelonia mydas* in both places (Table 3).

Because individuals are tagged before release, upon recapture data on growth rates and behavior are obtained.

Table 3. Records of sea turtle captures in Femando de Noronha and Atol das Rocas Stations; CCL = curved carapace length (in cm), CCW = curved carapace width (in cm), weight in kg.

STATION	Max CCL	Min CCL	N	Max CCW	Min CCW	N	Max Weight	Min Weight	N
F. Noronha									
E. imbricata	84.0	30.5	395	68.0	26.0	287	42.0	1.5	277
C. mydas	81.0	32.0	73	73.0	28.5	36	31.0	3.8	40
Atol das Rocas									
E. imbricata	86.5	35.0	153	75.0	32.0	133	51.0	6.5	29
C. mydas	65.0	33.5	160	75.0	30.0	151	22.0	4.5	22

When capture happens away from the beach, researchers only tag and measure the turtles, without weighting them. At Atol das Rocas, the same methodology is also used for adult individuals that reproduce in the area, which are not weighted due to their dimensions (Table 4). The only species nesting there is *Chelonia mydas*.

The number of turtles saved and released at sea is increasing annually at TAMAR stations (Figure 2). Through these research and conservation activities, TAMAR is gaining a better understanding of sea turtles at different life history stages, and is working to protect them as well as their habitats. All work is carried out with due consideration of the environmental, social, economic and cultural conditions of the local communities.

Table 4. Biometric parameters of C. mydas captured at Atol das Rocas using free diving.

	Max CCL (cm)	Min CCL (cm)	N	Max CCW (cm)	Min CCW (cm)	N
Males	118.0	85.0	54	110.0	85.0	54
Females	132.0	110.0	8	117.0	102.0	8

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SIZE CLASS OF SEA TURTLES IN NEW YORK FROM 1986 TO 1996

David P. Reynolds[1] and Samuel S. Sadove[2]

[1] Dept. of Bioscience and Biotechnology, Drexel University, Philadelphia, PA 19104 U.S.A. reynoldsdp@juno.com

[2] Puffin Consulting Inc., PO Box 361, Jamesport, NY, 11947 U.S.A.

Sea turtle occurrence is seasonal in the temperate waters around Long Island, New York and appears to provide important summer foraging habitat for juvenile sea turtles. Sea turtles regularly caught in commercial fishing gear (pound nets) in near shore embayments are loggerhead (*Caretta caretta*), Kemp's ridley (*Lepidochelys kempii*) and green (*Chelonia mydas*) sea turtles. These captures are a result of an ongoing program with commercial fishermen. Upon capture, straight carapace length (SCL), width, and mass were measured. We tagged turtles with either a Passive Integrated Transponder (PIT) tag or a Monel Tag. All data was recorded for the New York Sea Turtle Stranding and Salvage Network and the NMFS Cooperative Marine Turtle Tagging Program.

The sea turtles that were retrieved from pound nets were used in various studies. The studies reported mean straight carapace lengths (SCL) for three species of sea turtles. Standora *et al.* (1989) examined growth rates and movements of Kemp's ridleys (mean SCL = 29.4 cm) in New York. Telemetry studies were also done by Standora *et al.* (1991) on Kemp's ridley (mean SCL = 30 cm). Investigation on the diets of green turtles (range 25 to 40 cm) (Burke *et al.*, 1991), Kemp's ridleys (mean SCL = 32.5 cm) (Burke *et al.*, 1994) and juvenile Kemp's ridleys (mean SCL = 32.8 cm) and loggerheads (mean SCL = 50.1 cm) (Burke and

Standora, 1993) were performed using pound net captures. Additional SCL were reported for cold-stunned greens (mean SCL = 32.7), Kemp's ridleys (mean SCL = 29.4 cm) and loggerhead (mean SCL = 49.5 cm) sea turtles in New York (Morreale *et al.*, 1992).

Age estimations are based on SCL of nesting female turtles (Frazer and Ehrhart, 1985). Caillouet *et al.* (1995) used 600 mm SCL and Marquez-M (1994) used 650 mm SCL for the estimate of age at sexual maturity. The reported mean SCL for the sea turtles in New York between 1986 to 1996 indicate that these loggerhead (mean = 49.4 cm, SD = 1.34), Kemp's ridley (mean = 30.2 cm, SD = 1.43), and green (mean = 32.2 cm, SD = 4.54) sea turtles are juveniles.

We compared the variance of SCL within each species for loggerhead (n = 233), Kemp's ridley (n = 107) and green (n = 80) sea turtles that were caught in pound nets in New York waters between 1986 and 1996. The null hypothesis is that there is no significant difference in the mean SCL for loggerhead, Kemp's ridley and green sea turtles from 1986 to 1996. The alternative hypothesis is that there is a significant difference in mean SCL for loggerhead, Kemp's ridley and green sea turtles from 1986 to 1996. We fail to reject the null hypothesis that there is no significant difference in the mean SCL for loggerhead ($p = 0.5525$), Kemp's ridley ($p = 0.5584$) and green ($p = 0.3492$) sea turtles from 1986 to 1996. The likelihood that a Type I error was made was set by (= 0.05. According to the data, there is no significant difference in the mean SCL for loggerhead, Kemp's ridley and green sea turtles over the 10-year period.

The analysis of the data showed no significant difference in the variance of SCL of three sea turtle species over a 10-year period. Sea turtles captured in near shore waters around New York during the summer have been considered to be juvenile and sub adults based on SCL. The reported means of SCL in previous studies using pound net captured sea turtles were similar to those found in this analysis. This study indicates that there has been no significant change in mean SCL of three species of sea turtles over a 10-year period. The size class of the three species of sea turtles comprises the majority of sea turtles that occur in New York waters. This analysis also provides further support that for some juvenile and sub adult sea turtle species, the Northeast U. S. is an important summer foraging habitat.

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Special thanks are owed to the commercial fishermen of Long Island. We thank all the volunteers who have collected data over the last ten years. We also thank Dr. Mike O'connor for comments on the data analysis.

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GENETIC POPULATION STRUCTURE OF THE LEATHERBACK TURTLE IN THE EASTERN PACIFIC: CONSERVATION IMPLICATIONS

Ana R. Barragán[1] and Peter Dutton[2]
[1]Laboratorio de tortugas marinas, facultad de ciencias, unam. Circuito exterior c.u México D.F. 04510, México
[2]Noaa-nmfs southwest fisheries science center. La jolla, ca 92038, U.S.A. arbr@hp.fciencias.unam.mx

Genetic techniques have given a fast and relatively easy way to handle some basic management problems for sea turtle populations, that can't be solved using traditional monitoring techniques such as tagging. During the past few years, genetic studies have shed light in some of the biological characteristics of the leatherback turtle (*Dermochelys coriacea*) in the Eastern Pacific, and have made significant contributions to conservation programs for the species. During these studies, samples taken from the major rookeries in Mexico and Costa Rica were analyzed for several loci (mithocondrial DNA and microsatellites), in order to assess the population structure of this species in the Eastern Pacific. None of the two kinds of DNA studied, mithocondrial or nuclear, showed evidence of population substructuring. Concordance among the results with different loci, high haplotypic diversity and high values of Nm suggest a significant degree of contemporary gene flow between all the nesting colonies within Mexico; this conclusion is supported by a few recaptures of tagged females found nesting in different beaches in the same season. Comparing the populations of Mexico and Costa Rica, a low level of population subdivision as well as high values for Nm are also observed, which suggest the same degree of gene flow, yet recent common ancestry can't be discarded as an explanation. These results support the idea that the nesting colonies in the Mexican Pacific belong to the same Management Unit (MU) as described by Moritz, 1994, which possibly includes the Costa Rican population. If this is true, institutions working in the conservation of the leatherback in the Eastern Pacific must collaborate closely together to effectively protect this species.

GENETICS OF MEXICAN BLACK TURTLE ROOKERIES BASED ON mtDNA D-LOOP SEQUENCES- PRELIMINARY RESULTS

Omar Chassin Noria[1], Daniel Piñero D.[1], Peter Dutton[2], Javier Alvarado[3], and F. Alberto Abreu Grobois[4]
[1]Laboratorio de Genética y Evolución. Instituto de Ecología, UNAM. A. P. 70-275., México, D. F. C. P. 04510 ochassin@miranda.ecologia.unam.mx
[2]NOAA-NMFS Southwest Fisheries Science Center P. O. Box 271. La Jolla CA 92038
[3]Instituto de Investigaciones sobre Recursos Naturales, UMSNH. Santiago Tapia No. 517. Morelia, Michoacán, México. C. P. 58000.
[4]Laboratorio de Conservación y Manejo de Recursos Bióticos, Estación Mazatlán, Instituto de Ciencias del Mar y Limnología UNAM, Apdo. Postal 811 Mazatlán, Sinaloa México C. P. 82000

The black turtle, *Chelonia agassizi* nests at more than a dozen beaches on the coast and islands of Western Mexico. More than 90% of its nests are found in Colola and Maruata beaches in Michoacán state. The systematic status of this turtle has been debated recently, as its alleged singularity (particularly with respect to other Pacific basin *Chelonia* populations) in terms of biogeographic isolation, carapace coloration and shape, breeding skull morphology and reproductive biology may not be sufficiently compelling to classify as an independent taxonomic category. It is of interest that previous molecular genetic analyses, using RFLP and sequences of mtDNA and nDNA loci, do not support a genetic distinctiveness of the black turtle (Dutton *et al.*, 1996; Bowen and Karl, 1997). Nonetheless, these studies, although indicative, have suffered from low sample sizes and rookery coverage to be conclusive.

This study is extending previous genetic surveys to a greater number of rookeries and utilizing larger sample sizes. Based on the sequencing of the d-loop of mitochondrial DNA, it seeks to ascertain the extent of genetic structuring of these assemblages and their relationship to other rookeries in the Pacific that have also been studied with the same methods. which should provide a better understanding of the evolutionary relationships among *Chelonia* populations and aid regional management strategies.

Preliminary comparisons of D-loop sequences from Colola individuals (N=36) and those from other portions of the Chelonia range in the Pacific basin are discussed. Within the 36 sequences analyzed there were found two haplotypes that differ in three positions, the frequency value of Haplotype E was of 0.611, whereas Haplotype F was of 0.3889. The estimated values of haplotype diversity (h) was of 0.4888

± 0.0408 and the nucleotide diversity (π) was of 0.003612 ± 0.00249.

The haplotypic diversity is the probability that two haplotypes taken at random from the population should be different and the nucleotide diversity is the probability that two nucleotides with homologous positions taken at random should be different; therefore, at larger values of this quantities corresponds a higher genetic diversity of the population.

The genetic variability could be reduced in small populations and a scarce variability diminishes the capacity for adaptation to environmental changes because the fitness of each individual is limited.

The diversity values found in this investigation are high in comparison to the results obtained in Costa Rica, Surinam and Ascención (Encalada, 1996); although their beaches, just as Michoacan's, have a similar number of nests per year. Besides, the variability values obtained in Michoacán are somewhat lower than the ones from beaches with a less number of nests per year, like Quintana Roo, Florida and Brazil (Encalada, *op. cit*). For making comparisons it would be important to obtain results from other beaches and ideally to compare them with a "healthy" population. As a preliminary statement it could be said that the genetic variability of the *Ch. agassizi* from Michoacán hasn't been diminished in spite of the reduction of individual numbers in the last decades.

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MATING SYSTEM OF CARIBBEAN LEATHERBACK TURTLES AS INDICATED BY ANALYSIS OF MICROSATELLITE DNA FROM HATCHLINGS AND ADULT FEMALES

Caitlin Curtis[1], Charlene J. Williams[2], and James R. Spotila[3]
[1]Department of Bioscience and Biotechnology, Drexel University, Philadelphia, PA 19104, U.S.A.
[2]Department of Medicine, Division of Rheumatology, Thomas Jefferson University, Philadelphia, PA 19107 U.S.A.
[3]*School of Environmental Science, Engineering, and Policy, Drexel University, Philadelphia, PA 19104, U.S.A.*
caitlincurtis@hotmail.com

We examined the mating system of leatherback turtles, *Dermochelys coriacea* on the Caribbean coast of Costa Rica in 1996. We collected 5-50 µl of blood from 35 nesting females and 20-30 hatchlings from 18 nests of those females. We stored blood in Longmire's solution and on PCR DNA sample isolation paper. We used primer sets (Ei8 and Cc117) from *Caretta caretta* and *Eretmochelys imbricata* (FitzSimmons *et al.*, 1995) and (Dc99) from *D. coriacea* (Dutton, 1995) in PCR reactions to amplify microsatellite (CA)n/GT)n regions from leatherback DNA. We screened families at two loci, and if further clarification was needed, at Dc99 as well. If more than 2 paternal alleles were detected we assumed they came from more than one male. There was no difference in amplification of microsatellite regions between blood stored in lysis buffer or on sample isolation paper. The DNA paper is superior for collecting DNA samples in the field. Single maternity occurred in 10 of 11 nests. Multiple maternity occurred in one nest. Successive nests laid by one female contained the same paternal alleles in both nests indicating that they were fathered by the same male. These results differ from Pacific leatherbacks (Rieder, *et al.*, 1998) which appear to have a polygynous mating system at Playa Grande, Costa Rica. The mating system in the Caribbean would maintain more genetic variation in the population and may be related to its greater population size.

TENDENCY TOWARD SINGLE PATERNITY IN LEATHERBACKS DETECTED WITH MICROSATELLITES

Peter H. Dutton[1], Elyse Bixby[1], and Scott K. Davis[2]
[1]National Marine Fisheries Service, Southwest Fisheries Science Center, La Jolla Laboratory, P. O. Box 271, La Jolla, CA 92038, U.S.A. peterd@cliban.ucsd.edu
[2]Dept. Animal Sciences, Texas A&M University, College Station, TX 77843, U.S.A.

Molecular techniques provide new tools for peeking into the sex life of sea turtles. Observations on courtship and mating in leatherbacks are almost non-existent, although sea turtles are generally presumed to be promiscuous based on extensive studies of green turtles (Alvarado and Figueroa, 1991). FitzSimmons (1996) surprisingly found that multiple paternity was rare in Australian greens. Leatherback paternity studies to date have been invalid due to an insufficient number of reliable polymorphic loci. We have identified informative new microsatellite loci, and have sampled successive clutches laid by the same females over a three month period in St. Croix, U.S. Virgin Islands. A total of 6 loci were used to construct the genotypes of nesting females and their offspring. Loci were amplified by PCR using fluorescent dye-labelled primers analyzed on a 377A ABI automated sequencer with GENESCAN. Paternal genotypes were inferred by comparing the known offspring and known maternal genotypes.

Using allele frequencies for the St. Croix nesting population, the probability of detecting multiple paternal alleles (d) was determined for each locus and across all loci (D) (see FitzSimmons, 1996). The probability of detecting multiple paternity was relatively low for some individual loci (DC99 and N32 in particular), combined D for all 6 loci was 99%. Analysis of data from a total of 178 hatchlings from series of 3 to 5 clutches (n=17 total) laid by each of 4 females, did not reveal any evidence of multiple paternity. Unexpected paternal alleles were detected in four cases; however, since in each case these alleles were only present at one locus, they were considered to be mutations rather than contributions by a second male. Two instances of mutation of the maternal allele were also detected in this way. Mutation rates were highest in DC2-95, one of the most polymorphic loci. The lack of multiple paternity in this study corroborates previous findings with microsatellites for green turtles in Australia (FitzSimmons 1996), and suggests either that female leatherbacks rarely mate with multiple males (perhaps as a result of behavioral factors, like competition, or because they rarely encounter them), or that sperm competition occurs. Either scenario would require the ability to store sperm. The detection of mutation within one generation turnover emphasizes the importance of using multiple loci when attempting to detect multiple paternity with microsatellites. Samples from additional females are presently being analyzed.

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MORPHOLOGICAL COMPARISONS IN SKULLS OF LOGGERHEAD TURTLE, *CARETTA CARETTA*, AMONG THREE ROOKERIES OF AUSTRALIA, FLORIDA AND JAPAN

Naoki Kamezaki and Masafumi Matsui
Graduate School of Human and Environmental Studies, Kyoto University, Japan. JCG03011@niftyserve.or.jp

The loggerhead turtle, *Caretta caretta*, is widely distributed in the Atlantic, Pacific, and Indian oceans, mainly in subtropical and temperate waters. Comparative morphometric study is useful for determining taxonomic relationships within an animal group, but few such data are available for this species. We investigated geographic variation in skull morphometrics among three localities (Australia, Florida, and Japan). Twenty-four measurements were examined for 108 skulls. In the canonical discriminant analysis, the Japan sample was completely separated from the other two samples on the first canonical axes. The stepwise discriminant analysis chose five measurements that were greatest contributors to separate samples. In the canonical discriminant analyses using these five measurements (height of nasal opening, length of secondary palate, width of preorbital, cranial length, and height of premaxilla), most of the Japan specimens were separated from other two samples on the first and second canonical axes. Discriminant analysis showed that all specimens from Japan were classified correctly, but 6% of the Florida were misclassified to the Australia samples. These results showed that the Japan sample is notably distinct from the Australia and Florida samples. But, there is no single skull character that perfectly distinguishes the one local sample from others. Therefore, we think it better to consider this species to be monotypic.

THE USE OF SHADE OVER OLIVE RIDLEY, *LEPIDOCHELYS OLIVACEA*, HATCHERIES

Carlos Roberto Hasbún[1], Mauricio Vásquez[2], Emilio A. León[3], and Carlos Thomas[3]
[1] Department of Biological Sciences, University of Hull, Hull, HU6 7RX, U.K. c.hasbun@bioci.hull.ac.uk
[2] Servicio de Parques Nacionales y Vida Silvestre, Ctn. El Matasano, Soyanpango, El Salvador
[3] Asociación Ambientalista AMAR, Rep. Palomo 1314, Col. Layco, San Salvador, El Salvador

The Asociación Ambientalista AMAR in joint effort with the National Parks and Wildlife Service of El Salvador, initiated in 1989 a sea turtle conservation program in Barra de Santiago, close to the Guatemalan border. The use of artificial shade over hatcheries to incubate olive ridley, *Lepidochelys olivacea*, eggs has been considered as a product of observing low hatch success rates between 0% and 40%, from nests left under total sunlight during the months of August and September of 1989 through 1992.

During the first week of August of both 1991 and 1992 field seasons (August through December) three hatcheries with different amounts of shade, approximates of 100% (total shade: no direct rays of sun entering horizontally to the hatchery but being well illuminated), 50% (partial shade) and 0% (no shade), were built to study the hatchery thermal regimes and its effect on hatch success rates. Since 1989, hatchery walls have been constructed of stripped coconut palm fronds. These fronds of approximately 1.5 m in length by 1 to 3 cm in width, are nailed vertically to a wooden frame leaving a space of 1 to 2 cm from each other. Unstripped coconut palm fronds were used as shade. The amount of shade cast over the nests was established by observing the ratio between direct sun light and shade over 1 m^2 at different locations inside the hatchery at 12:00 p. m. Surface and 35 cm in depth sand temperatures were recorded twice daily. Sand moisture content at 35 cm in depth from all hatcheries was measured on a monthly basis.

During 1991, hatch success rates expressed as percentages were as follows: 90.2% with total shade (80 nests), 79% with partial shade (12 nests) and 40% with no shade (40 nests). Low hatch success rates between 0% and 15% observed in the hatchery with no shade, corresponded to the eggs incubated during August when sand temperatures at 35 cm in depth averaged 34.4°C, with a maximum of 35.5°C. These high temperatures were considered as probable causes of low hatch rates. Temperatures lowered after the first week of September through December, documenting an average temperature of 32.5°C with a range of 29.8°C to 33.8°C. Average moisture content of the sand in all hatcheries throughout the season was 10.5%. These did not vary significantly between each hatchery.

During 1992, hatch success rates were as follows: 85.7% with total shade (11 nests), 87% with partial shade (38 nests) and 8.8% with no shade (10 nests). Temperatures from the hatcheries under total shade and partial shade remained relatively constant throughout the season with a monthly average of 29.5°C, range (r) 28.3°C-30.0°C and 29.8°C-30.8°C respectively. On the other hand, temperatures recorded from the hatchery with no shade averaged 34.1°C, r = 33.5-35.5°C, in August and 33.7°C, r = 32.5-35°C, in September. After September, temperatures stabilized to an average of 32.5°C in October. Similar to 1991, sand moisture content was not significantly different in all hatcheries, averaging 11.2% throughout the season.

Considering the documented pivotal temperatures which produce a 1:1 sexual ratio in olive ridley hatchlings and the hatch success rates observed in these studies, partial shade in all hatcheries in El Salvador has been used since 1992, especially during August and September. However, and due to temperature sex dependency, hatchery thermal regimes are monitored twice a day to avoid possibilities in skewing sexual ratios and lowering hatch success rates. In addition, palm fronds used as shade are not fixed to the roof structure, and often, are positioned so as to increase or reduce the amount of shade over the nests as to maintain a desired temperature range between 30°C and 31°C.

ACKNOWLEDGEMENTS

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REPRODUCTIVE BIOLOGY OF THE BLACK TURTLE IN MICHOACAN, MEXICO

Javier Alvarado Diaz[1]**, Carlos Delgado Trejo**[2]**, and Alfredo Figueroa Lopez**[2]
[1]Instituto de Investigaciones sobre los Recursos Naturales U.M.S.N.H. Aptdo. 35-A, Morelia, Michoacán 58000, México jadiaz@zeus.ccu.umich.mx
[2]Fac. Biología U.M.S.N.H. México

Seven years of data (1986-1992) on nesting periodicity, nesting frequency, egg cluctch size and remigratory intervals of the black turtle in Michoacan are presented. Information about relative clutch mass and size and weight of hatchlings and eggs is also presented. Most frequent internesting intervals were 11 to 13 days (47.7%) (X = 14.7+6.2 days, range=5-49, n=700 turtles. Average number of nests per female in a season was 2.2 +- 1.3 (range = 1 - 7, n = 700). Average clutch size was 67.8 +-19.3 eggs (range = 1 - 137, n = 1,400 nests). Average overall fecundity per season was 141.6 +-92.2 eggs showed a positive correlation (r = 0.369, P < 0.001, n = 1,400). Mean relative clutch mass was 4.24+-0.9% (range = 2.8 - 6.1, n = 20). Most frequent remigratory intervals were three and four years.

COMPARISON OF GROWTH CURVES FOR SEA TURTLES OF TWO NEST IN CAPTIVITY, AND THE FOLLOW OF EVOLUTION OF LIVING TAG TECHNIQUE IN GREEN TURTLES *CHELONIA MYDAS* AT XCARET ECO-ARCHEOLOGICAL PARK.

Alejandro Arenas, Rodolfo Raigoza, and Roberto Sánchez
Acuario Xcaret, Av. Xpuhuil No. 3, Suite, 150, S.M. 27 C.P. 77500, Cancún Q. Roo, México. acuario@cancun.rce.com.mx

INTRODUCTION

Xcaret Eco-Archeological park started its sea turtle captivity program with research work and environmental education in 1993 with Green Turtles *Chelonia mydas* and marking "living tag" technique (Zurita, 1994). The research with turtles with turtles has been taking place at several sites around the world, with different species and objectives; in a commercial way Mariculture in Grand Cayman with *Chelonia mydas* since 1968 (Wood and Wood, 1980), the head start program in HMFS in Galveston since 1989 with *Lepidochelys kempii* (NOAA, 1990, furthermore the work described by W. N. Witzell in 1983 with *Eretmochelys imbricata* and the ones that took place in Brazil by the Brazilian Marine Turtle Foundation.

The conservation work done in the Mexican Caribbean from 1964 to 1982 were described by Zurita (1985) and it mentions the sea turtle at the Puerto Morelos Acuacultura Station Q. Roo for research of the species growth, it was suspended in 1982 due to lack of funding. The current work's objective us to describe the growth, sexual dimorphism and the living tag development on the *Chelonia mydas* in captivity.

METHODOLOGY

In 1993 off springs from two nest out of Xcacel beach were transported and were considered as lot 1 and 2 after they reached 15 days old they were given the living tag (Hendrickson and Hendrickson, 1981). Each nest was kept in separate, 12,000 lt3 pools with a continuous sea water flow and a nourishment based on pelet form food (Tortugas AS) with 40% of raw protein, with a daily ration of 3% of their body weight, given three times per day during the first year of life, reducing the protein percentage from the raw protein down to 35 % after the first year twice a day, in according with Wood (1991).

Out of each lot we kept 15 specimens, at 19 mouths old they were tagged with microchip on the rear left fin for their individual identification and were confined to a lagoon a 600 m2 surface and an average depth of 1.5 m; an average temperature of 26.18 °C, pH of 6.985 and 25.4 of salinity. This lagoon is connected with the sea by an inlet and fresh water in flows through underground currents.

The turtle samples took place each month and afterwards it was done every two months, until they reached 27 months of life with the purpose of reduce the stress by handling. The parameters that were taken are the Curved Carapace Wide (cCW), Curved Carapace Long (cCL) and the weight for each turtle, using a tailor´s ruler strip and a digital roman scale in a tripod (FAO, 1991).

RESULTS AND CONCLUSIONS

The growth analysis for the *Chelonia mydas* in captivity is from 19 months old through 27 months old. To analyze the behavior in lot 1 and 2, a multiple linear regression out of the data in each parameter and it was compared with the difference between the slops and elevation for each regression. The data number for lot 1 is $n = 12$ and $n = 15$ for lot 2.

We was found that the weight has a lineal relation, wile the cCL and cCW do not show a linear behavior there for a transformation of the data was used according with the expression (y = y2).The comparison of the two regressions was performed by evaluation the likeness between regression coefficients of each lot using *t student* like in Zar J. 1996. For the test we established that each of one of the parameters regressions has the same slope and elevation (*Ho*) assuming that the turtles are growing under the same conditions.

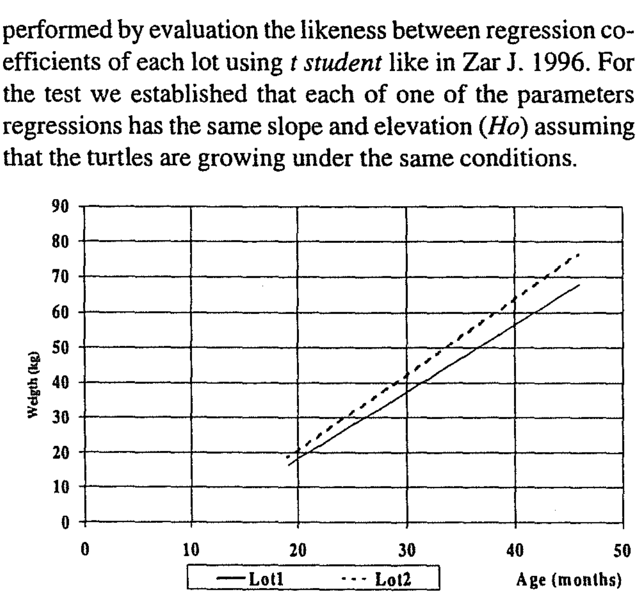

Figure 1. Weight increase in lot 1 and lot 2 Chelonia mydas (Adjusted lines)

For the slopes weight comparison a $t = 3.4717$ was obtained and the value in tables was $t_{0.05(2),254} = 1.965$ which is less than the calculated and according to the test we reject *Ho*. In the same way when the elevations are compared the result of the calculation is $t = 8.5991$ and the value in tables was $t_{0.05(2),254} = 1.965$, so we reject *Ho* again. (Figure 1).

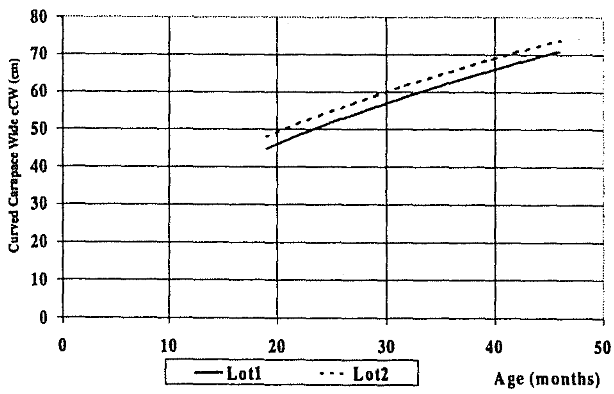

Figure 2. Growth (cCW) lot 1 and lot 2 Chelonia mydas (Adjusted Curves)

The same relation was observed for the other two parameters in the cCW the comparison of the slopes have a calculated value of $t = 1.0832$ and the Table value $t_{0.05(2),254} = 1.965$. The calculus for the elevations is $t = 10.3225$ with a value table of $t_{0.05(2),255} = 1.965$ (Figure 2). For the cCL values the $t = 1.3144$ for the slopes with their correspond on tables $t_{0.05(2),254} = 1.965$ and the elevations with a calculated value of $t = 7.6800$ and $t_{0.05(2),254} = 1.965$ obtained in tables, shows that *Ho* is rejected, so there are significant differences between each slope and elevation of regressions. (Figure 3)

Based on analysis we observed that the relationship between the increase on weight and the time in months is lineal, the lot 1 presents a rate of 1.92 kg/month and the value in lot 2 is bigger with a rate of 2.16 kg/month. Márquez R. M. in 1976 report to Grand Cayman a commercial size for *Chelonia mydas* of 45 kg at 5 years old, if we assume that the relation between weight is lineal these turtles show a rate of 1.33 kg/month, which is lower than the rates we obtained for the first 4 life years. During these years the turtles has reached an average of 75 kg.

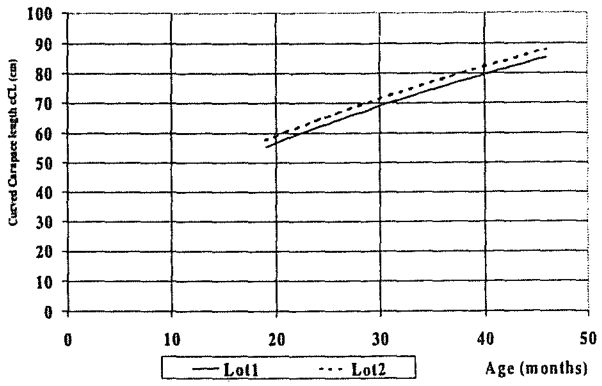

Figure 3. Growth (cCL) lot 1 and lot 2 Chelonia mydas (Adjusted Curves)

For the cCW y cCL the relation is not a line, so the increase rates at different points are variable with a tendency to decrease a long the time. To compare we obtained the rates on the three first months and the last ones. For cCW the lot 1 show a rate of 1.63 cm/month at the beginning and 0.92 cm/month at the end, while the lot 2 on the first months had an increase of 2.03 cm/month and on the last ones this value is 0.98 cm/month.

The grow rate for cCL in the lot 1 during the first period is 2.25 cm/month and 0.84 cm/months for the last months. The lot 2 had an increase of 2.49 cm/months and at the end the value is 0.94 cm/month. It shows a decrease on the grow of turtles a long the time.

About the living tag evolution the data shows in a global way for both lots, which have 27 organisms, the lost of mark in 2 turtles and in 25 of them (92.60 %), we can observe a scar in the first dorsal shield, this mark has grown with the turtles, but it has been alight. In the ventral part of the turtles of both lots the mark can be recognized, so this technique have success in the turtles for 4 years old.

In a fenotipic view and based in the morphology of the tail we observe the beginning of sexual dimorphism in the turtles of both lots. The lot 1 have 10 females and 2 males that represent a proportion of 5:1. In contrast the sex proportion in lot 2 is near 1:1 with 8 males and 7 females but we think that laparoscopy exam is required to have accuracy in some cases.

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SEA TURTLES OF THE CAPE FEAR RIVER BASIN (NORTH CAROLINA, U.S.A.): AN IMPORTANT NURSERY AREA?

Denise M. Barnes[1], Heather Miller Woodson[1], Wm. David Webster[1], Erin Redfearn[2], and Gilbert S. Grant[3]

[1] University of North Carolina at Wilmington, Department of Biological Sciences, Wilmington, North Carolina, U.S.A., 28403. BarnesD@UNCWIL.EDU

[2] Florida Atlantic University, Boca Raton, Florida, U.S.A., 33486

[3] Coastal Carolina Community College, Jacksonville, North Carolina, U.S.A., 28540

INTRODUCTION

Studies of many shipping channels of the southeast coast of the United States (Charleston harbor, SC; Savannah, GA; St. Mary's entrance, GA; Ponce de Leon inlet, FL; Canaveral ship channel, FL; Ft. Pierce inlet, FL; St. Lucie inlet, FL) conducted surveys, which investigated the relative abundance or distribution of sea turtles (Van Dolah and Maier 1993; Butler *et al.*, 1987). Extensive surveys of the Core and Pamlico Sounds in North Carolina have been completed by the Beaufort Laboratory (National Marine Fisheries, NOAA, in Beaufort, NC) and have demonstrated that these areas are utilized by immature loggerhead, green and Kemp's ridley sea turtles (Epperly *et al.*, 1996; Epperly *et al.*, 1995; Epperly *et al.*, 1994; Epperly and Veishlow 1989; Epperly *et al.*, 1991). However, the importance of the Cape Fear River basin as a sea turtle habitat has been largely overlooked. Since the majority of the turtle nesting in North Carolina occurs on the beaches surrounding the mouth of the Cape Fear River, this area could be an important habitat. To examine turtle utilization of the Cape Fear River basin, live animal captures and stranding data for this region were reviewed.

MATERIALS AND METHODS

Stranding: Data from the Sea Turtle Stranding and Salvage Network from 1980-1996 were examined for the study area, the Cape Fear River basin. These data include such information as stranding location (latitude/longitude and a physical description of the area), carapace width and length, species, final disposition (release, burial, salvage, etc.), sex of turtle, condition (alive, fresh dead, etc.), and tag information. Stranding reports from the area were grouped by species to generate monthly and yearly totals for each species as well as combined species totals. Mean carapace sizes were also calculated for each species.

Trawling: Live animal captures as a result of trawling were obtained by endangered species observers during the wood debris removal project conducted by the U.S. Army Corps of Engineers, Wilmington District, April 14-May 24, 1997. Twenty-nine trawling days were completed during this period; some days were missed due to dangerous weather conditions. Total trawl time was 798 hours, with 1406 trawls made; the average tow lasted 34 minutes. Six shrimp trawlers were contracted to remove wood debris from shrimping

Table 1. Monthly strandings, by species, for the years 1980-1996.

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL BY SPECIES
Caretta caretta	3	0	0	10	77	99	64	39	16	7	6	3	324
Lepidochelys kempi	0	0	0	0	7	7	4	5	2	0	0	0	25
Dermochelys coriacea	0	0	0	1	11	2	0	0	0	0	0	0	14
Chelonia mydas	0	0	0	0	12	10	0	0	0	1	1	1	25
TOTAL	3	0	0	11	107	118	68	44	18	8	7	4	388

grounds in the Cape Fear River basin near the Corps' Ocean Dredge Material Disposal Site, within eight kilometers of the mouth of the river. These grounds were fouled by debris scattered from the disposal site as a result of two hurricanes that struck the area in 1996. Corps of Engineers' guidelines required boats of at least 18 m in length which towed 13-15 m twin-rig fish trawls, with 6.4 cm mesh, with no turtle excluder devices (TEDs) to maximize debris removal. The absence of TEDs necessitated the presence of endangered species observers. Tow times were limited to 40 minutes, from the time the trawl doors entered the water until the time the doors were brought to the surface. All turtles captured were measured, photographed and tagged before release approximately eight kilometers from the trawling site. Information on trawling locations which resulted in sea turtle captures was provided by boat captains. Mean sizes were calculated for loggerheads and Kemp's ridleys, which were the only species captured during the project. A map of capture locations was provided by U.S. Army Corps of Engineers personnel.

RESULTS

Stranding: From 1980 to 1996, 388 sea turtles stranded in the study area: 324 loggerheads, 25 Kemp's ridleys, 25 greens and 14 leatherbacks. Monthly strandings by species are displayed in Table 1.

Mean size (in centimeters) of turtles is as follows: 33.7 curved length (CL), 31.2 curved width (CW) for loggerheads (range 10.5-127.0 CL, 11.2-122.0 CW); 28.9 CL, 29.2 CW for Kemp's ridleys (range 12.8-49.5 CL, 13.0-50.8 CW); 33.9 CL, 29.9 CW for greens (range 11.0-68.6 CL, 9.5-62.2 CW); and 74.1 CL, 50.7 CW for leatherbacks (range 47.0-134.6 CL, 32.0-91.4 CW). Of the 169 live strandings, 141 were loggerheads; 15 were Kemp's ridleys, and 13 were green turtles. No live leatherbacks were reported. Strandings of loggerheads and greens were widespread in the region, whereas Kemp's ridleys were consolidated around the Carolina Power and Light Brunswick Plant intake canal and leatherbacks were concentrated at the mouth of the river.

Trawling: A total of 19 sea turtles were captured during the wood debris removal project: 14 loggerheads and five Kemp's ridleys. Mean carapace size (in centimeters) of the loggerheads was 62.9 CL and 58.5 CW (range 40.0-102.0 CL, 40.0-93.0 CW); mean carapace size (in centimeters) of the Kemp's ridleys was 34.3 CL and 36.4 CW (range 22.9-36.5 CL, 22.9-42.5 CW). One leatherback was sighted during the study period, but was not captured. All captures during this endeavor were live.

DISCUSSION

This paper demonstrates the importance of the Cape Fear River basin as a habitat for immature and adult sea turtles of many species. Stranding reports do not provide a complete picture of sea turtle presence in an area, as not all specimens are seen on beaches and reported. In a study conducted by Epperly *et al.*,, only 7-13% of known fishery-induced turtle deaths resulted in strands on the mainland due to water movement away from beaches during the winter (1996). Similar studies have not been conducted during other times of the year, but our data indicate that dead turtles wash ashore more frequently in the summer months in the Cape Fear River basin.

Although a few studies have looked at the Cape Fear River as a possible habitat for sea turtles, there has been less coverage of the area than other areas of the state, such as Core and Pamlico Sounds. The Cape Fear River, as well as other North Carolina waters, was examined for sea turtle presence as reported by local fishermen (Epperly *et al.*, 1995). It was found that the Cape Fear River had the second most frequent turtle sighting per fishing hour with one turtle per 124 fishing hours. The average of all North Carolina inshore waters was one turtle sighting for every 227 hours of fishing. A lower sighting ratio of one turtle per 141 fishing hours was reported for the extensively studied Pamlico Sound.

Trawling data are likely to be an underestimate of sea turtles in the study area due to the possibility of larger, nesting size turtles avoiding the trawl. It is also possible that turtles are spending less time at the bottom in April and May due to cold bottom water. Nelson (1996) found that turtles in St. Mary's River, GA, U.S.A., spent less time at the bottom compared with other times of the year, presumably due to colder bottom water temperatures and the need to bask.

Several studies have investigated the presence of turtles in the shipping channels and inlets of Charleston harbor, SC; Savannah, GA; St. Mary's entrance, GA; Ponce de Leon inlet, FL; Canaveral ship channel, FL; Ft. Pierce inlet, FL; and St. Lucie inlet, FL. Trawl data from our study was collected outside of the Wilmington shipping channel, which is the first of its kind. When the Wilmington shipping channel was trawled before dredging, only one turtle was found (Wilder, pers. comm.). It would seem that since we found so many turtles outside of the Wilmington channel, other studies may actually be underestimates of the abundance of turtles in the vicinity of those channels.

More work needs to be completed in this area during all times of the year to properly assess this area as an important sea turtle habitat, especially for young loggerhead and Kemp's ridley turtles. The majority of turtles captured and stranded were not adults, indicating the use of the river as a nursery area by immature turtles. This is especially important as the Cape Fear River is a deep water shipping channel which undergoes dredging on a frequent basis. Dredged channels have been shown to attract sea turtles as reported by Butler *et al.*,(1987) in the Canaveral ship channel, Cape Canaveral, Florida.

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REPRODUCTIVE CYCLES OF LEATHERBACK TURTLES

Debora García M. and Laura Sarti

Laboratorio de Tortugas Marinas, Fac. de Ciencias, UNAM. Circuito Exterior, Ciudad Universtiaria, México D.F: 04510, México. arbr@hp.fciencias.unam.mx

Over the last 15 years the leatherback turtle in Mexiquillo beach, Michoacan, Mexico, has been surveyed for nesting population size and some reproductive parameters (*e.g.* remigration cycles). From a total of 4,411 observed females (tagged), only 238 have been found bearing tags from other nesting beaches. Most of these females are observed only once in the nesting beach and only 79 have returned to nest in Mexiquillo in subsequent years (barely 1.8% of the remigrations). Five percent of these females returned to nest with one year periods, 39.2% with 2-year periods, and 36.7% with 3-year periods. Since the 1986-87 nesting season, year in which there was a peak of 4,816 clutches laid in 4 km stretch of beach, an important decrease in nesting numbers has been observed, and by the 1996-1997 season only 60 nesting were registered in 18 km of beach.

Females lay an average of 64 yolked eggs per clutch, with an average frequency of about 4 clutches per season. Each clutch is laid within a 9.3-day interval.

RESULTS FROM THE TAGGING PROGRAM ON JUVENILE HAWKSBILL TURTLES OFF RIO LAGARTOS, YUCATÁN, MEXICO

Mauricio Garduño Andrade
INP Centro Regional de Investigación Pesquera de Yucalpetén. AP 73, Progreso, Yucatán, CP 97320. México mgarduno@minter.cieamer.conacyt.mx

A tagging program of juvenile hawksbill turtles (*Eretmochelys imbricata*) have made from 1985 up to 1997 in the Rio Lagartos protected area. Tagged juvenile have been recaptured, must of them inshore of Rio Lagartos. Four have been recaptured in far places like the Miskito zone in Nicaragua (900 km; 5 years), Laguna de Terminos (Atasta) in Campeche, Mex. (700 km; 6 years), Mariel Bay in Cuba (300 km; 3 years), and in front of Progreso, Yuc.; Mex. (250 km; 1.4 years). A regression analysis linear model adjusted to the origin (Y=0.378 X; r2=0.74) show an emigration rate of 37.8 km/100 days. We are shown length frequencies in 4 stages 1985-87(n=269), 1990-94 (n=197), 1996 (n=337) and 1997 (n=256). In 1996 is shown two modes separated by 8 cm could be interpret like two different cohorts. In 1997 there is mode about 24 cm. we interpret like a new recruitment cohorts. The 4 length frequencies present the same range of size.

FECUNDITY OF THE HAWKSBILL TURTLE *ERETMOCHELYS IMBRICATA* IN LAS COLORADAS, YUCATAN

Mauricio Garduño Andrade
INP Centro Regional de Investigación Pesquera de Yucalpetén. México. mgarduno@minter.cieamer.conacyt.mx

We analyze the fecundity of the Hawksbill turtle *Eretmochelys imbricata*. We don't found a variation in the mean of eggs/nest between 6 years (F=1.3< F.05=2.21). Also there are not a diminished in the number of eggs/nest throughout the season (p>0.025; one tail). A regression analysis linear model between the size of the turtle v.s. number of eggs/ nest yields a slope (0 (p=0.0014), but there is a correlation coefficient r2=9.48% very weak between the variables. Also there is a difference in the mean eggs/nest between turtle were record one time on the season v.s. those were record 3 or more times (155 v.s. 168 eggs/nest). These hypothesis has been found in the literature.

BIAS-FREE ESTIMATES OF MEASUREMENT ERROR IN SEA TURTLE MORPHOMETRIC DATA COLLECTION

Jonathan Gorham, Michael Bresette, and Bruce Peery
Quantum Resources, Inc. P.O. Box 1691, Jensen Beach FL 34958 U.S.A. jonathan_gorham@email.fpl.com

Quantification of measurement error is a critical factor in somatic growth rate studies, particularly with slow growing animals. Most estimates of error have been generated by repeated measurements of an individual turtle, either with one or several observers. Whenever observers are aware data is being collected for calculating measurement error, there is an almost unavoidable bias to minimize error. In our study, straight and over the curve measurements were collected under routine field conditions by multiple observers who were unaware the data would be used for measurement error calculations. Turtles selected for this study were recaptures from our tagging program with at large intervals of less than 14 days, where true growth is negligible (less than 0.01cm from our growth data). Therefore, any measurement differences between subsequent recaptures are attributable solely to measurement error. Results indicate that measurement error for experienced observers is small, but is sufficient to obscure real growth over short recapture intervals of 1-2 months. In all cases, straight line measurements were found to be more reliable than over the curve measurements.

TIME SERIES FRAMEWORK (TSF): A TOOL FOR RESOURCE MANAGEMENT OF MARINE TURTLES MERRITT ISLAND, FLORIDA, U.S.A.

Mark J. Provancha[1], Jane A. Provancha[1], Joao Ribeiro da Costa[1], and Henrique Bentes de Jesus[2]
[1]Dynamac Corporation, Kennedy Space Center, Florida, U.S.A.
[2]Chiron, Information Systems, Lisbon, Portugal. Mark.Provancha-1@ksc.nasa.gov

A times series framework (TSF) tool was utilized to view time series data for marine turtles as related to conservation efforts at Kennedy Space Center (KSC) and the Merritt Island National Wildlife Refuge (MINWR). Recently, 109,587 records were entered into an Oracle database. Parameters measured for species *Caretta caretta* and *Chelonia mydas* included: nests, false crawls above and below the high tide, number of nest depredated, and disturbed. Future initiatives will include adding marine turtle netting data collected from the lagoonal waters and beach temperature profiles of KSC. Data are queried and viewed using the TSF browser which may run in a UNIX or Windows environment without prior knowledge of standard query language (SQL) or Oracle's procedural language (PL). The TSF browser includes the Browser tool, controlling all the navigation in the database, the Manager Tool controlling data analysis, the Inspector Tool presenting time series characteristics, the Display Tool creating tabular presentations of data, a Plotter Tool, the Slide Show Tool associating images with themes and sites, and the Slide Tool presenting selected images. The TSF browser allows the user to search the desired datasets within the database and select data based on location or parameter. Furthermore, TSF allows for a GIS interface between ArcView and the database. The user selects the datasets to query and a graphical display of those selected sites is presented in the GIS by accessing information within the database.

COMPUTER PROGRAM THAT GENERATES A LESLIE MATRIX FOR THE ANALYSIS OF THE TAGGED INFORMATION IN THE SEA TURTLE

Noé Andrés Villanueva López[1], René Márquez Millán[1], Miguel Angel Carrasco Aguila[1], María Carmen Jiménez Quiroz[1], Juan Díaz Flores[2], and Manuel Sánchez Perez[2]
[1]Centro Regional de Investigaciones Pesqueras de Manzanillo, Playa Ventanas s/n. Apartado Postal 591, Manzanillo, Colima, México, C.P. 28200.
[2]Instituto Nacional de la Pesca Pitágoras No. 1320, 4to piso, Col. Santa Cruz Atoyac, México, D.F. 03310. anoevi@bay.net.mx

A computer program, compiled in Clipper 5.2 language was done, that can organize the registers of tagged turtles of a seasons and follow an individual during and inside each season, it also elaborates abstracts of the information. The program used as reference the data base information of the beach Rancho Nuevo, Tamaulipas, on Kemp's ridley (*Lepidochelys kempii*). Information of 8,000 registers, on electronic tags of the Pittag (Passive Integrated Transporder Tag) of the years from 1988 to 1997 were analyzed with the Leslie Matrix, which simplifies the interpretation of the information and its posterior analysis. The program can purify any information in relation to different tagged species of sea turtle or other animals. The program is friendly, because it works in basic operative system (MS-DOS), with low resources of hardware and it is compatible with any Windows environment. The information to process must have a DBF version 4 format, with the fields of the tagged information organized in vertical form, the capacity of the program is limited to the computer size.

A DOUBLE-CHAMBERED EGG CHAMBER IN A LOGGERHEAD TURTLE (*CARETTA CARETTA*) NEST FROM NORTHWEST FLORIDA, U.S.A.

Martha L. Maglothin, Margaret M. Lamont, and Raymond R. Carthy
Cooperative Fish and Wildlife Research Unit, University of Florida, Gainesville, FL 32611, U.S.A. MMLAM@gnv.ifas.ufl.edu

Variations in the shape of a sea turtle's egg chamber have been observed, however the general shape of one egg chamber with one surface opening is consistent. A nest of two egg chambers with one common opening has not previously been reported. In 1997, two loggerhead turtle (*Caretta caretta*) nests were discovered along Cape San Blas, Florida with two egg chambers joined by a single surface opening. The first nest (#15) was observed on June 20, 1997, at mile marker 2.56. Both chambers were not initially discovered, therefore only 60 of 96 eggs were relocated (60 eggs; #15a). The remaining eggs (#15b) were inadvertently left *in situ*. On July 3, a second double-chambered nest (#33) was observed at mile marker 2.55, and all 154 eggs were relocated. Hatchlings emerged from Nest 15a on August 19/20 and from Nest 15b on the following night. Of the 36 eggs in 15a, 35 (97.2%) hatched, and of the 60 eggs in 15b, 54 (90%) hatched. Nest 33 experienced emergence on August 30/31, and of the 154 eggs, 112 (72.7%) hatched.

Because the nests shared similar characteristics, it appears the same turtle laid both double-chambered nests, although it is unknown how this was accomplished. The shape of the nesting crawls and the conjoined egg chambers was typical, therefore variation was most likely not in the shape of the flipper. Possibly the turtle had an abnormality in the function of the rear flippers causing her dig a separate chamber with each flipper. Hatching success indicated the eggs laid by the turtle were viable. In addition, the double-chambered nests appear to provide an adequate environment for successful incubation and hatching.

DIET COMPOSITION OF THE BLACK SEA TURTLE, *CHELONIA MYDAS AGASSIZII*, NEAR BAJA CALIFORNIA, MEXICO.

Jeffrey A. Seminoff [1], Wallace J. Nichols[1], Antonio Resendiz[2], and Anthony Galvan[1]
[1] Wildlife and Fisheries Science, University of Arizona, Tucson, AZ 85721 U.S.A. seminoff@ccit.arizona.edu
[2] Centro Regional de Investigacion Pesquera, El Sauzal de Rodriguez, Ensenada, Baja California, México.

INTRODUCTION

The coastal waters of the Baja California peninsula have been considered important to the life history of the black sea turtle, *Chelonia mydas agassizii* (Townsend, 1916; Carr, 1961; Caldwell, 1962; Felger, 1976, Alvarado and Figueroa, 1992; Cliffton *et al.*, 1982). The Gulf of California on the eastern coast of the peninsula and the eastern Pacific ocean on the west offer a variety of marine habitats. As turtles move into the Gulf, they enter a semi-enclosed body of water that is considered a dynamic and productive ecosystem (Brusca 1980, Pacheco and Zertuche 1996). Supported by seasonal upwelling of nutrient rich waters, coastal areas of this sea host diverse assemblages of fish (Thomson *et al.*, 1979), invertebrates (Brusca 1980), marine alga (Norris 1975), and seagrasses (Felger and Moser 1973). Previous data from the Gulf shows that black turtle diet is composed primarily of red algae species (Seminoff *et al.*, In press). In addition, invertebrates such as sponge, soft corrals, Sabellid worms, and gastropods are ingested.

Upon dispersal to Pacific coastal waters of the Baja peninsula, turtles enter a region characterized by sandy coasts interspersed with bays and estuaries. These bays are typically soft bottom and host seagrass communities dominated by eelgrass, *Zostera marina* (Dawson, 1951). Black sea turtles have been documented as historically abundant these areas (Townsend, 1916; Nelson, 1921; Hodge, 1979). Although to date few data have revealed eelgrass consumption by black turtles in this region (Stinson, 1984), consumption of eelgrass by black sea turtles has been documented at similar latitudes within the Gulf (Felger and Moser, 1973).

While it is apparent coastal ecosystems along the Baja California peninsula may provide a variety of potential food resources for black sea turtles, the diet of this species is poorly understood. Based on three years of data, it appears that black turtles in the Gulf are primarily herbivorous. In the Pacific, it is probable that blacks consume eelgrass, but data are lacking. In this report we present additional data from the Gulf of California and preliminary results from the Pacific coast of the Baja peninsula.

METHODS

Turtle capture was facilitated by the use of two entanglement nets (100 m x 8 m, mesh size= 60cm stretched). Nets were regularly monitored during each netting trial and turtles were removed immediately to minimize capture-related stress. Upon capture, straight carapace length (SCL), weight, and other physical data were recorded and diet samples collected. Oral examination was used to recover residual food particles and lavage, the esophageal flushing of food components, was performed to recover ingested food samples (Forbes and Limpus, 1993). In-flow and retrieval tubes measured 1.5 m. For small turtles (<55 cm SCL), both tubes were 12 mm inner diameter (I.D.) and 17 mm outer diameter (O.D.). For large turtles (>55 cm SCL) in-flow tubes remained 12 mm I.D. / 17 mm O.D. and retrieval tubes measured 17 mm I.D. and 21 mm O.D. Volume was calculated through water displacement in a graduated cylinder.

Fecal samples were collected from a subset of captures. All fecal samples were collected from the Bahia de Los Angeles study area. For this study turtles were placed into solitary holding tanks (2 m diameter) at the CRIP Sea Turtle Research Station in Bahia de Los Angeles. Turtles were monitored and feces were removed immediately after excretion. All turtles were released at the site of initial capture within 24 hours.

RESULTS

Lavage samples were collected from a total of 84 turtles from five sites. Average lavage sample volume was 437 ml. Fecal samples were collected from a total of 34 individuals. All fecal samples were collected at the Bahia de Los Angeles study site. Average sample vol. was 587 ml.

In the Gulf of California, marine algae accounted for 92% of the average lavage sample volume. A total of 20 algae species were recovered, 8 major diet components. Overall, Rhodophyta dominated with an average of 89% sample volume from the Gulf. The most prevalent was *Gracilariopsis laeminoformis* (83% of average sample volume, freq. of occurrence = 71/78 samples). Further, in the 78 lavage samples, red algae were dominant (72 samples with >5% sample volume). Chlorophyta was second most utilized (17 samples with >5% sample volume) and Phaeophyta was the least frequent (1 sample with >5% sample volume).

In Bahia de Los Angeles, non-algal diet components included a total of 22 species; 9 spp. recovered from lavage and 20 spp. from feces. The most frequently occurring non-algal ingesta included Sabellid worms (56% of samples), sponges (47%), Stinging Hydroids (41%), small Gastropods (41%), and sea pen tests (23%). Plastic debris was found in 20% of all samples. Substrate particles were found in a total of 61% of lavage and 97% of fecal samples.

Preliminary data from the Pacific show marine algae and seagrass accounted for 99% of the average sample volume. Eelgrass (*Zostera marina*) was the most prevalent seagrass (44% average sample volume, occurred in 4/6 of samples) and the red algae *Gracilaria* spp. was the most prevalent marine algae (47%, 4/6). In addition, the seagrass *Halodule wrightii* (1.6%, 4/6) and marine algae *Codium* sp. (10%, 1/6), *Ulva lactuca* (<1%, 1/6), and *Sargassum* sp. (<1%, 1/6) were found. Non-algal items included soft Gorgonia (<1%, 2/6) and substrate (<1%, 5/6).

DISCUSSION

Black turtles feeding along the shores of the Baja California peninsula exhibit a strong tendency toward herbivory. Though over 20 algae/seagrass species were recovered in lavage samples from both coasts, there were only eight major diet components. We define major diet components as any food item that comprises >5% of total volume of at least one sample. Other algae with lower consumption levels may have been incidentally taken during foraging. In all cases, the major algae species present in lavage samples were consistent with predominant algae species in the area of capture. For example, the high proportion *Gracilariopsis laeminoformis* and *Gracilaria robusta* in lavage samples from Bahia de Los Angeles may reflect the high abundance of these species at this study area (Pacheco-Ruiz, pers. com.).

Fecal sampling yielded the highest number of non-algal food items recovered (20 spp.) when compared to lavage samples (9 spp). There are a number of possible explanations for this. First, while lavage samples represent recent feeding, fecal samples may represent feeding over a longer period of time and therefore increase the likelihood of recovering more species. Second, invertebrate fragments may be too large to pass through the lavage retrieval tube (17 mm O.D.). Nevertheless, this demonstrates the importance of using lavage and fecal sampling in the analysis of diet composition. In our study, the concurrent use of both methods concurrently greatly increased the number of species recovered.

Non-algal species were more prevalent in Gulf of California samples as compared to those from the Pacific. This apparent higher use of non-algal resources may reflect high prevalence of macroinvertebrates in the rocky shoreline habitats of the Gulf (Brusca 1980). Of particular interest was the frequent occurrence of Sabellid worms in both lavage and fecal samples. These worms were prevalent in a majority of samples. Considering their patchy distribution, it is possible that these items are actively sought out during foraging activities. A similar scenario may occur with the fleshy sea pen, *Ptilosarcus undulatus*. This solitary species appears to be uncommon in the study area yet in several fecal samples (N=7) up to 50 tests were recovered.

The frequent occurrence of substrate particles in dietary samples from all sites suggests that feeding turtles may be may be ingesting this material incidentally as they closely crop seagrass and algae. Substrate may also be ingested as turtles feed on Sabellid worms, fleshy sea pens, and other benthic organisms.

CONCLUSION

Although *Chelonia mydas agassizii* utilize non-algae food resources, their predominantly herbivorous diet is consistent with other *Chelonia* populations. To further elucidate this trend, we must continue to collect dietary samples from a variety of sites along the Baja California peninsula. Additionally, we recommend that analyses of diet composition of other *Chelonia* populations utilize both lavage and fecal sampling in order to maximize the number of food species recovered.

This analysis of diet composition is the first step towards understanding the feeding ecology of the black sea turtle in Baja Californian waters. Future study will include the analysis of local movement and food availability within individual homeranges. When this information is coupled with diet composition, a more thorough understanding of black sea turtle behavior and feeding ecology will be gained. Furthermore, by learning what resources they are most commonly using and where they are moving on a daily basis, we can begin to make educated management decisions regarding gill netting activities and commercial algae harvest.

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REMOTE VIDEO CAMERAS AS TOOLS FOR STUDYING TURTLE BEHAVIOR

Robert P. van Dam[1] and Carlos E. Diez[2]
Mona Island Hawksbill Research
[1]Apartado Postal 121-031, México DF 04361, México. rvandam@compuserve.com
[2]Negociado de Pesca y Vida Silvestre, Depto. de Recursos Naturales y Ambientales, P.O. Box 9066600, San Juan, Puerto Rico, 00906-6600,

During the 1997 field season we employed two different video camera systems to remotely observe the behavior of hawksbill turtles at Mona and Monito Islands (Puerto Rico). The recording devices, named Crittercam and Benthoscam, allow turtle conduct to be monitored without the interfering presence of human observers. Hawksbill turtles ranging from 20 cm juveniles to adults of both sexes are present in the shallow-water habitats of the islands..

A- CRITTERCAM

The Crittercam was developed by Greg Marshall (National Geographic Television) for recording the behavior of animals from a close perspective. Several models of this camera system exist and have been successfully deployed on a variety of large marine animals, such as seals and sharks. The shallow water Crittercam used in this study consists of a reconfigured Sony Hi8 video camera linked to a computer

Table A-1. Crittercam deployments on adult male hawksbills.

Turtle ID	SCL (cm)	Body mass (kg)	Deployment dates
95-077	77.0	50	2> 4-SEP-97
97-124	81.4	~66	5> 6-SEP-97
97-112	82.0	60	11>13-SEP-97

controller and placed in a cylindrical metal housing. External sensors include hydrostatic pressure for recording dive profiles.

A- METHODS

Adult male hawksbills turtles were selected as candidates for Crittercam deployment. These large animals inhabit the waters adjacent to the nesting beaches of Mona Island for periods of approximately two months. Peak abundance of males is reached in September, the month corresponding with the height of the nesting season, and matings are frequently observed at this time.

Turtles were captured by hand and brought aboard the research boat for camera deployment. The anterior central scutes of the carapace were scrubbed and sandpapered, after removal of obstructing barnacles. Ten-Set brand two-part epoxy was used to adhere the forward-looking camera onto the carapace. Sonic and VHF radio transmitters were added to the camera to facilitate its recovery. Turtles were released at the location of capture as soon as the epoxy had hardened (within ~1½ hrs of capture).

Video recording was set to 90 seconds of recording every 10 min, with recordings disabled at night. A 180 min video tape therefore allowed the monitoring of up to 1.5 days of turtle behavior. The time-depth recorder incorporated into the Crittercam controller was set to record continuously from turtle release, registering depth at 7.2 second intervals.

Turtle recapture by hand followed tracking of the animals through VHF and sonic telemetry, and by visual observation. Recaptured turtles were brought aboard the research boat for camera detachment and removal of epoxy residue. Turtles were released at the location of recapture as soon as this was completed.

A- RESULTS

Crittercams were deployed on three adult males and subsequently recovered (Table A-1). Behaviors most frequently observed were resting on the seafloor and cruising (Table AB-2). Encounters between turtles occurred regularly, with male-male interactions most frequent. No copulation was observed involving the monitored animals, however the behaviors exhibited are consistent with mating-related conduct (cruising to intercept females). These males foraged regularly at depths from 12m to >50m, apparently on Geodia neptuni and other sponges. The Crittercam images facilitate interpretation of time-depth records and more accurately classify turtle diving behavior.

B- BENTHOS- CAM

The Benthos-cam is a submersible video system for surveillance of a fixed site on the seafloor. It consists of a consumer-grade Sony 8mm video camera fitted with a wide angle lens adapter and external sealed lead-acid battery. A timelapse controller directs the camera to record during 5 seconds out of every 30 seconds. Recording are suppressed at night (19:00-06:00 hrs) with a programmable timer. Using a 150 min tape cassette and with the camera recording mode set to "long play" (LP), video surveillance covering >2 days is possible per deployment.

B- METHODS

The Benthos-cam was deployed at a total of nine known or suspected feeding sites around Mona and Monito Islands, in a variety of habitats and at depths of 10-24m. Deployments typically lasted two days, each yielding >2000 video segments and a total monitoring time of >3 hrs per site.

B- RESULTS

All potential feeding sites monitored using the Benthos-cam revealed hawksbill turtle activity. Turtles observed ranged from ~35cm SCL juveniles to large adults. Behaviors most frequently observed were actual feedings or turtles sampling prey sponges (Table AB-2). Individual turtles fed at large Geodia neptuni sponges for periods of up to 1 hr, with regular breaks for respiration, and returned to feed on the same sponge on consecutive days. One turtle feeding on Geodia behaved aggressively towards another (biting it in the neck), perhaps to avoid competition at the feeding site.

Table AB-2. Classification of turtle behaviors monitored by Crittercam and Benthos-cam, listed in decreasing order of occurrence

CRITTERCAM (ADULT MALES)	BENTHOS-CAM
Resting on bottom	Swimming through feeding site
Steady swimming over seafloor/reef	Feeding
Surfacing to breathe	Sampling sponge
Feeding	Fighting
Sampling (biting) benthos	
Encounters with other turtles	
Scraping on reef	
Stretching	
B- Benthos-cam	

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FACTORS INFLUENCING WITHIN-BEACH NEST DISTRIBUTION IN HAWKSBILL TURTLES

Kimberly K. Woody[1], Julia A. Horrocks[2], and Lotus A. Vermeer[1]
[1]Bellairs Research Institute, St. James, Barbados. bellairs@sunbeach.net
[2]Department of Biological and Chemical Sciences, University of the West Indies, Barbados

INTRODUCTION

The highest density of hawksbill (*Eretmochelys imbricata*) nesting in Barbados occurs on a relatively developed 1.5 km stretch of beach on the south west coast of the island. In 1997, 22 females were tagged whilst nesting on this beach. The distribution of nesting on this beach stretch has not previously been assessed.

Nesting frequency may differ on different segments of the beach for several reasons. More nesting may occur on some beach segments than others simply because segments vary in size, i.e., there is more available nesting space on some beach segments than others. Females may prefer to nest in some beach segments more than others because the segments have physical characteristics that increase the hatching success of nests. Females may nest more frequently on some beach segments because they are more accessible from the sea, i.e. less beach frontage is obstructed by nearshore rubble reefs. Finally nesting frequency may be higher on some beach segments than others because females avoid brightly illuminated beach areas. The purpose of this study was to investigate the distribution of hawksbill nesting along this most frequently used beach stretch in Barbados, and to assess the factors that might be influencing the distribution.

METHODS

The dataset used for the study includes all nesting activities (N=439) that occurred along this beach over a five year monitoring period (1993-1997). Nests were recorded as occurring within one of eight beach segments along the stretch, from Segment 1 in the west to Segment 8 in the east (see study area).

The % of beach frontage obstructed by nearshore rubble reefs was measured at low tide. Luminance at points of emergence from the sea and at nest sites was measured using a Minolta LS-100 luminance meter.

RESULTS AND CONCLUSION

Over the five-year period, the number of hawksbill nests was not uniform across the eight beach segments (ANOVA; F=2.9, P<0.02). Most nests occurred in beach segments 1, 4 and 5, and this pattern was consistent across years (Chi-square contingency, X^2=43.4, P<0.001). The number of nests in a segment was not correlated with the area of the segment (Spearman's r=-0.24; P>0.05), the most heavily used segment (Segment 1) having the smallest beach area. This suggests that nest density must vary between segments, and this was confirmed by ANOVA (F=6.39; P<0.0001).

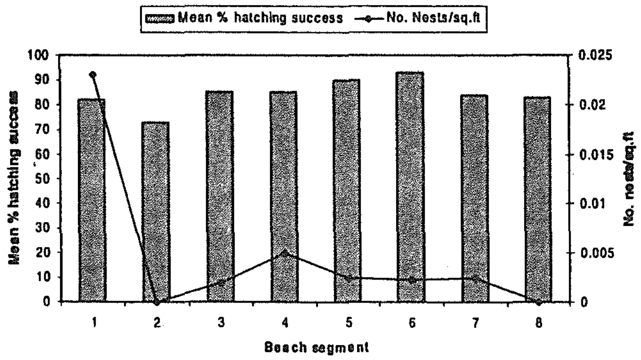


Figure 1. Chart showing nest density and % of hatching success in the eight beach segments.

Hatching success (% eggs that hatched) did not differ between the eight beach segments (ANOVA on transformed data; F=0.53; P>0.05, see Figure 1), suggesting that females are not choosing segments based on characteristics of the beach that result in higher hatching success. The % of beachfront obstructed by exposed reef rubble at low tide differed between beach segments (see Figure 2), but was not correlated with nest density on the beach segments (r_s=-0.36, P>0.05).

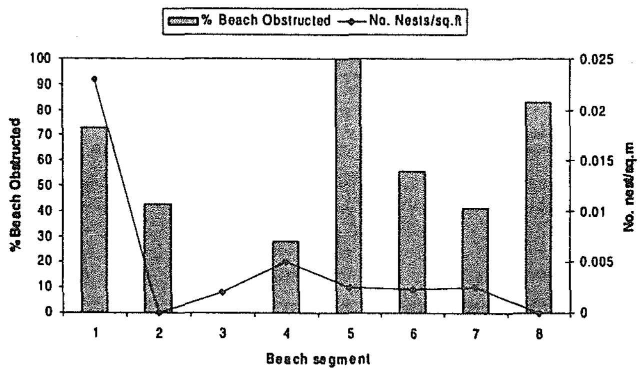


Figure 2. Chart showing nest density and % of beach obstructed reef rubble at low tide in the eight beach segments.

Luminance at points of turtle emergence from the sea differed signficantly between beach segments (ANOVA; F=4.24, P<0.001), and was significantly correlated with nest density on the beach segments (Figure 3; r_s=-0.76, P<0.05). Luminance at nest sites also differed significantly between beach segments (ANOVA; F=3.75, P<0.003). Luminance at emergence points was significantly correlated with luminance at nest sites across beach segments (r_s=0.79, P<0.05). Beach segments with high nest site luminance tended to have lower nest density, but the relationship was not statistically signifi-

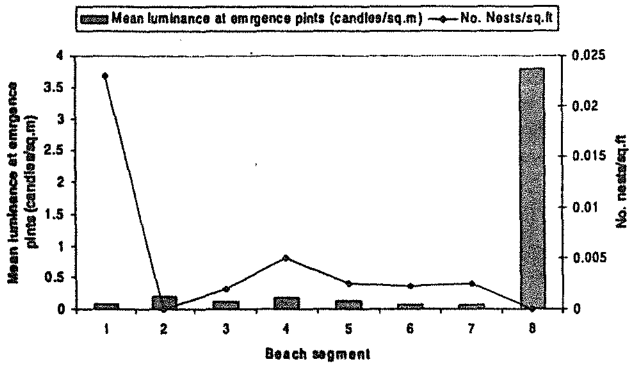


Figure 3. Chart showing nest denity and mean luminance levels at emergence points onto the beach from the sea in eight beach

cant (Figure 4; r_s=-0.64, P=0.08). The results suggest that, at the spatial scale investigated here (i.e. 8 beach segments along a 1.5 km beach stretch), the best predictor of nest site distribution is the degree of luminance experienced by females as they emerge from the sea. Emerging females avoid beach segments which they perceive as more illuminated.

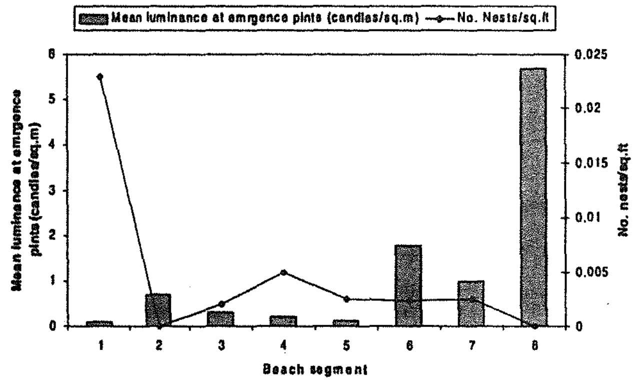
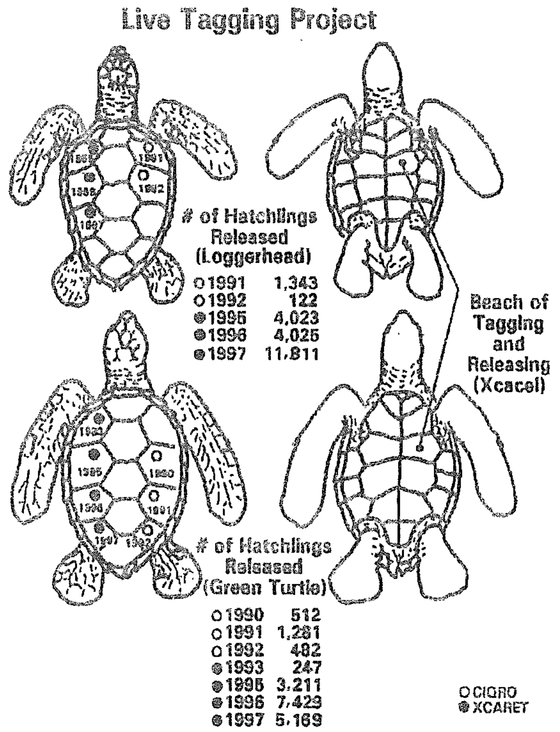


Figure 4. Chart showing nest density and mean luminance levels at nest sites in the eight beach segments.

THE SEA TURTLE POGRAM OF XCARET, '97 NESTING'S SEASON RESULTS.

Alejandro Arenas, Rogelio Villavicencio, Adriana D'Amiano, Leonel Gomez, and Rodolfo Raigoza.
Acuario Xcaret, Carretera Chetumal-Puerto Juárez km 282, Playa del Carmen, Quintana Roo, México. CP 77710.
acuario@cancun.rce.com.mx

Xcaret is located near to Playa del Carmen city. Since 1991 we have participated in various activities for preservation and research with sea turtles in Mexican Caribbean



beaches. This paper, show the results of the program in 1997. We protected 12 beaches, covered approximately 26.3 miles long, from May to October. Some nests were left *in situ* and others were taken to hatcheries. In total we registered 1391 loggerhead nests (*Caretta caretta*) and 415 green turtle nests (*Chelonia mydas*). The principal beaches in this season are Aventuras DIF (AV), Chemuyil (CH), Xcacel (XC), Punta Cadena (PC). 114006 loggerhead and 39625 green turtle hatchlings were released. 11811 loggerhead and 5169 green turtle hatchlings were tagged using the "living tag" technique. 200 green turtle hatchlings kept in captivity since last year in the park we have conducted educational activities for more than 300,000 visitors. We improved the technique of using incubators and nowadays it is one of our atractions and a good alternative for environmental education. This year 21 *C. mydas* nests and 11 *C. caretta* nests were, also taking useful data for research projects on the park sea turtles.

Conserving the country's natural resources has not only been a governmental concern, in the last 20 years non governmental organisations have also played an increasing role. The protection of marine turtles has had strong support. The turtle breeding grounds in operation are actually run by the federal government, universities, conservation societies, local and state authorities and ministries. In the state of Quintana Roo, the Xcaret Park controls the protection of approximately 26.3 miles of coastline. From 1991 until 1995, Xcaret collaborated with the disappear "Centro de Investigaciones de Quintana Roo" (CIQRO) in the turtle protection base in Xcacel (XC) beach, supplying food for breeding and supporting various activities in the program. In 1996 Xcaret, with the purpose of continuing the works done the during the former 9 years by CIQRO together with the "Delegación de la Secretaria del Medio Ambiente Recursos Naturales y Pesca" (SEMARNAP) in Q. Roo, the protection and vigilance project towards other beaches within the Maya Riviera, Tulum's National park and part of the Sian ka'an Biosphere Reserve.

In 1997 the park's educational program and hatching exhibitions exceeded our expectation. Approximately 200 hatching green turtles were successfully kept in captivity. We took special care of them and they were displayed during their first year of life, we showed their development and talks about their reproduction were given to the public. This starting program fulfilled our objective of being purely educational. In grounds so we obtained more and better information about nesting females. This whole work was done in co-ordination with the ministry of SEMARNAP, the head of the Sian Ka'an Biosphere Reserve and the park Xel -Ha, we also took advice from "El Colegio de la Frontera

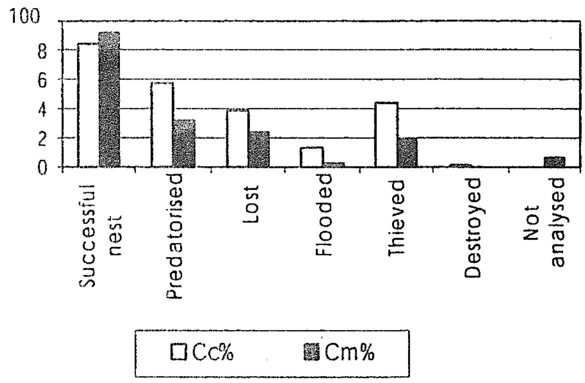


Figure 1. Situation of nests

Sur" (ECOSUR). This has generated the present project whose main objective is to support the preservation of marine turtle populations, as well as to generate useful scien-

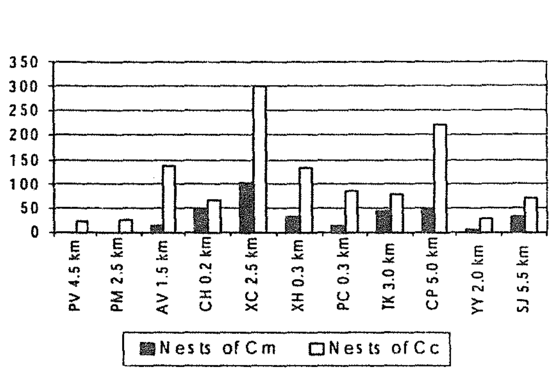


Figure 2. Importance of nesting according to extention of the beach

tific information which helps to apply the best unknowledge to the cause.

- Daily visits to the nesting sites to locate and protect breeding females.
- Recording of nursing details, counting of breeding females, their nests and eggs laid.
- Collecting and transplantation of eggs to protect incubation units, especially those nests vulnerable to being destroyed by natural phenomena or predators.
- Incubation of eggs, care and observation of broods and rate of deaths at birth.
- Nests near to hatching time were used in the exhibition incubators.
- The eggs from nests used in the incubators were separated into: apparent development and non-apparent development, these were considered infertile and not used.
- The eggs with apparent development were placed in crystal panelled incubators to simulate a natural turtle nest.
- The broods were registered by following the technique of Hendrickson and Hendrickson (1981) technique of live tagging, this has been used for several years on the turtles born at Xcacel (XC) beach

Concerning the Loggerhead turtle (*Caretta caretta*) during this season a total of 1391 nests were in the protect area: 5.68% was predated, 0.14% was destroyed by other turtles, 1.37% flooded, 3.81% were lost and 4.46% thieved, 84.54% represents the successful nests, this achievement is less than the results obtained for *Chelonia mydas* (Figure 1). There were quite fewer green turtle (*Chelonia mydas*) nests a total of 414 were registered of which 3.14 were predatorised, 2.42% were lost, 1.93% thieved, 0.72% of nests were not analysed as the season ended and the sites were not revised, 0.24% of the nests were flooded leaving a 91.54% of the nests considered successful (Figure 1). The principal beaches of nesting during this season are Aventuras DIF (AV), Chemuyil (CH), Xcacel (XC) and Xel-ha (XH) in relation for the extension for the beach to coincide with Zurita *et al.* (1993) (Figure 2). One should consider this as a low period, the number of turtle arrivals is fewer when compared to previous years. It has been observed that these species demonstrate biannual cycles, in the number of turtles that nest on the coasts of Quintana Roo, year after year.

During the hatching season in 1997 two sets of records were made on the nesting green turtles found, in accordance whit the "1er. Encuentro Regional para la Estandarización de Métodos de Campo en los Programas de Conservación de la Tortuga Marina" co-ordinated by Biol. Laura Sarti and M. en C. Julio Zurita. This was applied to a total of 238 of turtles, 138 *Caretta caretta* and 105 *Chelonia mydas*. The Figure 3 shows observed that the majority number of hatchings was achieved in Xcacel (XC), this applies to both *C. caretta* and *C. mydas* species. Other beaches which maintain a similarity in breeding patterns of the two species are Kanzul (KZ), Punta Venado (PV) and Yu-yum (YY); but in different proportions. On the other hand, dissimilarity can be seen in San Juan (SJ), Tankah (TK) and Chemuyil (CH). They show a bigger number of *C. mydas* hatchlings, while the dominating number of C. *caretta* is found on the beaches of Aventuras DIF (AV), Xel-há and Punta Cadena (PC). What is important to emphasise is that in order to protect these species it is not sufficient enough to cover a few beaches, but it is necessary to try to enlarge the breeding grounds. Finally we also see results of the beaches Caahpechen-Lirios (CP), Yu-yum (YY) and San Juan (SJ) which are inside Sian Ka'an Biosphere Reserve; Kanzul (KZ) is part of Tulum's hotel zone (still undeveloped) and the rest of the beaches are part of the Mayan Riviera.

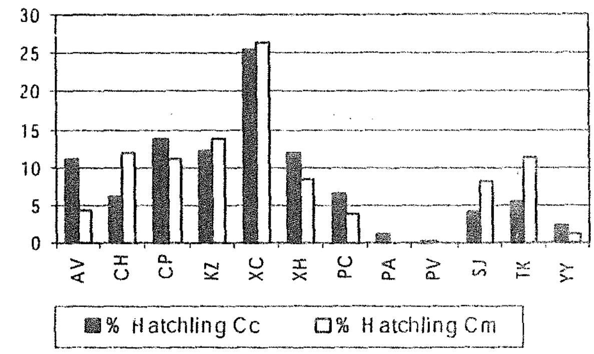


Figure 3. Percentage of hatchlings for species for beach

The Figures 4.1 and 4.2 show the occupancy of nests of both *C. caretta* and *C. mydas* in all the beaches. The percentages of emergence success, hatching success and survivals can be appreciated in each case. What we have in Aventuras DIF (AV) is an extreme difference in percentage of emergence and successes of almost 2% for *C. caretta* and 1% for *C. mydas*, it is of vital importance to emphasise that the beach site was only using the corral method, same as in Chemuyil (CH) where the results indicate the same percentages but more balanced, with a difference of 2% in both species. At Xcacel (XC) the results of emergence is

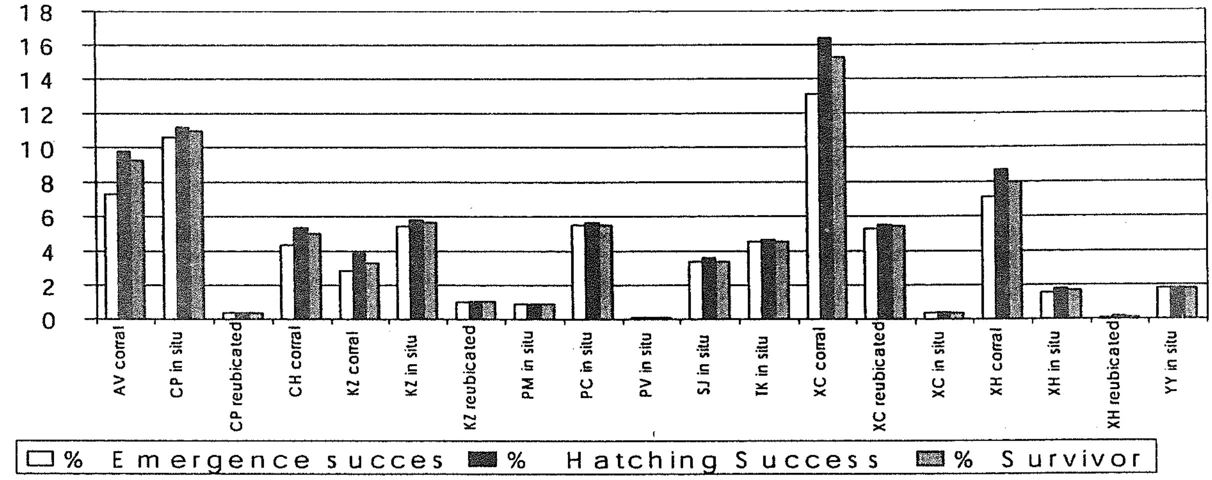


Figure 4.1. Use of the nests for Cc

3% higher from the success rate for *C. caretta* and a difference of 2% for *C. mydas*, the difference between corrals and *in situ* nests is not considered. As for Kanzul (KZ), where three different methods were used and the other beaches we're only applied *in situ* methods show no difference between their percentages.

Originally we thought of using incubators as insurance against the possibility of a hurricane damaging the nests on the beach. An unexpected benefit from improving this technique is that it is now one of our atractions and an useful tool in our environmental education program. Incubators offer a higher rate of survival than corral nests. The nests used in incubators were kept most of the time in Xcacel (XC)'s protecting corral. A few days before hatching they were transferred to Xcaret park. We separated developing eggs from the undeveloped ones to avoid possible infestations of dipterous and premature fatalities. By removing

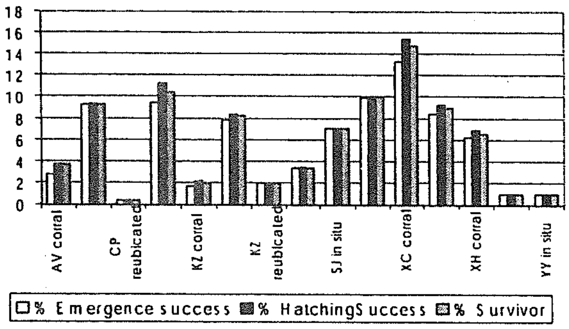


Figure 4.2. Use for the nests for Cm

the eggs a few days before hatching we get a more reliable counting of broods freed at the beach. This year 21 *C. mydas* nests and 11 *C. caretta* nests were used as samples and results obtained show little difference in survivor, emergence success and hatching success compared to actual *in situ* results (Figure 5). As touristic development is starting to interfere with the turtles well-being in the region, this method has become their only choice protection.

Another part of this same program is the use of the living tagging technique previously mentioned. This is a means of recording biological data on each of the species. Enabling us to know the development in different stages,

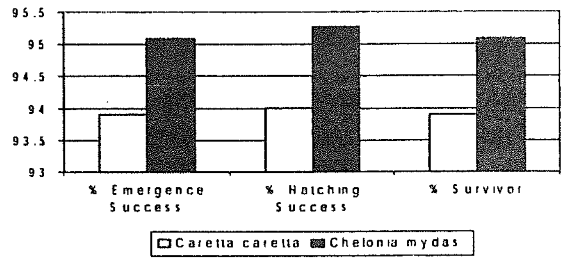


Figure 5. Hatching results for Cc and Cm

determine the age, When they reach sexual maturity and their migratory habits up to the point when they go back to lay eggs where they were born themselves. Until now Xcaret has worked only with hatchlings from Xcacel (XC) an this year we tagged 16,980.11.811 were *C. caretta* and 5,169 of the *C. mydas*. This work has been carried out in the park for several years, it is the continuation of the project originally developed by CIQRO, the results of previous years and those of the present time are shown in the following diagram.

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MARINE TURTLE NESTING AT THE ARCHIE CARR NATIONAL WILDLIFE REFUGE IN 1997.

Dean A. Bagley, Linh T. Uong, Allie B. Danner, Shigatomo Hirama, Laura A. Wick, and Llewellyn M. Ehrhart
Dept. of Biology, University of Central Florida; P. O. Box 162368; Orlando, FL 32816. dab15782@pegasus.cc.ucf.edu

INTRODUCTION

The summer of 1997 was the sixteenth consecutive season that the UCF research group has studied marine turtle nest production and reproductive success in south Brevard County, Florida; the area known as the Archie Carr National Wildlife Refuge (ACNWR). It was also the ninth consecutive year in which the group studied marine turtle reproduction in central Brevard County, north of the Refuge, between Melbourne Beach and Patrick Air Force Base. The 19.5 km stretch of beach in the Central Brevard Study Area (CBSA) and 21 km within the Carr Refuge Study Area (CRSA) are subdivided into 0.5 km sections. All nesting and non-nesting marine turtle emergences were identified as to species and enumerated during daily surveys between 5 May and 9 September 1997. A sample of 380 nests was marked to calculate reproductive success. Unlike the turbulent seasons of 1995 and 1996, the 1997 season was extraordinarily calm and remained unscathed by tropical systems.

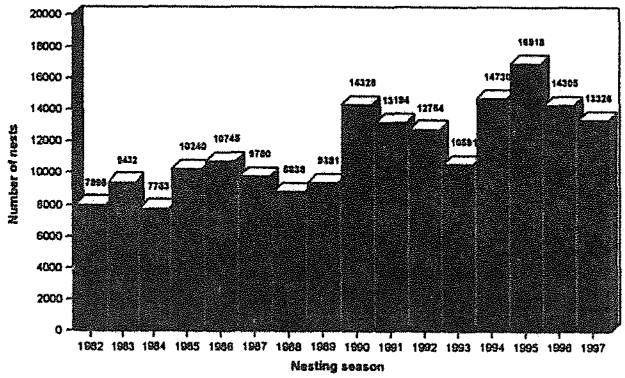

Figure 1. Loggerhead nest totals in the Carr Refuge Study Area. 1982-1997.

Since the establishment of the Carr Refuge in 1990, we have seen an increase in nesting activity by all three species that regularly nest on these beaches (Figures 1, 2, 3). These results continue to show that the beaches of the Carr Refuge support the greatest aggregation of nesting loggerheads and Florida green turtles in this hemisphere. Each year nest production figures serve as a tribute to the decision-makers who envisioned "a marine turtle refuge" in south Brevard County (Figures 5 and 7). While acquisition of refuge lands is only about 72% complete, commercial and residential development continue at an alarming rate within the Refuge boundaries.

LOGGERHEADS (*CARETTA CARETTA*)

The 1997 loggerhead nest total, at 13,326 exceeds the old long-term average of the 1980s by about 43%, and was 4% below the average of the 1990s (Figure 1). Ignoring the apparent upswing in the nest production figures seen in the first half of the 1990s and computing a comprehensive 15-year (1982-1996) average (11,399), loggerhead nest production in 1997 exceeds the 15-year average by about 1,927 nests or 17%. So, any way one looks at the figures for 1997, nest production was sustained at the higher level characteristic of this beach since the creation of the Carr Refuge in

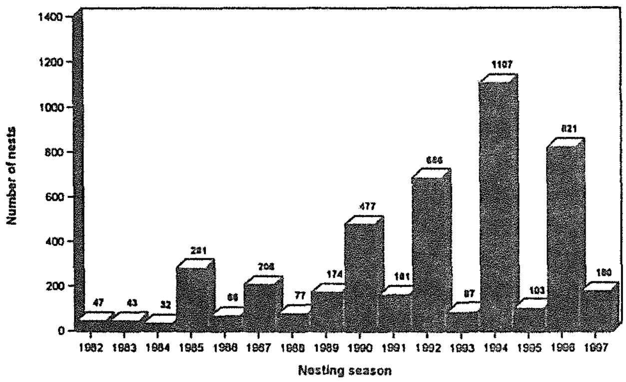

Figure 2. Florida green turtle nest totals in the Carr Refuge Study Area. 1982-1997.

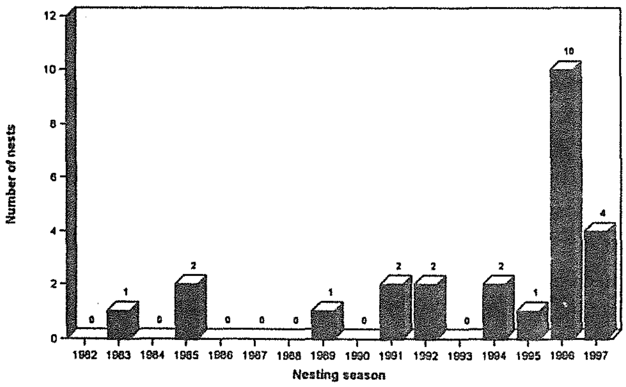

Figure 3. Leatherback nest totals in the Carr Refuge Study Area. 1982-1997.

Nesting Success

(The percentage of total emergences which result in a nest)

	CBSA	CRSA	OVERALL
Loggerheads	57.7%	60.9%	59.4%
Florida Green Turtles	44.3%	54.6%	50.4%
Leatherbacks	n/a	100%	100%

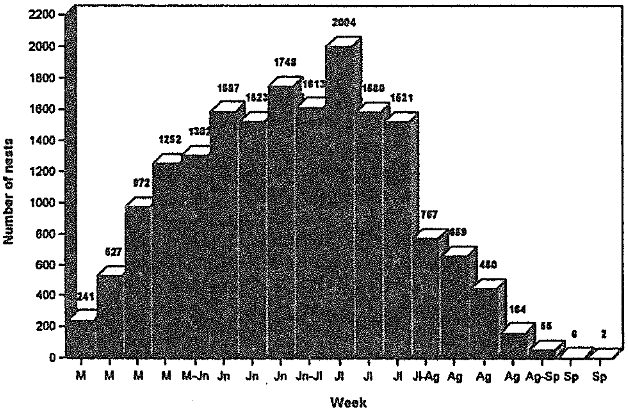

Figure 4. Temporal distribution of loggerhead nests in the Central Brevard and Carr Refuge Study Areas in 1997.

1990.

The first nesting loggerhead was found on the evening of 25 April, the earliest ever actually encountered by the UCF group. Figure 4 shows the temporal distribution of loggerhead nests throughout the season The spatial data in Figure 5 represents an overall mean of 238 nests/km in the CBSA (383/mile) and 634 nests/km (1021/mile) in the CRSA for the 1997 season. Loggerhead nesting success at 60.9% was at the the highest level since 1987. An additional 4,647 in CBSA brought the total nest production to 17,973 for that stretch of beach from Patrick AFB to Sebastian Inlet State Recreation Area. Reproductive success at 48.8% was lowered due to raccoon depredation, which accounted for 9% of the total number of nests in CRSA.

FLORIDA GREEN TURTLES (*Chelonia mydas*)

Green turtles characteristically exhibit a biennial nesting pattern of "high" and "low" years (Figure 2) and 1997 was expected to be a "low" year. With 180 nests in CRSA and 28 additional nests in CBSA, green turtle nesting activity was at the highest level in a "low" year since surveys began in 1982. In CRSA, this represented an increase of 75% and 107% over 1995 and 1993, the previous two "low" years. Like loggerheads, green turtle activity began early this season, but began very slowly. Figure 6 indicates that there were probably only five turtles nesting in South Brevard County for the first four weeks of the season, yet by the end of August we had encountered 34 individuals Spatial distribution of green turtle nesting is given in Figure 7. In CRSA, green turtle nesting success at 54.6% was nearly 7% higher than in 1996, and reproductive success was 56.5%.

In 1997 we continued our collaboration with Barbara Schroeder (National Marine Fisheries Service) in placing satellite transmitters on post-nesting green turtles You can follow the progress of these animals courtesy of National Marine Fisheries Service, Florida Dept of Environmental

Reproductive Success

Reproductive Success
(The percentage of hatchlings that emerge from the nest)

	# nests	CBSA	# nests	CRSA	OVERALL
Loggerhead	68	67.5%	148	48.8%	54.7%
Florida Green Turtle	13	53.5%	64	56.5%	56%
Leatherback	n/a		4	40%	40%

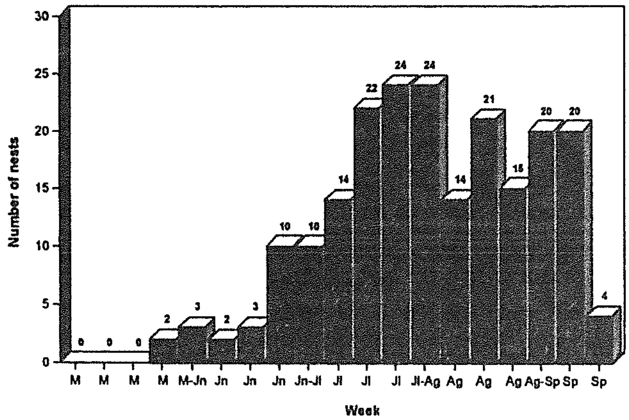

Figure 6. Temporal distribution of Florida green turtle nests in the Central Brevard and Carr Refuge Study Areas in 1997.

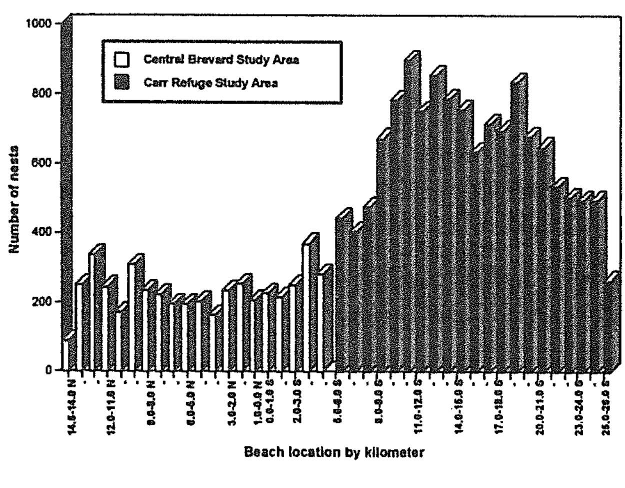

Figure 5. Spatial distribution of Loggerhead nests in the Central Brevard and Carr Refuge Study Areas in 1997.

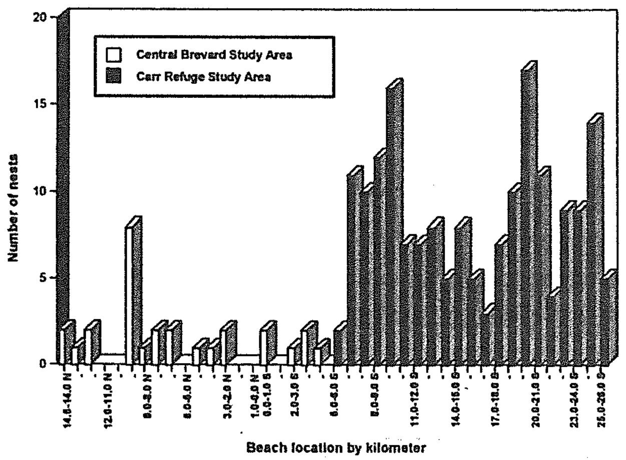

Figure 7. Spatial distribution of Florida green turtle nests in the Central Brevard and Carr Refuge Study Areas in 1997.

Protection, and Caribbean Conservation Corporation by accessing the World Wide Web at http://www. cccturtle. org.

LEATHERBACKS (*DERMOCHELYS CORIACEA*)

These beaches have never been thought of as critically important leatherback nesting grounds but we noted in 1995 that there was "a meager suggestion of increased leatherback activity on these beaches in the past five years There were only four nests in the eight years between 1982 and 1989, and 21 nests during the eight year period from 1990 to 1997 (Figure 3). These data indicate that leatherback activity is on the increase and can no longer be regarded as negligible or unimportant at the Carr Refuge In 1997, we encountered four leatherback nests at ACNWR. Nesting success was 100%; reproductive success was 40%

ACKNOWLEDGEMENTS

We thank the U.S. Fish and Wildlife Service (especially Sandy MacPherson) and the Richard King Mellon Foundation for their continued support; to Earl Possardt for making his vision of the Archie Carr National Wildlife Refuge a reality, and to Doc, who keeps on "keepin' on" in the Archie Carr tradition. Thanks also to Jason Drake, Jason Godin, and Dr. John Weishampel of the GAMES (Geospatial Analysis and Modeling of Ecological Systems) LAB for their assistance, technical skills, time and patience

RETROSPECTIVE ANALYSIS OF ELEVEN YEARS OF WORK ON TURTLE NESTING ON THE COAST OF COLIMA, MEXICO

Noemí Barajas Campuzano, Armando Hernández Corona, and Germán Reyes Ortega
SEMARNAP- Colima, Victoria 360 Colima, Col., México

The state of Colima has 160 kilometers of coastline, where the olive ridley (*Lepidochelys olivacea*) turtle arrives to nest. The population of this turtle is larger than the population of the leatherback turtle (*Dermochelys coriacea*) and black turtle (*Chelonia agassizi*). The work of protection of the turtles began in the state of Colima in 1987 with the prospection of four important beaches. We put four points of observation on the beach of Playa de Oro, Volantin-Tepalcates, Tecuanillo and El Chupadero. After obtaining results we began to work permanently due to the importance of nesting on this beach. At this moment we only have two areas of observation because of a reduction on our budget. SEMARNAP which is in charge of th El Chupadero area covers 25 km. of coast, from de Boca de Apiza to Tecualillo. SEDESOL which is in charge of Cuyutlan covers also an area 25 km. from Boca de Pascuales to Tepalcates beach. These two areas are the most important for turtle nesting on the coast of Colima. We describe and compare eleven seasons of nesting for the three species of turtle that arrive on Colima's coast. This analysis is based on the variables related to reproductive ecology. We also have a program on marking and recaptured of the turtle.

SEA TURTLE NESTING VARIATION IN THE BEACHES OF THE SOUTH ZONE OF SIAN KA'AN RESERVE, DURING 1991, 1992 AND 1993 SEASONS

Carlos López, Juan Bezaury Creel, and Jorge Carranza Sánchez
Amigos de Sian Ka'an A.C. México. sian@cancun.rce.com.mx

Sea turtle research and protection activities have been done in almost all the coast of Quintana Roo, in the Mexican Caribbean, including the protected areas of Special Biosphere Reserve of Contoy Island, in the north, and the Biosphere Reserve of Sian Ka'an in the south. In this last area, sea turtles have been studied in 1991, 1992, 1993 and 1997. These research projects have focused on the nesting density for the different species that reproduce in these beaches, on the evaluation of emergence percentage in natural nests as well as on size of females, nesting frequency and interval. In these years we have described 12 nesting beaches in the area of Sian Ka'an, being the beaches of San Lorenzo, San Martín and Mosquitero the ones with highest nesting densities. Although there's no significant variation, an increment in the number of tracks can be observed for 1997 season. Percentages of emergence are high in natural nests and there's no variation among seasons. Female tagging has resulted in some recaptures throughout the years and an observed growth of the turtles.

The species important for this area are the green turtle, the loggerhead and the hawksbill. The beaches in this area have proven to be important for sea turtle nesting, and due to the prevalent conditions in the Reserve, it is possible to keep the nests *in situ*, which is difficult to do in other coastal zones of Mexico and the rest of the world.

EVALUATION OF QUARTZ, ARAGONITE AND CARBONATE BEACH COMPATIBLE SAND ON NEST TEMPERATURE AND SUCCESS PARAMETERS OF *CARETTA CARETTA* NESTS IN SOUTHEASTERN FLORIDA, U.S.A.

Stephen M. Blair[1], David Nelson[2], Rebecca Cheeks[3], Joe Hibler[1], Timothy Gross[4], Peter Lutz[3], and Jim Hoover[5]
[1]Dade County Department of Environmental Resources Management, Miami, FL, U.S.A. blairs@itd.metro-dade.com
[2]United States Army Corps of Engineers, Waterways Experiment Stations, Vicksburg, MS, Florida U.S.A.
[3]Atlantic University, Boca Raton, FL, U.S.A.
[4]University of Florida, Gainesville, FL, U.S.A.
[5]Dade County Department of Parks and Recreation, Miami, FL, U.S.A.

Due to the ecological and economic importance of coastal beaches in South Florida, state and federal agencies have made the commitment to maintain and rebuild them, through beach renourishment, utilizing off-shore sand deposits. Unfortunately, deposits are dwindling, particularly along the Southeast coast of Florida (Broward and Miami-Dade counties). Accordingly, alternate sources of sand for beach renourishment are being explored, including: presently unidentified offshore deposits, non-domestic aragonite and carbonate sands, and quartz sands from upland/ inland deposits. Since nearly one-third of the world's population of nesting loggerhead sea turtles nest in the southeastern United States, an important part of the evaluation process is to determine the effects of alternative sands on sea turtle nests and nesting. A hatchery study was initiated to test the effects of various sand types on the general nest success parameters, sex ratios and temperature environment of loggerhead sea turtle nests. The program was initiated in 1995 and has continued through three nesting seasons (95-97). The program has been a cooperative effort of the U.S. Army Corps of Engineers Waterways Experimental Station, Miami-Dade County Department of Environmental Resources Management, Florida Atlantic University and the University of Florida.

An experimental hatchery was established on Miami Beach, Florida, within which, 4 to 6 20 ft X 20 ft X 4 ft "cells" were filled with one (or a mixture) of the following sands: renourished (from off-shore borrow source), aragonite (Great Bahama Bank, Bahamas), or quartz (from inland central Florida). Not all sands were used during each year. Renourished sand and aragonite sand were utilized during each of the three years with replicate cells tested during 1997. Quartz evaluation began in 1996 and replicate quartz cells were also tested during the 1997 season. Up to 36 loggerhead nests were relocated into nests of standardized depth, within each sand cell. Nests were positioned on three foot centers. Temperature of the nests were recorded with either a Vemcoâ Minilogger (self contained temperature datalogger) or thermocouples connected to a Campbell Scientific AM416 Mutiplexer, and recorded on a Campbell Scientific 21X Datalogger. Data were transferred to PC's and evaluated with MS Excel (Microsoft) and SAS statistical software (SAS, Inc.). Approximately 5-7 days prior to estimated emergence, selected nests were opened and eggs isolated for sex determination. Sex of hatchlings was determined utilizing the estrogendiol/testosterone ratios (Gross *et al.* 1995). Post emergence success evaluations were conducted on each nest. The number of dead-in-nest, live-in-nest, pipped-live, pipped-dead, unhatched-developed (showing visual signs of embryonic development), unhatched-undeveloped (no visible indications of any embryonic development) and shells were tallied and recorded. Sand color was characterized utilizing Munsell Soil Classification Charts (1994, GretagMacbeth, Windslow, NY). Reflectance, hue and chroma were determined for each sand type.

First year's temperature, nesting success and sex ratio information have been reported previously (Cheeks *et al.*, In press; Cheeks, 1997; Nelson *et al.*, 1996). This paper presents results of the temperature and nest success information for the 1997 replicated renourished, aragonite and quartz sands, and compares these data with past results.

SAND TEMPERATURE

Sand temperature was expected to follow a gradient relative to color as indicated by past results (Nelson *et al.*, 1996, Milton *et al.*, 1997) and the sand color classification. Aragonite and Upland sand (lightest colored) were expected to be the coolest, with Renourished carbonate (the darkest), the warmest of the sands. Figure 1 illustrates the daily fluctuation of sand (control) temperatures recorded during 1997, and illustrates the consistent difference noted between aragonite and renourished sand. Renourished sand was consistently 1.25 to 1.50 °C warmer than the aragonite. This difference was a s great as 2.6°C during 1996, and exceptionally warm and dry year (during the nesting season), however, in '95 and '97, the nominal difference was 1.5°C.

The average daily temperatures of the upland silica sand was much warmer than anticipated in consideration of the sand's color and apparent reflectant surface. The silica sand was comparable to the temperatures found in the darker renourished sand. Upland silica was approximately 2°C warmer than the aragonite, and 0.25 - 0.5°C warmer than the renourished sand. Specific, but presently undetermined physical properties or characteristics of the sand (*i.e.*, mineral characteristics, more translucent) are believed to result in greater heat conductance than the renourished or aragonite sands.

The daily fluctuation (range) in the upland sand was largest of the sands, being about twice that of the aragonite or the renourished sands. The greater daily fluctuation was a consistent trait in the '96 and '97 tests. Additionally, the upland sand appeared to lose more heat during periods of cooling (*i.e.*, during rain and cooler air temperatures; Figure 1, ref: 8/20, 9/7 and 9/15) than the aragonite or renourished sands. This greater range of temperature fluctuation could result in modified proportions of incubation time spent at specific temperature, and therefore, in consideration of Georges (1994), could have an effect on the overall hatchling sex ratios produced by the nests.

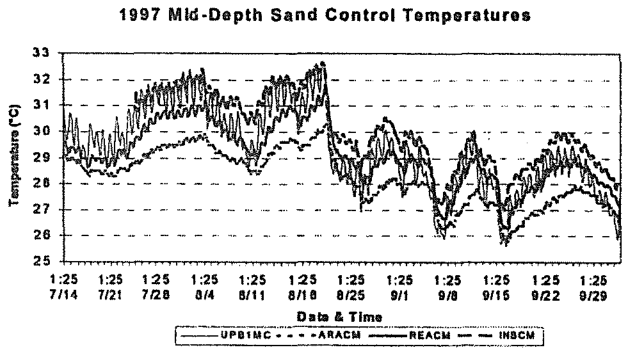

Figure 1. Daily sand temperature fluctuation in aragonite, renourished, upland and 'in-beach' sand.

The '96 nesting season was the warmest and driest of the seasons investigated. This is reflected in the high average sand temperatures for both aragonite and renourished sands (Table 1). The average sand temperature (throughout incubation) for renourished sand was 31.39°C. Daily average nest temperatures in renourished sand reached as high as 35.69°C in central (mid and sides) of the nest. Specific low success rates for certain renourished nests are considered to be an effect of these high temperatures, however, other nests with similar temperatures (+35°C) showed high (75-90%) hatching and emergence levels.

Table 1. Average Sand Control Temperatures (°C)

Sand Type	1995	1996	1997
Aragonite	27.56	28.89	28.18
Renourished	28.95	31.89	29.15
Upland			29.32
In-Beach			30.07

Statistical analysis of the sand temperatures, normalized to the aragonite control found the renourished sand to be significantly warmer than aragonite during each year of the project. The upland sand was significantly warmer than the aragonite, but not significantly different from the renourished.

Data from 1996 are used to illustrate the relationship between the nest and sand (control) temperature during incubation (Figure 2). Little increase, relative to the control is noted through the first third of the incubation. A moderate but steady increase is consistently seen during the second "trimester". The greatest rate of change is seen in the third trimester, with maximal temperatures occurring just prior to pipping. Although precipitation contributed to the decrease at the end of the incubations illustrated in Figure 2, a decline in temperature during the pipping period (1-3) days prior to emergence, was noted in the nests. Mid-depth clutch temperatures were between 1.5 - 3.0 °C warmer than the sand temperatures and average daily nest temperatures were as high as 35.69 °C (in renourished sand).

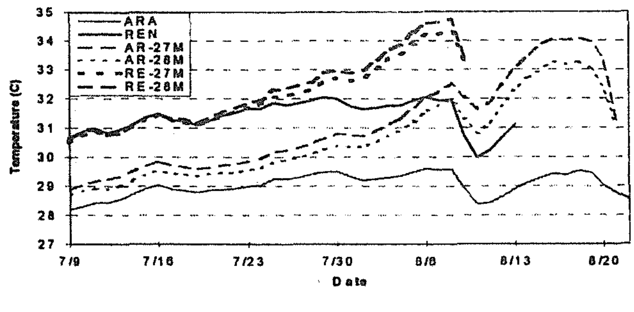

Figure 2. 1996 Daily average Temperature in Renourished and Aragonite nests and controls

HATCHING AND EMERGENCE SUCCESS

Yearly average hatching success by cell (average success of all nests in a cell) over the three seasons varied from 71.6% to 86.7%, and emergence success between 64.7% and 81.3% (Table 2). Although these ranges refer to all sands combined, they are also indicative of the amount of year to year variation documented within each sand type. For example, average hatching success of renourished nests was significantly greater than that of aragonite in 1995. However, the reverse was true in 1996. No significant difference was found between any other combinations of sands in 1996 or 1997.

Table 2. Hatching and Emergence Success, and Incubation Length for the sand cells tested 1995-1997

	Hatching		Emergence		Incubation (days)	
	Mean	Std. Dev	Mean	Std. Dev	Mean	Std. Dev
ARA 95	78.6%	15.4	74.9%	15.4	59.9	2.2
ARA 96	86.7%	9.3	81.3%	11.8	58.1	3.7
ARA 97	75.0%	22.3	69.3%	27.3	58.1	2.9
ARB 97	78.5%	12.2	72.1%	20.9	56.6	2.6
REA 95	83.8%	13.0	81.2%	13.3	52.5	2
REA 96	71.6%	19.6	64.7%	21.9	50.8	3
REA 97	74.3%	19.8	68.3%	21.5	54.1	3
REB 97	75.1%	25.2	69.5%	28.3	52.4	1.7
UPA 96	79.0%	30.4	76.9%	29.6	53.5	1.4
UPA 97	77.6%	23.7	73.6%	24.0	51.9	2.8
UPB 97	77.7%	21.9	74.7%	21.6	53.1	2.3
INS 97	73.8%	26.3	73.0%	25.9		

The average length of incubation for each cell is presented in Table 2. Each season, nests incubated in aragonite sand had a significantly greater incubation length than

Table 3. Significance summary of comparisons of hatching and emergence success, and incubation length 1995-1997

SAND	HATCHING SUCCESS	EMERGENCE SUCCESS	INCUBATION LENGTH
Aragonite	80. 3%	76. 7%	58. 3(A)
Renourished	76. 4%	72. 0%	52. 3(B)
Upland	77. 9%	74. 6%	52. 6(B)
Significance	n. s.	n. s.	p<0. 05
(Duncan Multiple Range)			(A)≠(B)

renourished or upland sands. Nests in aragonite sand had a four to seven day longer incubation than those in renourished, and three to six day longer incubation than nests in upland silica sand. Nests in the upland sand had equivalent incubation time as the renourished sand, and, although not significantly different, averaged 1 to 2 days shorter than the nests in the renourished sand. As with the temperature, we found the lighter upland silica sand to have characteristics similar to the renourished sands.

Table 3 presents a summary of the statistical analyses of hatching and emergence success, and incubation length for the pooled (across years) data. No significant differences were found between the sands for the hatching or emergence success. Significant differences were identified in the incubation length of the sands, with aragonite having a significantly longer incubation period (three to seven days) The upland and silica sands showed comparable nest incubations lengths, with the upland sands have a slightly shorter, but not significantly different incubation length

ACKNOWLEDGEMENTS

This project is the result of numerous individuals dedication and assistance. We thank Sarah Milton, Sue Kim, Tim McIntosh, Martin Roch, Leanne Welch and Sabina Beg, for daily assistance with field and hatchery work Special thanks are also give to Bill Ahern, Tony Way and the crew at the Miami Beach Sea Turtle Hatchery facility. Additional thanks go to Bill Margolis who manages the Broward County Hatchery Facility at Fr. Lauderdale, Florida for providing us with additional nests during the 1995 and 1997 portions of the study.

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TEMPERATURE AND THE TEMPORAL SPREAD OF MARINE TURTLE NESTING AND HATCHING IN CYPRUS, EASTERN MEDITERRANEAN.

Annette C. Broderick and Brendan J. Godley
Marine Turtle Research Group, Division of Environmental and Evolutionary Biology, Graham Kerr Building, University of Glasgow, Glasgow G12 8QQ, Scotland, U.K. A.Broderick@bio.gla.ac.uk

INTRODUCTION

Both nesting and hatching of marine turtles were monitored at Alagadi Beach, a major rookery on the north coast of Cyprus throughout the seasons of 1993-1997. For details of methodology see Broderick and Godley (1996).

ONSET OF NESTING

Variation in the onset and duration of nesting, was recorded between species and among years (see Table 1). These data have been compared to temperature data for the region. After five seasons monitoring, it is premature to undertake any statistical analyses, however the timing of the nesting season appears to be correlated with the prevailing temperature conditions *i.e.* an earlier season when temperature rises earlier. The onset of nesting appears to coincide with a rise in mean daily air temperature to approximately 25°C (see figures 1 and 2). It is likely that if environmental temperature is acting as a seasonal cue, that this would be a threshold temperature earlier in the season which would stimulate egg production and/or migration to the breeding sites.

Table 1. Onset of the nesting season for C. mydas and C. caretta in Cyprus in each of the years 1993-1997.

Year	Onset of nesting	
	C.mydas	C.caretta
1993	16th June	15th June
1994	31st May	31st May
1995	6th June	24th May
1996	11th June	27th May
1997	5th June	27th May

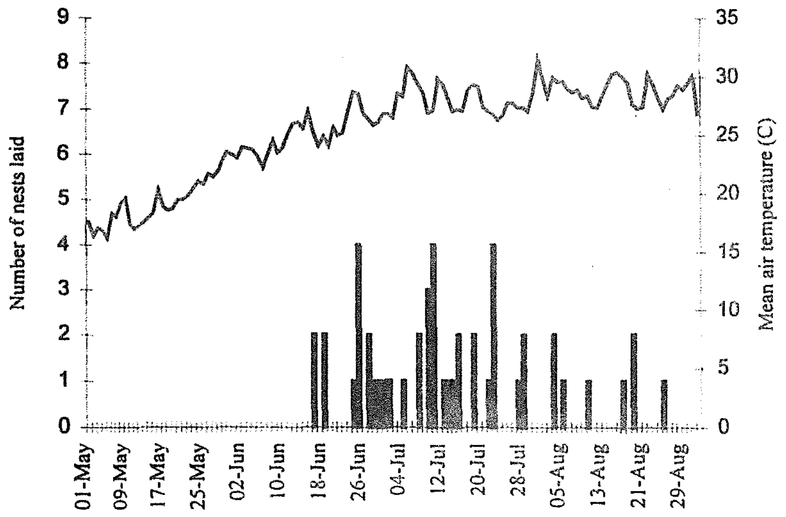

Figure 1. The temporal distribution of nesting of C. mydas, *1993, with mean daily air temperatures in centigrade.*

Several studies have questioned how a rise in temperature due to global warming will affect such temperature dependent species (*e.g.* Mrosovsky and Provancha 1992). However, if the start of the nesting season is dependent on the ambient temperature reaching a certain threshold, then if global warming occurs, females may shift their nesting season, with their clutches effectively incubating during similar temperature regimes.

Table 2. Length of incubation periods of C. mydas and C. caretta nesting in Cyprus in each of the years 1993-1997 with standard

YEAR	C.MYDAS			C.CARETTA		
	MEAN	S.E.	N	MEAN	S.E.	N
1993	50.6	0.57	24	47.9	0.62	17
1994	51.4	0.53	45	47.9	0.36	58
1995	51.1	0.55	52	51.1	0.55	40
1996	49.86	1.75	7	48.18	0.54	44
1997	50.23	0.80	13	47.43	0.45	40

INCUBATION PERIODS

Incubation periods ranged from 44-59 days in *C. mydas* nests and 42-60 days in *C. caretta* nests. The mean incubation periods recorded in each of the five study years for both species are given in Table 2. Mean incubation periods of *C. mydas* nests laid in Cyprus, are shorter than those laid in Turkey (53.8 days), the only other major nesting site of *C. mydas* in the Mediterranean (Gerosa *et al.*, 1995). Similarly, incubation periods of *C. caretta* nests in Cyprus are shorter than those recorded in by Margaritoulis (1989) in Greece (55.5 days) and by Erk'akan (1993) in Turkey (59.3 days).

In some years, linear relationships were recorded between the date of lay and the incubation period of the nest for both *C. mydas* (*e.g.* Figure 3) and *C. caretta*. Quadratic equations better explained these relationships in long nesting seasons for both species (*e.g.* Figure 4).

It has been well documented that an increase in temperature decreases the incubation period of marine turtle nests (Mrosovsky *et al.*, 1995). This fact may explain the shorter incubation periods of *C. mydas* and *C. caretta* nests in Cyprus. A prevailing sunnier and

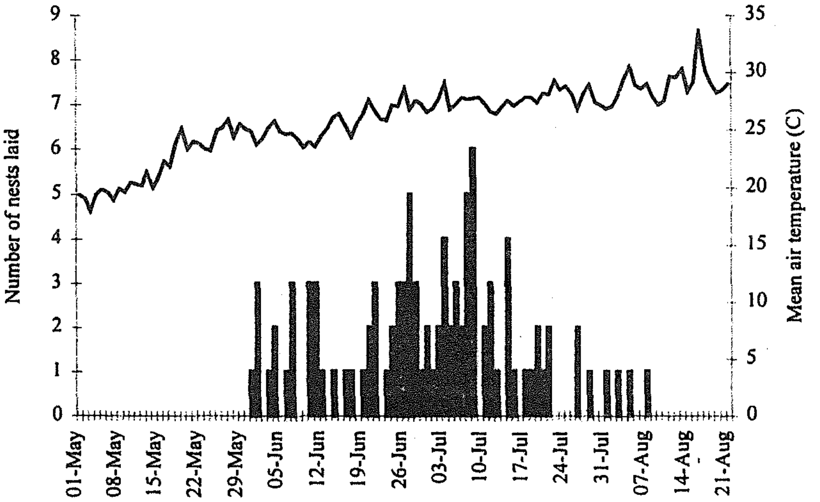

Figure 2. The temporal distribution of nesting of C. caretta, *1994, with mean daily air temperatures in centigrade.*

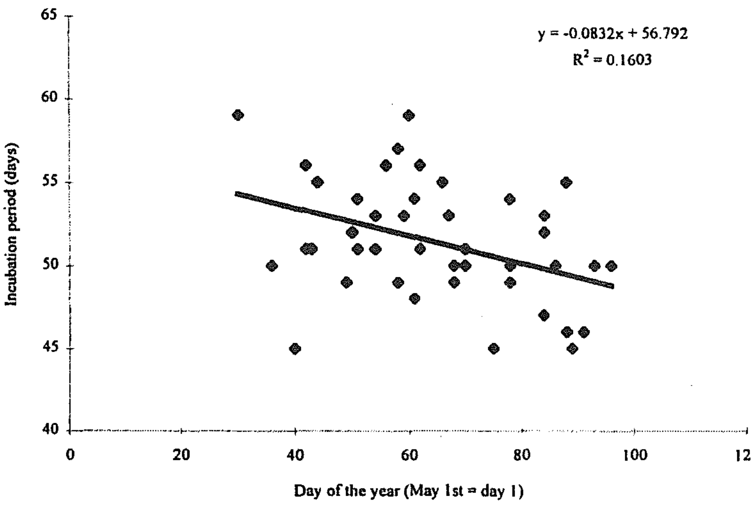

Figure 3. The linear relationship between the day of the year on which a nest was laid and the resultant incubation period of C. mydas *nests, 1994.*

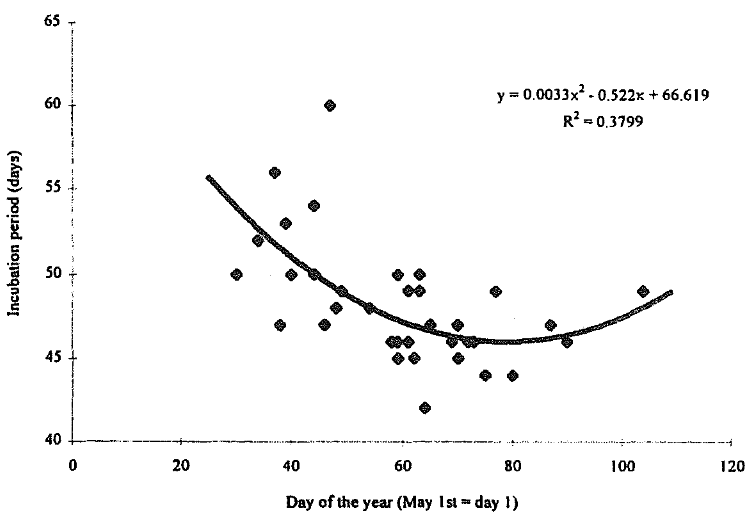

Figure 4. The quadratic relationship recorded between the day of the year on which C. caretta *nests were laid and their incubation period in 1995.*

warmer climate is found in Cyprus compared to other sites where marine turtle nesting studies have been undertaken in the Mediterranean. As can be seen figures 1 and 2, air temperature increases throughout the early part of the nesting season. This will account for the decrease of incubation periods as the season progresses, except for the occasional late nests which are incubated in the cooler temperatures of September and have slightly longer incubation periods.

ACKNOWLEDGEMENTS

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MARINE TURTLES NESTING MONITORING IN EL CUYO, YUCATAN, MEXICO. SEASON 1997

Eduardo Campos Bravo[1] and Felipe Be Estrella[2]
[1]Pronatura Península de Yucatán, A.C. México.
[2]Secretaría de Medio Ambiente Recursos Naturales y Pesca, Delegación Yucatán, México. pronatyuc@laneta.apc.org

The hawksbill turtle (*Eretmochelys imbricata*) nesting period lasted for six months, from mid-April to October. During this time twenty eight female Hawksbill turtles were marked and twenty eight recaptured. Were registered 406 nests of which: 82% (333) were incubated in situ, 11.5% (47) were relocated near of the nesting site and 6.6% (27) were transported to the corral. A total of 12.8% (52) fell subject to depredation by foxs, racoons and dogs, 3.9% (16) were wiped out as a result of high tide and 2% (8) were looted by humans. For undisturbed nests the average hatch success and emerge success of in situ nests (n=227) was 88.5% y 90.2% respectively, in relocated nests on the beach (n=39) 65% and 55%, and relocated at corral nests (n=27) 77.1% and 60.4%. In 42,424 eggs incubated in 300 nests aproximately 34,165 hatchlings emerged. The nesting period for the green turtle (*Chelonia mydas*), lasted five months, from May until mid-September, during which five female green turtles were marked and seventeen were recaptured. Of the 44 nests which were registered, 93.2% were incubated in situ (42) and 6.8% were relocated on the beach (3). A total of 13.6% (6) of the nests were affected by high tide and flooding. For undisturbed nests the average hatch success and emerge success of in situ nests (n= 32) was 92.2% and 87.9% respectively. Of the 3,607 eggs incubated in 33 nests, proximately 3,313 hatchlings emerged.

REPRODUCTIVE SUCCESS OF HAWKSBILL TURTLES (*ERETMOCHELYS IMBRICATA*) IN ISLA DE AVES WILDLIFE REFUGE

Evaristo Caraballo[1], Lenin Parra[2,3], Samuel Narciso[4], Yovanni Aponte[2], and Guillermo Sánchez[2,3]
[1] FUDENA, Programa de Areas Marinas y Costeras, Apdo 76. 471, Caracas 1071-A, Venezuela lparra@ciens.luz.ve
[2] FUDENA, Programa de Tortugas Marinas, Apdo 76. 471, Caracas 1071-A, Venezuela
[3] Universidad del Zulia, Museo de Biología, Apdo. 526, Maracaibo 4011, Edo. Zulia, Venezuela
[4] PROFAUNA, Edif. Camejo, Mezzanina, El Silencio, Caracas 1010, Venezuela

Isla de Aves Wildlife Refuge, in the eastern Caribbean Sea (15°40'30'' N, 63°36'26'' W), is one of the most important nesting sites of the green turtle (*Chelonia mydas*). Since 1979, FUDENA with the help of the Venezuelan Navy has sent researchers to tag and monitor the green turtles that nest on the Island. A 1968 fishermen's report of hawksbill nesting on Isla Aves was described by Caldwell and Rathjen (1969), but there have been no authenticated records of species other than green turtles nesting on the Island. On 8 August, 1996, several turtles - distinct from the green turtles - were observed swimming to the north of the island. A few hours later a female turtle was observed on the sandy beach of the west side of Aves, and it was observed by researchers for about 65 minutes. This turtle was tagged on its left fore flipper with tag number N3632, and it was measured with a flexible tape: standard curved carapace length = 92 cm; curved carapace width = 88 cm. In September 1997, several dead hatchlings were found near the site of the nest, and they were subsequently identified as *Eretmochelys imbricata*.

This species of turtle is known for its isolated nesting strategy and the use of small, remote beaches. Increased human perturbation of hawksbill beaches could drive these animals to nest on beaches where nesting has not bee recorded in recent years, and it is possible that a new nesting site may develop on Isla Aves.

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HATCHING AND EMERGENCE OF LEPIDOCHELYS OLIVACEA FROM PROTECTED AND UNPROTECTED NESTS IN "LA GLORIA" (PLAYON DE MISMALOYA),JALISCO, MEXICO: 1991 - 1994.

Rosa Estela Carretero Montes and José Antonio Trejo Robles
Centro de Ecología Costera, Universidad de Guadalajara, Gómez Farías # 82, San Patricio-Melaque, Jalisco, C.P. 48980, México. jtrejo@costera.melaque.udg.mx

The protective activities for the marine turtle by the University of Guadalajara, began in the eithies in the now Reserve Zone -Playon Refuge of Mismaloya. The principle activity that has envolved to the present time are the patroll through the zone with the objective of finding marine female turtles either depositing eggs or nests of the same and collecting and transporting them to protective corrals and thereby later freeing the young. This practice is constant and intensive and thanks to the presence of investigators and counterparts along with the Mexican Naval Marine forces the preying incidents have declined, so as to permit the allocation of 1 km of beach for the nests in situ and allow investigations of the same. Specifically during their time of nesting in 1991, 1992, 1993 and 1994 a total of 91 nests in situ of the open sea marine turtle *Lepidochelys olivacea* were protected and observed. The study is based on percentages of hatchings, emergency and incubation of the natural nests as compared to the transported and protected ones in corrals on the same dates as the previous. This way the obtained results thru four years of protection of natural nests give us the hatchings and emergency percentages are higer than the protective corrals nest. One must mention that in the natural nests as in the corraled ones a temporal behavior of hatching was found through -out the period.

CHARACTERIZATION OF HAWKSBILL TURTLE'S NESTING BEACHES IN THE DOCE LEGUAS KEYS

Elvira Adelaida Carrillo Cárdenas
Centro de Investigaciones Pesqueras, 5ta. Ave. Y 248, Santa Fe, C. de la Habana, Cuba. *cubacip@ceniai.inf.cu*

The Doce Leguas Keys is the main area of hawksbill's reproduction in the Cuba Archipielago. Keys are located south of Camagüey province, 60 km far from land 45 keys are included in the are, extending over 120 km, and more than 60% of the area is formed by sandy beaches of fine sands, favoring nesting. In others, sands is thicker and mixed to coral residues, mollusks and stones. Length varies (must of then between 300 and 3500 m), and nearly all beaches are narrow (12 m as an average) with long coral barriers limiting an inner area mainly composed of sand spots, stone and seagrass meadows; bottoms are generally low, and vegetation is mainly formed by mangrove, pines, some varieties of palms and other native species.

RESULTS OF THE PROTECTION AND MANAGEMENT OF THE KEMP'S RIDLEY TURTLE (L. KEMPI) IN TAMAULIPAS, 1995-1997

Refugio G. Castro M.[1], Leo P.[1], Alma S.[1], Enrique Conde G.[1], Rolando Orta N.[1], Juan Díaz[2], and Manuel Sánchez P.[2]
[1]CRIP- Tampico Calle Altamira s/n col. Isleta Pérez, Tampico Tamaulipas, México
[2]Instituto Nacional de la Pesca, Pitágoras 1320, 5 Piso, Col. Sta. Cruz Atoyac. México D.F. 03310, México *criptam@tamnet.com.mx*

The Program of Conservation and Management for the kemp's ridley turtle (*L. kempi*) in the coast of Tamaulipas and North of Veracruz state, carry out a Mexico-E.U.A. (MEXUS-Golfo) cooperation agreement. Both countries support the program with important contribution of human resources and equipment. This collaboration have allowed the increase of the area patrolled to 200 Km of beach in the NW of the Gulf of Mexico and the protection of thousands of nests and the recruitment of hundreds of thousand of hatchlings to the wildlife population. In 1995 were collected 1,868 clutches, releasing 125,639 hatchlings. In 1996, 2,047 clutches were collected and 119,196 hatchlings were released. In 1997, 2,340 clutches were collected representing the recruitment of 149,567 hatchlings.. These numbers show an increase of nestings of 25% and hatchlings of 19% in relation to 1995. In this project participate other Mexican and American institutions and organizations such as National Marine Fisheries Service E.U.A., U.S.A. Fish and Wildlife Service, Gladys Porter Zoo, Secretaría de Marina, Delegación Federal-SEMARNAP, Tamaulipas, PROFEPA, Gob. Estatal y Munici-

pal, CANAINPES, México-NFI, EUA, PEMEX, Universidad del Noreste (UNE), CET-Mar No. 9 Secretaría de Educación Pública and Boy Scouts

MARINE TURTLE NESTING AND CONSERVATION AT GANDOCA BEACH 1990-1997 (TALAMANCA, COSTA RICA)

Didiher Chacón
Programa Marino/Humedales, Proyecto Conservación de las Tortugas Marinas Asociación ANAI, Apdo. 170-2070, Sabanilla, San José, Costa Rica. *anaicr@correo.co.cu*

The leatherback sea turtle was studied in Gandoca, an important nesting beach on the southeastern Caribbean coast of Costa Rica (82° 37′W;09° 37′N), from 1990 to 1997 during March through July. The 9 km of beach was patrolled every night from approximately 2000 through 0400 hours by 3-5 groups, so that all turtle nests are identified and collected are 20 biotic and abiotic paramenters. The trend for the number of nest every year is growing by an index of 127 nest/yr. The minimum nesting season was 226 nests and the maximum 1,135 with a average of 534 nest/yr. and a median of 405 nest/yr. (r=0.5883); the biometric datas show coincident information with others rookeries in the Caribbean. The most important problems in Gandoca are poaching (that was reduced from 100% in 1985 to 13% in 1997), the erosion and the big pieces of garbage of the beach. The project has developed a model with 9 components and, with the participation of part of the community and the Wildlife Refuge Authorities, work in microbusiness in ecoturism with volunteers produced over US$14,000 input into the local economy.

ESTADO ACTUAL DE CONSERVACION DE LAS TORTUGAS MARINAS EN LOS DEPARTAMENTOS DEL MAGDALENA Y LA GUAJIRA, CARIBE COLOMBIANO.1997

Jorge Alberto Córdoba, Sigfried Milklin, and Diego Amorocho
Fundación FES alle 64 Norte No.5B-146 Local 26 Cali. Colombia. fesambi@cali.cetcol.net.co

The present work was accomplished with the purpose of gathering and updating the information produced untill this moment in the Departments of Magdalena and la Guajira in the Caribbean coast of Colombia. This research includes characterization of the nesting beaches, identification of species harvested by local inhabitants and efforts developed in the zone by sea turtle conservation organizations.

The beaches of the zone are suitable for the reproduction of sea turtles, but the high predation has decreased the number of nesting turtles. Other factors that have affected this decrease are the shrimp trawling in shallow waters near the beaches, the tourism in the area and the social problems that converts the turtles in a way of subsistence for local inhabitants, most of them indigenous people.

The few sea turtles conservation projects developed in the zone, have never had enough founds, so they can no protect the whole area, althoug they are protecting and relocating nests in 3 different sites establishing beach hatcheries.

During our field trip in August of 1997, we registered 36 nests, which were protected by different NGOs and Gubermental organizations. Surely the nesting activity was higher, but due to the excessive poaching and the lack of vigilance in the zone, it was impossible to give an exact nesting data.

With the registered data we established the following relation for nesting species: 8 *C. caretta* : 3 *D. coriacea* : 1 *E. imbricata*

INVESTIGATION ABOUT THE QUANTIFICATION OF SEA TURTLES AT THE NATURAL RESERVE "JUAN VENADO ISLAND", LEON, NICARAGUA

Francisco Raúl Cruz Martínez
Ministerio del Ambiente y Los Recursos Naturales; Delegacion de León, Contiguo a la Biblioteca del Banco Central; León, León, Nicaragua. *nicam@sdnnic.org.ni*

The protection of the seaturtles and the forest in "Juan Venado" Island is made it with the help of the community. The Natural Reserve of Juan Venado Island is located at the pacific coast, southly of Poneloya, Leon, Nicaragua. Under decree # 1,320 it has extension of 4,600 has and 22 km of perimetral area of beach, where como to nest nearly 500 turtles from October to January each year. The species that we have here are: Paslamas (*L. olivacea*); Toras (*D. coriacea*) and Carey (*Erethmochelys imbricata*). From them the two first are more predominant and the third one is less known. In order to protect these species we trade in account the Comunities of "Las Peñitas" and "Salinas Grandes" which make some damages on the eggs resources, because of the economical conditions. The people make the collection or pick up the turtles eggs during the night and pur them in hatchery (nursery) which are located in the coast of the island, we give some help in food to the people who participate in the collection, which has an equivalent of C$ 150 Cordobas or US$ 15.00 Dls. The surviving average of the eggs that we got from the little turtles is about 70% which are throw to the sea and the people of the communities are witness of than our goal for this year is to sew (scatter) around 40.000 eggs and we want a production of 28.000 little turtles or hatchlings. Beside with the account of how many turtles come to nest to the beach the quantity that nest every one of them, and also the ones dies by different reasons and the nests which care ilegaly stealed through the same people. It's important to point out that we made some inspections in differents restaurants, market and places during the nesting period in order to avoid the comsumption of the people.

PROTORMAR-UAS: 21 YEARS OF RESERCH AND CONSERVATION OF SEA TURTLES

Fernando Enciso Saracho[1],.Marco A. Barraza Ortega[1], Ignmar Sosa Cornejo[2], and Jesús Pérez Márquez[2]
[1]Facultad de Ciencias del Mar, Universidad Autónoma de Sinaloa, Paseo Claussen S/N , Mazatlán, Sinaloa; A.P. 610, C.P. 82000, México
[2]Escuela de Biología, Universidad Autónoma de Sinaloa., México. *cali@facimar.maz.uasnet.mx*

Activities worked out by the diverse schools, and departments of the Universidad Autónoma de Sinaloa since 1976 involving those of conservation, research, enviromental education for kids, and cultural activities mainly on the olive ridley turtle from Sinaloa's coast are summarized.

CARACTERIZACIÓN DEL SITIO DE ANIDACIÓN EN LA PLAYA DE "LAGUNAS DE CHACAHUA", OAX. PARA LA ESPECIE *LEPIDOCHELYS OLIVACEA* (TORTUGA GOLFINA).

Ma Teresa Espino Chávez[1] and Gustavo Casas Andreu[2]
[1]Facultad De Ciencias U.N.A.M. espino@chajul.ine.gob.mx
[2]Instituto de Biología U.N.A.M, México D. F.

INTRODUCCION

Estudios realizados en diversas playas del mundo, demuestran que las características en las playas de anidación son diferentes en unas y otras e incluso dichas características difieren dentro de la misma playa. Varios autores como Hendrickson (1966) y Mortimer (1980, 1990), han observado, que factores como temperatura, humedad y tamaño de grano de la arena son características importantes para la selección del sitio de anidación así como para el avivamiento de crías de tortuga marina.

OBJETIVOS

Describir las características del sitio de anidación de la tortuga marina *Lepidochelys olivacea*, (golfina), en función de la temperatura, humedad y granulometría.

Definir el patrón de granulometría, el porcentaje de humedad y la temperatura presentes en nidos naturales.

Establecer si existe correlación entre la línea de marea y el sitio de anidación; y la distancia del nido a la vegetación.

Con base en la temperatura, humedad y granulometría determinar si la tortuga *Lepidochelys olivacea*, (golfina), sigue un patrón o gradiente en la selección del sitio de anidación.

METODO

Utilizándose un termómetro de lectura rápida (Shulteis, 10-50°) se tomó la temperatura de la arena en dos temporadas de anidación (1993-94) de 33 nidos naturales a tres diferentes profundidades, (superficie, parte media y fondo del nido) así como, muestras de arena para obtener la humedad y conocer la granulometría, de las mismas. Así mismo se colectaron muestras de arena y se tomaron registros de temperatura sobre 26 rastros a cada 3.75 mt. El trabajo de laboratorio consistió en obtener el porcentaje de humedad (Método de Kezdi, 1980) y el tamaño de grano de la arena (Método de Wentorth).

RESULTADOS

La caracterización de los nidos de la tortuga marina *Lepidochelys olivacea* en la Playa de Chacahua se realizó con base en el análisis de los datos de las variables consideradas: temperatura, humedad y granulometría.

Para caracterizar el nido en función de su temperatura, se analizaron los datos según la profundidad del nido a cual habían sido tomadas las mediciones, considerándose para cada nido tres partes, una sobre la superficie del nido, otra en la parte media y la última en el fondo del mismo. La descripción sucinta de la distribución de esta variable según la profundidad del nido, se realizó a través de un análisis de varianza por rangos de Kruskal-Wallis, el cual determinó que el 75 % de los datos registrados en la superficie del nido presentan una temperatura de 34.0°C siendo la mediana de 30.3. Para la parte media de los nidos se obtuvo que la mediana es de 32.1°C y que el 75% de los datos presenta una temperatura de 33.5°C, mientras que el fondo del nido tiene una mediana de 32.3 °C y que el 75% de las mediciones presenta una temperatura de 34 °C. Dentro de este mismo análisis se comprobó que existe una diferencia significativa entre la temperatura de las tres partes de los nidos siendo esta de P=0.0000328, por lo que se puede decir que se trata de tres «poblaciones estadísticas» diferentes. (H= 20.6 g. l. =2 P=< 0.0001).

El Coeficiente de Correlación de Spearman, demuestra que existe una correlación positiva entre las mediciones de las tres partes del nido. El coeficiente de correlación entre la temperatura de la superficie y la parte media del nido es de 0.84, entre la temperatura de la superficie y el fondo del nido es de 0.82 y por último entre la temperatura de la parte media y el fondo del nido es de 0.95, lo cual nos muestra una alta correlación entre las.

La caracterización en función del porcentaje de humedad de la arena de las tres partes del nido, superficie, parte media y fondo, se realizó a través del análisis de varianza por rangos de Kruskal-Wallis, el cual demostró que el 75 % de los datos tomados de la superficie del nido presentan un porcentaje de humedad de 1.95 siendo la mediana de 1.39 en la parte media de los nidos se obtuvo que la mediana del porcentaje de humedad es de 3.14 y que el 75% de los datos presenta una porcentaje de humedad de 3.65, mientras que el porcentaje de humedad del fondo del nido tiene una media de 3.87 y que el 75% de las mediciones presenta una porcentaje de humedad de 4.38. Así mismo se puede observar que existe una diferencia significativa con P= 0.000000000561, entre las mediciones tomadas a diferentes profundidades, por lo tanto se habla de tres poblaciones estadísticamente diferentes. (H=42.6 g. l. =2 p=< 0.0001).

A través del Coeficiente de Correlación de Spearman, se muestra que existe una correlación positiva entre las mediciones de las tres partes del nido. El coeficiente de correlación entre el del porcentaje de humedad de la superficie y el de la parte media del nido es de 0.67, entre la parte media del nido y el fondo es de 0.76 y entre la superficie y el fondo es de 0.57 (el más bajo).

El análisis de los datos para la caracterización de los nidos naturales en función al tipo de grano presente, demostró que no existe diferencia significativa entre la superficie, la parte media y el fondo del nido, en relación con el tipo de grano de arena. Para este análisis se aplicaron las mismas herramientas estadísticas utilizadas anteriormente. La mediana para las tres partes del nido es la misma y el mayor porcentaje de los datos (75%) esta representado por arena mediana con predominancia de granos medianos.

Para conocer si existe una relación entre las temperaturas de las diferentes partes del nido, el porcentaje de humedad y el tamaño de grano de la arena se utilizó el Coeficiente de Correlación de Spearman, a través del cual se puede observar que existe una correlación negativa entre las temperaturas y el porcentaje de humedad. El coeficiente de correlación entre el tamaño del grano y la temperatura, y entre el tamaño de grano y la humedad, es demasiado bajo por lo cual no fue considerado.

El Coeficiente d Spearman también fue utilizó para identificar la relación entre la distancia de la marea más alta, la distancia del nido a la vegetación y cualquiera de las características del nido (temperatura, porcentaje de humedad, granulometría y profundidad del nido), los resultados, muestran que el coeficiente de correlación entre las variables, es tan bajo que no es posible señalar una relación entre las mismas.

La presencia de una tendencia en las variables medidas sobre el rastro que deja la tortuga, se comprobó a través de la prueba de Cox-Stuart la cual determina aparte de la existencia de una tendencia, si esta es creciente o decreciente. Los resultados obtenidos, señalan que la temperatura presenta una tendencia creciente, mientras que la tendencia que presenta el porcentaje de humedad es decreciente y que la granulometría no presenta tendencia alguna.

DISCUSIÓN

La caracterización en función de la temperatura, humedad y granulometría de las tres partes de los nidos de tortuga es la siguiente: La mediana de la temperatura en la superficie de nidos naturales es de 32.4 °C, en la parte media de 33.5 °C y en el fondo de 34.0°C, las cuales se incrementan conforme incrementa una de ellas. Los nidos naturales presentan una mediana del porcentaje de humedad en su superficie de 1.39, en la parte media de 3.14 y en el fondo de 3.87. El comportamiento de esta variable va a ser representado por un cambio o incremento de las mismas. Con respecto al tipo de grano de arena este es el mismo en cualquier parte del nido.

En relación con la correlación que existe entre las temperaturas y los porcentajes de humedad de las diferentes partes del nido se observa que es negativo, lo que puede significar que el incremento de la temperatura, conlleva al decremento en el porcentaje de humedad. El coeficiente de correlación obtenido entre la distancia de marea, la distancia de la vegetación y las diferentes características presentes en el nido es muy bajo para considerar que existe relación entre dichas variables.

Con relación al comportamiento que presentan las variables medidas sobre el rastro que deja la tortuga al seleccionar el sitio de anidación se observa que la temperatura presenta una tendencia creciente, el porcentaje de humedad una tendencia decreciente y la granulometría no parece presentar ninguna tendencia.

Los resultados hasta ahora obtenidos no precisan que la tortuga siga un patrón en la selección del sitio de anidación, aunque las variables temperatura y porcentaje de humedad si presenten un gradiente.

ACKNOWLEDGMENTS

A todas las personas que de una u otra forma han cooperado para la realización de este proyecto, muchas gracias por su ayuda.

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CHANGES IN LOGGERHEAD NEST PREDATION PATTERNS ON WEST CENTRAL FLORIDA BEACHES

Jerris J. Foote[1], Jennifer L. Floyd[2], Tracey L. Mueller[1], Michael Salmon[2], and Jay M. Sprinkel[1]
[1]Mote Marine Laboratory, 1600 Ken Thompson Parkway, Sarasota, FL 34236, U.S.A. jerris@mote.org
[2]Department of Biological Sciences, Florida Atlantic University, Boca Raton, FL 33431, U.S.A.

Depredation of loggerhead (*Caretta caretta*) nests increased from 4.3% (in 1989) to 30% (in 1997) on the northern 41 km of the Gulf of Mexico beaches of Sarasota County, Florida. The primary predators included raccoons (*Procyon lotor*) and nine-banded armadillos (*Dasypus novemcinctus*). Although predation of marine turtle nests is documented in the literature (Stancyk, 1982) documentation of armadillo predation of loggerhead nests had occurred only for the east coast of Florida. This report represents the first documentation of armadillo predation from the west coast of Florida.

INTRODUCTION

Annually loggerhead turtles (*Caretta caretta*) and occasionally green turtles (*Chelonia mydas*) nest on the sandy beaches along Florida's central Gulf Coast. Sea turtle nests in Sarasota County have suffered mortality of developing turtle eggs and/or emerging hatchlings due to predation by small mammals, insects, crabs, birds, and occasionally reptiles. The predation rate has increased significantly over the past nine years with some areas of shoreline experiencing more predation than others. The primary predators include the raccoon (*Procyon lotor*), the nine-banded armadillo (*Dasypus novemcinctus*), red fire ants (*Soleonopsis invicta)*, and ghost crabs (*Ocypode quadrata*). Other predators, although only incidental in number, include the fish crow (*Corvus osssifragus*), the coachwhip snake (*Masticophis flagellum*), the opossum (*Didelphis virginiana*), and domestic dogs and cats.

The raccoon is a dominate predator along Sarasota County beaches, as well as throughout the southeastern United States (Stancyk, Talbert, and Dean, 1980 and Stancyk, 1982). In recent years, raccoon populations on Florida's west coast have been allowed to unnaturally increase due to a number of causes. First, the populations of raccoons' natural predators, bobcats and horned owls, have decreased over time. Additionally, unnatural food sources supplied by humans have allowed local populations to become denser (Nebraska Game and Parks Commission, 1998). The combination of these factors has created raccoon populations which are more numerous than that which the habitat can adequately support.

The nine-banded armadillo, was introduced to Florida in the 1920's (Carr, 1982). Armadillos have a rapid reproductive nature. This fact, along with a dwindling natural predator population, consisting of cougars, bears, and bobcats, allowed the Florida population to explode. Armadillos had spread into south Florida by the early 1950's, and by 1974 were present in most sea turtle nesting areas in the United States (Humphrey, 1974).

Armadillos are omnivores who will eat almost any living thing (Carr, 1982). In 1988, armadillo predation upon sea turtle nests was documented on Jupiter Island at Hobe Sound National Wildlife Refuge (HSNWR) on the Atlantic Coast, Martin County, Florida (Drennen, Cooley, and Devore, 1989). The armadillo predation continues and has increased at HSNWR (Kemp, Jewell and Neely, in press; and Martin, personal communication). Armadillo predation of loggerhead nests was first documented on Casey Key on the Gulf Coast of Sarasota County during the summer of 1993 when 15 nests were damaged.

MATERIALS AND METHODS

Monitoring for marine turtle activity was conducted on 41 km of shoreline along the Central Gulf Coast of Florida, Sarasota County. The study area is composed of four barrier islands and a mainland beach.

Daily surveys of nesting activity document nests and evidence of nest depredation. When a damaged nest is observed the date of predation is recorded and the type of predator is documented from evidence gathered at the nest such as: viewing the predator itself or identifying tracks left at the nest location. When the predator cannot be identified, the predator type is listed as "unknown."

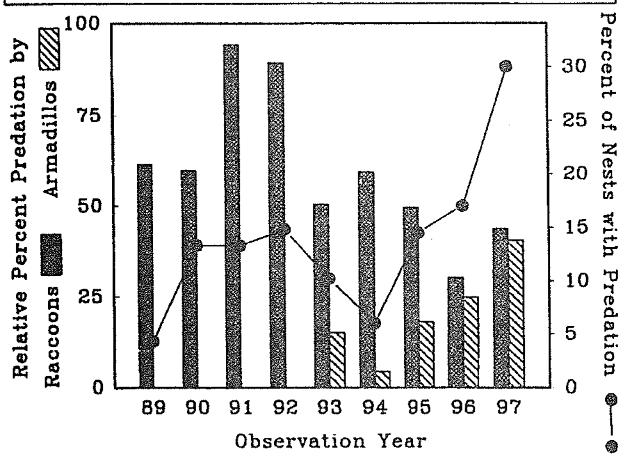
RESULTS

- There has been an increase in the number of nests and the number of nests that were attacked by predators (Figure 1).
- Historically, the most important predator is the raccoon. However, since 1993, armadillos have begun scavenging in nests. Between 1996 and 1997, the impact of armadillos has been almost as great as raccoons.
- Armadillo depredation was confined to Casey Key prior to 1997. During 1997 armadillo predation was documented on Siesta Key. In 1997 armadillos took more nests at Casey Key than raccoons.
- Armadillos and raccoons, together, are the major predators at Sarasota County nest sites.

DISCUSSION

- Overall depredation of marine turtle nests has increased from 4.3% (1989) to 30% (1997). Raccoons continue to be the primary predator accounting for 94.2% of all damaged nests in 1991. Following the 1991 and 1992 season a more aggressive nest protection effort was undertaken.

Figure 1. Percentage of predation on nests (right ●—●) and percentage of the total predation by raccoons (left ▩) and armadillos (left ▧).



Self-releasing cages were installed over all nests on south Venice beaches where raccoon populations were high and predation had occurred historically. In 1997 these cages were placed over 107 nests prior to any predation. Predators were not documented as damaging any of the 107 nests. On all other areas self-releasing cages were installed immediately following the initial predation of individual nests.

- Following the aggressive nest caging activities raccoon predation remained high but fell from the high of 94.2% of all depredated nests in 1991 to a low of 30.3% in 1996.
- Beginning in 1993 armadillos began preying upon marine turtle eggs. Armadillo depredation (as primary predators of loggerhead nests) has increased from 15.1% of all depredated nests in 1993 to a high of 40.6% in 1997.
- Armadillos, however, proved much more difficult to deter. Even with the self-releasing cages placed over the nest, the rooting nature of armadillos allowed them to successfully burrow under the flanges. Efforts were made to increase the depth of the cages under the sand by straightening the flanges and burying them deeper into the sand. Although this method did deter armadillo predation in some incidences, a successful solution has yet to be found.
- Armadillos destroyed a higher percentage of eggs per nest than raccoons (38% to 23%). The remaining eggs in nests depredated by armadillos shows lower overall hatch rates of 51.5% versus 78.6% hatch success for nests depredated by raccoons.
- The age of the nests at predation also varied by predator. The predation dates for raccoons was 27.8 +- 11.5 days of incubation. The predation dates for armadillos was 16.3 +- 15.*1* days of incubation.

CONCLUSIONS

- The amount of predation that is occurring appears to be directly related to human modification of habitat. This modification is responsible for an explosion in the populations of these predators.
- Attempts to protect nests utilizing self-release wire cages has proven beneficial in deterring raccoon predation but has not been successful in deterring armadillo predation.
- Armadillos may be expanding from Casey Key north to Siesta Key as predation records indicate. If something is not done to control this predator the predation rates may approach values similar to those on Casey Key.
- Something needs to be done in regard to predator control. Although there is currently some resistance to predator removal by animal rights groups it is the goal of the Endangered Species Act to increase the population of marine turtles. Thus some compromise must be reached in controlling the predatory animals while allowing marine turtle nests to incubate and hatch successfully.
- One option to predator removal would be sterilization of male and use of hormonal replacement in female raccoons and armadillos. This option, although time consuming and labor intensive, would prevent the current population from expanding to any great degree.

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TRABAJOS REALIZADOS EN LA TEMPORADA 93-97 EN EL CAMPAMENTO TORTUGUERO ZONA DE RESERVA PLAYA "PIEDRA TLALCOYUNQUE", MPIO. DE TECPAN DE GALEANA, GUERRERO, MEXICO

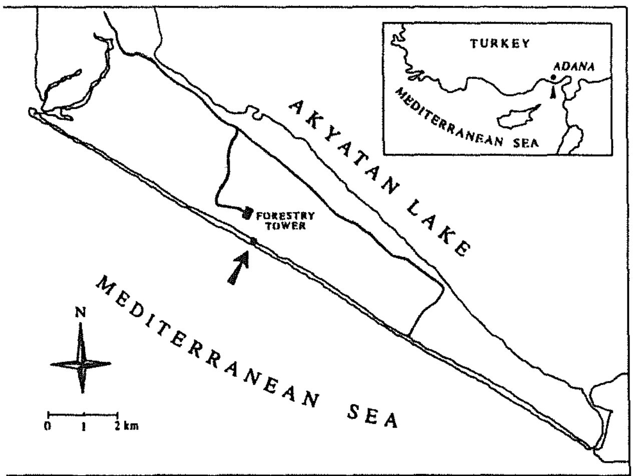
Luz Daniela Gallardo and J. Eugenio Zeferino
SEMARNAP Guerrero, México.

En el presente trabajo se hace una recopilación de los trabajos de protección y conservación realizados a partir de la temporada 1993 a la fecha, se analizaron los resultados de la especie golfina (*Lepidochelys olivacea*), se estima la población desovante de tortugas y los valores de reclutamiento que tiene en la zona.

PRELIMINARY STUDY ON PREDATOR CLUES TO DISCOVER A NEST: MARKS OF CAMOUFLAGING AS AN ATTRACTION TO PREDATORS

Guido Gerosa*, Monica Aureggi[1], and Sedat V. Yerli[2]
[1]CHELON Marine Turtle Conservation and Research Program (Tethys Research Institute)
Viale Val Padana, 134/B - 00141 Roma, Italy. chelon@tin.it
[2]Department of Biology, Hacettepe University, P. O. Box 40, 06692 Ankara, Turkey

This research was undertaken at Akyatan beach, Turkey, the most important green turtle nesting area in the Eastern Mediterranean. Natural predation is one of the main threat to the survival of the green turtle population in this site. Behavioural study on predators, mainly foxes, was carried out from the 7th of August 1997 until the 25th of September 1997. It focused on a restricted area of 196 meters. The aim of this study was to understand if the presence of the leaving pit and the moved sand, left on the beach by a nesting female, have any particular signal which induce foxes to approach and discover a nest on the beach. Five real green turtle nests were present in the study area and their leaving pit were covered with sand. Three kinds of simulated nest (false nest = "F", moved nest = "M" and hole nest = "H") were made by recreating the natural shape of a green turtle nest in order to understand the clues by which foxes discover the nests. "F" were an exact imitation of a nest with the moved sand area and the leaving pit (n=11); "M" (n=3) were nests with only an area of moved sand and "H" (n=3) were nests with only a hole similar to a turtle leaving pit.



Foxes were patrolling the false nests more often than the real nests covered with sand. Tracks were found more frequently on "F" nests than either on "M" nests and "H" nests.

The presence of fox trails of the same specimen going from one nest to another, showed that foxes look for nest by detecting the mark of camouflaging. Foxes seemed to follow paths running parallel with the sea shore line. A couple of false nests grouped at short distance (within 10 m) were more visited than the ones grouped at farther distance.

RESULTADOS DE PROTECCION DEL CAMPAMENTO LA GLORIA EN LA ZONA DE RESERVA NATURAL EL PLAYON DE MISMALOYA, JALISCO, MEXICO.

Luis Fernando González Guevara, Francisco Valadez Fernández, José Luis Acuña Domínguez, and Felipe Javier López Chávez
Programa de Conservación a las tortugas Marinas,Universidad de Guadalajara, Jalisco. México. lguevara@costera.melaque.udg.mx

The Results of sea turtle conservation along the central part of the reserve zone and sea turtle nesting site El Playon de Mismaloya are shown for the 1997-1998 nesting season in Jalisco,Mexico.

THE 'SEA TURTLES OF SURINAME 1997' - PROJECT. COMPARING RELOCATED NESTS TO UNDISTURBED NESTS.

Willem E. J. Hoekert, Luc H. G. van Tienen, Paul van Nugteren, and Sacha Dench
Biotopic Foundation, Plantage Middenlaan 45, 1018 DC Amsterdam, The Netherlands.

The 'Sea Turtles of Suriname 1997' - project was carried out by Biotopic during the 1997 nesting season in Suriname. As a part of this project, several aspects of the nesting ecology of leatherbacks and green turtles were studied. We compared temperature, moisture and hatching success in relocated *Dermochelys coriacea* and *Chelonia mydas* nests to temperature, moisture and hatching success in undisturbed Dc and Cm nests in the Galibi Nature Reserve in Suriname. A complete and detailed description of the results can be found in Van Tienen, *et al.* (in prep.).

METHODS

During the 1997 nesting season, temperature was measured in 10 *Dc* and 10 *Cm* nests. Half of the nests were relocated to a hatchery, the other half was left in the natural situation. Moisture was measured in a similar but different set of nests. In order to measure temperature, the nests were opened within a day after egg deposition, and a PVC tube (12 mm Ø) was buried in the nest at a depth of 65 cm (*Dc*) and 50 cm (*Cm*). The tubes were firmly fixed with chicken-wire. In order to measure moisture, the nests were opened within a day after egg deposition, and a tensio tube (Nieuwkoop, 1m) was buried in the sand 5 cm next to the nest at a depth of 65 cm (*Dc*) and 50 cm (*Cm*). Every day starting at 6 PM, temperatures were measured using a Nieuwkoop digital thermistor with a 1 m probe, and the pressure potential of the soil water was measured using a Nieuwkoop Loctronic tensiometer. The nests were measured in the same order every day. The temperatures of all 5 relocated *Cm* nests were averaged for each day, as were the temperatures for the 5 undisturbed *Cm* nests, the 5 relocated *Dc* nests and the 5 undisturbed *Dc* nests (see Figure 1 and Figure2). Within each group, the eggs were deposited within a range of 8 days (between June 5 and June 17).

In order to study the effect of inundation on *Dc* and *Cm* nests, all *Dc* and *Cm* nests that were deposited from May 10 until June 17 on a 1 km stretch of the main nesting beach were localised and recorded. During the same period, 50 doomed *Dc* and 50 doomed *Cm* nests that were laid on other beaches were relocated to a hatchery. After hatching, or after 80 (*Dc*) and 70 (*Cm*) days of incubation, the nests were dug up and the hatching success was determined.

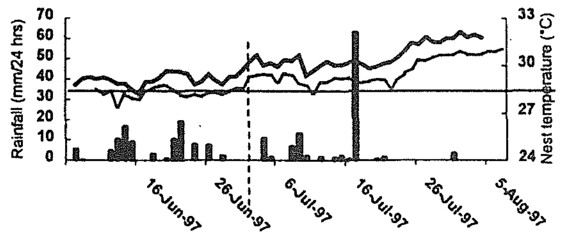


Figure 1. Average temperature in 5 undisturbed Dc nests (grey line) and 5 relocated Dc nests (black line). The pivotal temperature for Dc in French Guiana is indicated (horizontal line), (Rimblot-Baly et al.,1987). The start of the thermosensitive period is indicated (vertical dotted line). Rainfall (mm/24 hrs) is indicated by black bars.

RESULTS AND DISCUSSION

Temperature - Using this method, the average temperature in the 5 relocated Dc nests was on average 1.0°C higher

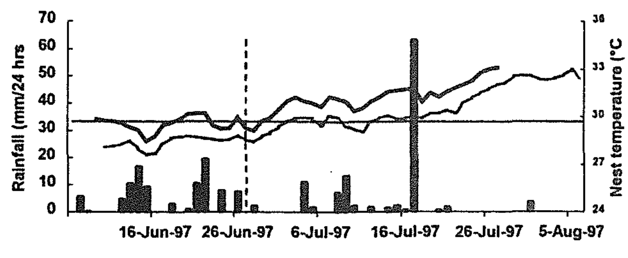


Figure 2. Average temperature in 5 undisturbed Cm nests (grey line) and 5 relocated Cm nests (black line). The pivotal temperature for Cm in Suriname is indicated (horizontal line), (Mrosovsky et al.,1984). The start of the thermosensitive period is indicated (vertical dotted line). Rainfall (mm/24 hrs) is indicated by black bars. 1997 Season.

than the average temperature in the 5 undisturbed Dc nests (Figure 1). During the thermosensitive period, the average temperature in the 5 relocated Dc nests was above the pivotal temperature, whereas the average temperature in the 5 undisturbed Dc nests was under the pivotal temperature known for Dc in Suriname.

The average temperature in the 5 relocated Cm nests was on average 1.2°C higher than the average temperature in the 5 undisturbed Cm nests (Figure 2). During the thermosensitive period, the average temperature in both the 5 relocated and 5 undisturbed Cm nests was above the pivotal temperature known for Cm in Suriname.

MOISTURE

Figure 3 shows the relative moisture in 2 undisturbed Dc nests and the relative moisture in 1 relocated Dc nest. Also, the sea level at spring tide is indicated. The relative moisture in the 2 undisturbed Dc nests is strongly correlated to the sea level and the distance to the spring tide line. Nests that are located more than 3 m below the spring tide line (*e.g.* Dc C) become completely saturated with water (42%) during high sea levels. In contrast, the relative moisture in the relocated Dc nest is not correlated to the sea level and the distance to the spring tide line.

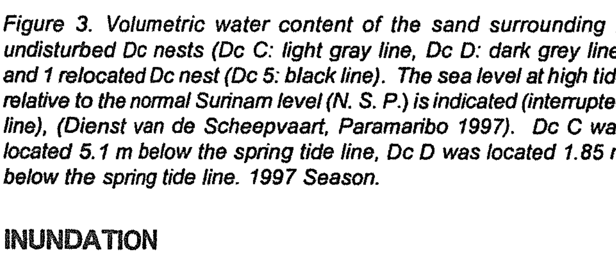


Figure 3. Volumetric water content of the sand surrounding 2 undisturbed Dc nests (Dc C: light gray line, Dc D: dark grey line) and 1 relocated Dc nest (Dc 5: black line). The sea level at high tide relative to the normal Surinam level (N. S. P.) is indicated (interrupted line), (Dienst van de Scheepvaart, Paramaribo 1997). Dc C was located 5.1 m below the spring tide line, Dc D was located 1.85 m below the spring tide line. 1997 Season.

INUNDATION

From may 10 until June 17, 102 Dc nests were counted on the 1 km stretch. Of the 102 nests, 66 were found back. Of these nests, 23 had hatched. The average hatching success of the 23 nests was 10% (sd=10%, n=23). The overall hatching success of the 66 undisturbed Dc nests was 3% (sd=8% ,n=66). The average hatching success of the 50 relocated Dc nests was 26% (sd=23%, n=50). 9 relocated Dc nests did not hatch .

From may 10 until June 17, 47 Cm nests were counted on the 1 km stretch. Of the 47 nests, 25 were found back. Of these nests, 21 had hatched. The average hatching success of the 21 nests was 64% (sd=23%, n=21). The overall hatching success of the 25 undisturbed Cm nests was 54%(sd=31%, n=25). The average hatching success of the 50 relocated Cm nests was 68% (sd=24%, n=50). 1 relocated Cm nest did not hatch

The average hatching success of the undisturbed Dc nests (3%) is very low. Whitmore and Dutton (1985) found much higher hatch rates (32.7% ± 6.6, n=12) for undisturbed, washed over Dc nests at Krofajapasi Beach in Suriname. It is likely that the low hatching success of Dc nests at Galibi is primarily due to inundation. Most of the Dc nests in the Galibi Nature Reserve are lad 0.5 to 2.5 m below the high tide line. Figure 3 shows that the relative moisture in a Dc nest located 1.85 m below the high tide line increases significantly as the water level rises. Another cause for the low hatching success is predation by the mole cricket. The average percent of eggs that were predated by the mole cricket was 40 % in Dc nests and 20 % in Cm nests.

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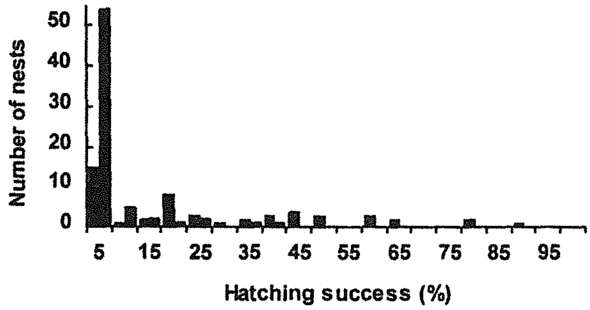

Figure 4. Hatching success for undisturbed (black bars) and relocated (grey bars) Dc nests.

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EFFECTS OF BEACH NOURISHMENT ON HATCHLING SIZE AND PERFORMANCE IN THE LOGGERHEAD SEA TURTLE (CARETTA CARETTA)

Linda E. Iocco
University of Charleston, SC, Grice Marine Laboratory, 205 Fort Johnson Rd., Charleston, SC, 29412, U.S.A. ioccol@edisto.cofc.edu

Incubation environment directly influences hatchling development and survivorship in sea turtles. Some of these incubation parameters, including hydric and thermal conditions and gaseous environment, can be affected by physical characteristics of the sand medium, such as grain size, moisture content, porosity and color. Because nourished beaches are composed of sand from alternate sources, physical characteristics of nourishment sand may vary from those of sand found on natural beaches.

Loggerhead clutches from two nourished beaches and two natural beaches in Florida were sampled during July and August 1997 to determine whether beach nourishment had a significant effect on hatchling body size (n=33 nests), performance (n=30 nests), and nest success (n=41 nests). Results showed no significant differences between turtles from the two beach types in carapace length, width, or body mass; hatchling crawling and swimming speeds also showed no significant differences between beach types, although performance was significantly affected by hatchling carapace length. Hatching and emergence success were also not significantly different between nourished and natural beaches. The results of this study suggest that there may be no detectable differences in hatchling size, performance, and nest success between clutches incubated in nourished and natural beaches.

CLIMATIC AND OCEANIC DATABASE OF NESTING AREA OF KEMP'S RIDLEY

Ma. del Carmen Jiménez Quiroz [1], Olivia Salmerón [2], and Noé Andrés Villanueva [1].
[1] Centro Regional de Investigación Pesquera- Manzanillo. Playa Ventanas s/n. Apdo. Postal 591. Manzanillo, Col., México. Tel (333)2 37 50, FAX 2 37 51. tormar@bay.net.mx
[2] Laboratorio de Observación de la Tierra. Instituto de Geografía. Circuito Universitario. Cd. Universitaria. Delegación Coyoacán, D. F., México

INTRODUCTION

There are numerous questions about the Kemp's ridley life cycle without answer. The environmental factors influence some aspects of the biology of this specie like: the temperature is determinant on the sexual rate and survival of embryos (Mrosovsky and Yntema, 1980); the direction and velocity of the wind and the sea surface temperature are related with the nesting behavior (Casas-Andreu, 1978) and the marine currents maybe contribute to the hatch dispersion (Collard and Ogren, 1990).

Is necessary to have many elements to make hypothesis to explain some aspects of the life cycle of this specie. Accordingly, the strategy is to construct a climatic and oceanic database, subsequently it will be one of the basis of the future investigation projects. In this work, we present some results of the selection, compiling and analysis of some environmental factors.

METHODS

Climatic factors. - the selected variables were: air temperature (maximum, minimum and average), direction and velocity of the wind, pluvial precipitation. The meteorological stations are listed in the Table 1.

Oceanic characteristics. The oceanic characteristics were observed with satellite imagery. Thermal band of NOAA-AVHRR imagery from April - September of 1989-1993 from NOAA files; and images from 1996 donated by the Instituto de Geografía (UNAM) were used.

The NOAA binary files were transformed in sea surface temperature using the algorithm of Vázquez (1995). Afterwards these images (monthly averages) were enhanced to bring out the marine fronts and circulation patterns.

RESULTS AND DISCUSSION

Table 1. -Meteorological stations. Source: CONAGUA: Comisión Nacional del Agua; CFE: Comisión Federal de Electricidad.

METEOROLOGICAL STATION	SOTO LA MARINA (SM)	BARRA DEL TORDO (BT)	PUNTA JEREZ (PJ)
POSITION (LAT-LONG)	23° 46' N 98° 13' W	23° 03' N, 97°46' W	22° 53' N 97° 46' W
ALTITUDE (M)	12	5	2
TIME INTERVAL	1927-1995	1986-1996	1925-1965
CLIMATE (KÖEPPEN SCALE)	BS1(H')HW(E)W"		(A)CA(W1)(E)W"
SOURCE	CONAGUA	CFE	CONAGUA

At the moment there are annual, monthly and daily registers of the climatic variables. The first analysis showed that in "Barra de la Coma", near to Rancho Nuevo camp, where the nesting activity is grater, the climatic characteristics are transitional between the dry and hot northern climate, measured at Soto la Marina (SM) and the warm and wetter southern climate registered at Barra del Tordo (BT) and Punta Jerez (PJ). Maybe this latitudinal differences have some influence on the selectivity of nesting zone by females.

There are time series of monthly temperature and rain from SM and PJ. The first are from 1927 to 1996 and the second from 1925 to 1965. The fluctuations of temperature in SM are great, specially at 40's. In recent years there are an apparent increment of this variable in SM and BT. The spectral analysis showed that there are some cycles of annual frequency. but in this moment we are ignorant about the influence of this changes on the sexual rates of the little turtles.

Monthly averages of temperature and rain indicate that the nesting season, specially the birth of turtles, is coincident with the warmer months of the year. The first analysis of the weekly averages indicate that the temperature is less variable when the nest are more abundant.

The rain pattern is different. At SM there are two peaks: June and September, whereas at BT the raining season begin at June and is greater in September. This pattern apparently is influenced by the hurricanes.

On the other hand, the circulation pattern of Gulf of Mexico is influenced by the anticyclonic gyres detached from Loop current and the wind stress curl (Elliot, 1982; Sturges and Blaha, 1976; Vida *et al*, 1992; Sturges, 1993). The rivers maybe are important too.

The Loop current and its variations are easily recognized in the sea surface temperature (SST) imagery in the colder months of the year. The penetration differences along time indicate the detachment of gyres. These structures are evident in the western margin by the longitudinal gradients between the coast and the core of Gulf. The gyres are poor because their primary productivity is low (Biggs, 1992).

Between May and August the SST is more and more uniform through the Gulf and it is not possible to detect the Loop current, but is usual the presence of a current like a "plume" leaving Tamaulipas's coast with lesser temperature than surround it. Brooks and Legeckis (1984) describe this plume like the front or transitional zone between antyciclonic and cyclonic gyres, whereas Howard (1996) said that it is a surgence evidence.

At the moment the first analysis indicated that the magnitude of monthly temperature changes and the presence of gyres in the border of the continental shelf can influence the arrival of females whereas the "plume" detected between June and August maybe disperse the little turtles to the northern zones, where the presence of cyclonic gyres is common. The productivity of this structures is high.

CONCLUSIONS

More and actualized information is needed, like the hurricane trends and the more recent registers of climate and oceanic variables. We wait that this database will be incorporated to a Geographic Information System of the nesting area of Kemp's ridley and we hope that it can be of public domain in future.

ACKNOWLEDGMENTS.

The climatic information used in this work was donated by the Servicio Meteorológico Nacional (Comisión Nacional del Agua) and the Departamento de Hidrometeorología from Comisión Nacional de Electricidad. The sea surface temperature imagery of 1996 was donated by the Instituto de Geografía (UNAM).

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BEACH EROSION REDUCES THE HATCHING SUCCESS AT PATARA BEACH-TURKEY

Yakup Kaska[1], Robert W. Furness[2], and Ibrahim Baran[3]
[1]Pamukkale Üniversitesi, Fen Edebiyat Fakültesi, Biyoloji Bölümü, Denizli, Turkey 9406804k@udcf.gla.ac.uk
[2]Institute of Biomedical and Life Sciences, University of Glasgow, Glasgow G12 8QQ, U.K.
[3]Dokuz Eylül Üniversitesi, Buca Egitim Fakültesi, Biyoloji Bölümü, Buca-Izmir, Turkey

INTRODUCTION

Two species of marine turtle have been recorded as nesting in the Mediterranean; the loggerhead *Caretta caretta* and the green turtle *Chelonia mydas* (Groombridge, 1990). According to previous investigations, it is estimated that on average some 2000 female *Caretta caretta* and 300-400 *Chelonia mydas* nest annually in the Mediterranean (Groombridge, 1990).

Based on our unpublished data and published sources (Geldiay *et al.*, 1982; Baran and Kasparek, 1989; Canbolat, 1991; Baran *et al.*, 1992, 1994, 1996; Erk'akan, 1993; Kaska, 1993; van Piggelen and Strijbosch, 1993; Baran and Turkozan, 1996) it is estimated that there are 1200-1700 *Caretta caretta* nests and 400-600 *Chelonia mydas* nests on 17 different beaches (with a total length of 140 km.) in Turkey annually. Using the assumption that each female nests an average of 3 times in a season every 2-3 years (Groombridge, 1990), this means that approximately 400-570 *Caretta caretta* and 130-200 *Chelonia mydas* nest annually on the beaches of Turkey. According to Groombridge's 1990 estimate, at least 25-30 % of the loggerhead and up to 50 % of the green turtles in the Mediterranean could nest on the beaches of Turkey. The protection of these beaches is critical to survival of these species in the Mediterranean.

Literature suggests that conservation initiatives based on incomplete natural history information can be disastrous (Frazer, 1992), and seemingly esoteric aspects of organismal biology or ecology (such as temperature dependent sex determination) make the difference between success and failure in wildlife management programmes. The preprogrammed female reproductive behaviour makes it unlikely that the loss of breeding habitats can be compensated for by emigration to other colonies; that is, the loss of nesting sites is accompanied by the loss of specific genotypes (Schroth *et al.*, 1996). It is also found that there is a genetic diversity within the loggerhead nesting population among the south-west beaches of Turkey (Schroth *et al.*, 1996). Thus, to preserve the genetic diversity of the sea turtle population in the Mediterranean one needs to protect individual nesting sites.

Although Patara beach is protected by the law under the Specially Protected Areas by the Minister of Environment of Turkey, interestingly it holds less turtle nesting and low hatching success compare to other nesting sites in the Eastern Mediterranean. We further speculated on the low nesting and hatching success on Patara Beach using last few years' data.

MATERIALS AND METHODS

We investigated the loggerhead turtle population on Patara Beach in 1992, 1993 and 1996. The total length of the beach is 11.8 km on the western border of Antalya, and is bisected by Esen Çay. In this study, the eastern part of the beach with a length of 7 km and only the 1 km western part of the Esen Çay was considered. Beach was patrolled continuously by groups of 2-3 people between 21:00at night and 8:00 in the morning. The sites of nests and tracks were determined with reference to their distance from numbered poles set at intervals on the beach. Eggs were counted whenever turtles were found during egg laying or 7-10 days after the first emergence occured. Hatching success of nests were calculated as a percentage of number of hatchlings successfully emerged.

RESULTS

The nesting season of *Caretta caretta* started at the middle of May and continued till the middle of August, and the hatching season began in July and ended in September on Patara beach during the years of 1992, 1993 and 1996. The number of nests per season were 52, 85 and 35 respectively. The mean incubation period was around 60 days with a mean clutch size of 70 eggs. For example, the average number of eggs per nest was 69.5[S. E. =2.9] (n=25) and the average incubation period was 60.0 [S. E. =1.0] days in 1992. The hatching success was very low being 37% in 1992 and 41 % in 1993 and 1996.

Hatching success was low due to sand erosion and subsequent inundation. Early in the nesting season the beach is a very suitable one for loggerhead turtles. Due to afforestation behind the beach, there is a fence which causes the blocking of sand movement towards the sea. Therefore, throughout the nesting season, the sea side of the beach becomes lower and 40-50 meters from the sea stays wet, causing embryonic mortalities in nearly half of the nests laid in any nesting season. For example, during the investigation season of 1992, 15 (28.84%) nests on Patara were inundated by the high spring tides. The reason for 28.84% of the nests exposed to wet area is the wind erosion on Patara Beach. Behind the beach a fence is erected for forestation purposes. In summer, off shore winds blow sand up the beach piling it against the fence and eroding the sand depth close to the sea. In winter, on shore winds would normally blow sand back, restoring the depth at the shore, but the fence reduces this effect with the overall result being that sand depth close to the sea has been reduced.

DISCUSSION

Using the published data (Geldiay *et al.*, 1982; Baran and Kasparek, 1989; Baran *et al.*, 1992, 1996; Kaska, 1993) and ours, there may be 50-100 nests annually, in other words around 20-35 *Caretta caretta* nest annually on Patara Beach.

Higher levels of salinity in the sand reduce the ability of the egg to absorb water and reduce the humidity in the nest chamber (Bustard and Greenham, 1968). High moisture levels caused by heavy rains and high tides can destroy entire turtle clutches (Ragotzkie, 1959; Kraemer and Bell, 1980). Temperatures influence the duration of incubation, sexual differentiation and rate of development (Mrosovsky, 1994; Miller, 1985). The phenomenon of temperature dependent sex determination has important consequences in conservation practices. That is why the location of nests in wet areas should be changed as early as possible on the night of laying (Limpus *et al.*, 1979) in order to increase the hatching success.

Eggs can be protected by relocating eggs for incubation under natural conditions (protected areas where eggs are reburied in the sand above the anticipated spring high tide level) or artificial conditions using expanded polystyrene incubators or other non-metal containers (Styrofoam boxes), but Mrosovsky (1982) stated that Styrofoam boxes were 1-1.5 °C cooler than the sand, and said this may cause the masculinization of *Chelonia mydas*. In the absence of data on temperature-dependent sex determination and a thermal transect of a beach, artificial hatcheries should not be used. Therefore, we suggest that nest relocation would be very useful in order to increase hatching success. The new site for relocated nests should be at least 50 meters away from sea and the temperature of some nests should be recorded in order to understand the sex ratio of these nests.

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TEMPERATURE DETERMINED PATTERN OF HATCHING AND EMERGENCE OF SEA TURTLES IN THE EASTERN MEDITERRANEAN

Yakup Kaska[1], Robert W. Furness[2], and Ibrahim Baran[3]
[1]Pamukkale Üniversitesi, Fen Edebiyat Fakültesi, Biyoloji Bölümü, Denizli, Turkey. 9406804k@udcf.gla.ac.uk
[2]Institute of Biomedical and Life Sciences, University of Glasgow, Glasgow G12 8QQ, U.K.
[3]Dokuz Eylül Üniversitesi, Buca Egitim Fakültesi, Biyoloji Bölümü, Buca-Izmir, Turkey

INTRODUCTION

Sea turtle hatchlings primarily emerge from their nests during the evening, shortly after sunset, and thermal cues are believed to be important in controlling emergence (Hendrickson, 1958; Bustard, 1967, 1972; Witherington *et al.*, 1990). Hatchlings may dig upwards from their nest chamber at any time during the 24 hour period (Bustard, 1972). However, when approaching the surface during daylight, the hatchlings generally stop digging, presumably in response to high sand temperatures (Bustard, 1967, 1972; Mrosovsky, 1980). Nocturnal emergence among sea turtle hatchlings presumably evolved as a means to reduce mortality due to physiological stress and possibly diurnal predation (Hendrickson, 1958; Bustard, 1972). Temperature has often been suggested as the main mechanism for controlling emergence, inhibition of the activity by temperatures above 28.5 °C (Mrosovsky, 1980), 30 °C (Bustard, 1967), 33 °C (Hendrickson, 1958) and 30-33 °C (Bustard, 1972) has been shown in both hatchling and posthatchling sea turtles. The possibility that hatchlings respond to negative thermotaxis has been raised (Mrosovsky, 1980) and temperature gradient in the top 10 cm of the sand column is the main factor controlling the emergence pattern of hatchlings (Gyuris, 1993).

It has been suggested that hatchling sea turtles remain in the egg chamber until their siblings hatch, so that individuals emerge as part of a group and not singly (Carr and Hirth, 1961). Alternatively group emergence may simply reflect synchrony in the time that eggs in a nest take to hatch. The number of emergences per nest was reported as 1-3 by Witherington *et al.*,(1990), 1.6±0.9 by Peters *et al.*,(1994) and the average emergence span was reported as 8.3 days by Hays *et al.*,(1992) and 2.3±1.9 days by Peters *et al.*,(1994) for *Caretta caretta* hatchlings.

No study has focused on the possibility that hatching time might be different for the hatchlings of one clutch because of temperature differences within the clutch. Therefore we investigated the pattern of emergence by loggerhead and green turtle hatchlings by examining the thermal environment of the clutch and sand adjacent to nests to identify any temperature differences within the clutch and to relate these to emergence times of the hatchlings and thermal cues used by the emerging hatchlings.

MATERIALS AND METHODS

We patrolled the beaches during the night and early in the morning during the 1995 and 1996 seasons at beaches (Akdeniz and Karpaz) of Northern Cyprus and at the south west beaches (Dalyan, Fethiye, Patara and Kizilot) of Turkey. All the beaches were marked by posts running along the back of the beach to allow accurate positioning of the turtle activity and egg chamber. Temperatures of all five green turtle nests and two loggerhead nests were recorded on the beaches of Northern Cyprus, and six loggerhead nests on the south-west beaches of Turkey. Temperature was measured using "Tiny talk" temperature recorders (Orion Components (Chichester) Ltd., U.K). The accuracy of the device was tested under laboratory conditions against a standard mercury thermometer, and they were found to have have a mean resolution of 0.35 °C (min. 0.3 °C, max. 0.4 °C) for temperatures between 4 °C and 50 °C. We launched the tiny talk by computer for a recording period of 60 days with readings taken at 48 min. interval. This gave 30 readings per day. They were placed at three different depths (top, middle and bottom) of the nest, during the oviposition or after excavating the nest in the morning of laying (approximately 10 hours after oviposition). The nest was then covered, and protected with wire mesh against dog and fox predation. The position of nest on the beach was recorded as distance (m.) from vegetation and sea. A few days before anticipated date of hatching these temperature recorders were taken from the nest and the information offloaded to a computer. Five or six eggs were taken from each level together with the Tiny talks. These eggs were retained in moist sand for a few days until they hatched. Hatching times of these eggs were also recorded.

Sand temperatures were also recorded just above the clutch (30, 20, 10 cm.) during the hatching period in order to understand emergence pattern of the hatchlings. Emerged nests were excavated approximately 1 week after the last emergence, thus allowing completion of the natural emergence process. We determined hatching success by counting empty eggshells and unhatched eggs left in the nest cavity, and we recorded number of dead hatchlings left in the nest column. Hatching times of hatchlings from 8 nests were also recorded by recording the number of hatchlings and time.

RESULTS

There were considerable intra-clutch temperature variations in both the loggerhead and green turtle nests (Table 1), with up to a 2.1 °C mean temperature difference in loggerhead nests and up to 0.8 °C in green turtle nests. The top level of the green turtle nest was warmer (max. 0.8 °C) than the bottom level and also warmer (max. 0.3 °C) than the middle

Table 1. Information on the recorded nests and temperature measurements at green and loggerhead turtle nests.

NEST NO	CLUTCH SIZE	INC. PERIOD	HATCHLING EMERGENCE SUCCESS (%)	TOP MEAN TEMP.±SE	MIDDLE MEAN TEMP.±SE	BOTTOM MEAN TEMP.±SE	MAXIMUM TEMPERATURE DIFFERENCE
C.MYDAS 1	118	63	59	29.8±0.05	29.9±0.05	29.4±0.05	0.5
C.MYDAS 2	78	60	73	30.3±0.03	30.0±0.04	29.5±0.04	0.8
C.MYDAS 3	109	54	94	31.5±0.05	31.3±0.06	31.0±0.06	0.5
C.MYDAS 4	96	59	75	30.7±0.03	30.4±0.04	30.0±0.04	0.7
C.MYDAS 5	87	55	96	31.2±0.05	30.9±0.05	30.6±0.05	0.6
C.CARETTA 1	95	54	48	30.9±0.04	30.6±0.04	30.0±0.04	0.9
C.CARETTA 2	77	50	68	31.7±0.03	31.7±0.02	31.4±0.02	0.3
C.CARETTA 3	90	51	89	31.6±0.03	31.1±0.03	30.8±0.03	0.8
C.CARETTA 4	65	50	68	32.1±0.03	31.8±0.03	31.1±0.04	1.0
C.CARETTA 5	78	61	88	28.8±0.01	28.1±0.01	27.4±0.02	1.4
C.CARETTA 6	93	55	73	30.9±0.02	30.4±0.02	29.8±0.02	1.1
C.CARETTA 7	62	52	79	30.5±0.01	29.9±0.01	29.3±0.01	1.2
C.CARETTA 8	77	52	81	31.6±0.02	31.0±0.02	29.5±0.03	2.1

level of the nest. The top level of a loggerhead nest was warmer (max. 2.1 °C) than the bottom level and the same as or warmer than (max. 0.7 °C) the middle level of the nest.

We monitored the times of emergence of loggerhead hatchlings from 8 nests. The mean hatching success of these nests was 76.1%. Hatching times varied between 2100 and 0530 h. Sand temperatures just above the clutch during the time of hatching were cooling (Figure 1). Hatchlings from these nests and other nests, determined by counting the tracks of the hatchlings, always emerged on more than one night. The mean nightly number of hatchlings that emerged from green turtle nests was higher in the first two hatchings (77%) and then showed a decrease. The mean nightly number of hatchlings that emerged from loggerhead turtle nests was higher in the first three hatchings (75%) and then showed a decrease. The hatching intervals of green turtles were shorter (mean=3 nights, range 1-5, n= 45) than at loggerhead nests (mean=6.2 nights, range 2-8, n=75).

Eggs that taken with the temperature recorders also hatched at different times during the 24h period. Eggs of green turtles (n=78) hatched during the 4 days, of which 50

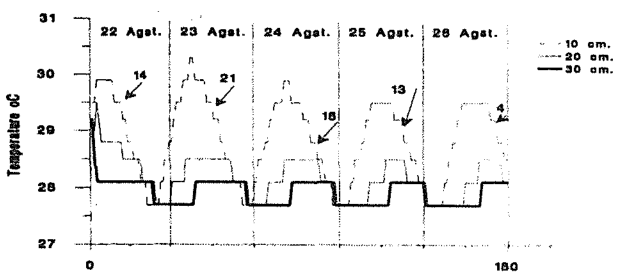

Figure 1. Sand temperatures over the nest during the hatching period. (Nubers indicate the number of hatchlings emerged on

% in the first day, 29.5 % in the second day and 19 % in the third day and only one egg hatched in the fourth day. Eggs (n=138) taken from loggerhead nests hatched during 6 days. Percentages hatching each day were 23.9, 32.6, 18.1, 6.5, 9.4, 9.4 respectively.

DISCUSSION

Sea turtle hatchlings mostly emerge from their nests during the evening and thermal cues are believed to be important in controlling the emergence (Hendrickson, 1958; Bustard, 1967, 1972; Witherington *et al.*, 1990; Gyuris, 1993). It has also been suggested that hatchling sea turtles remain in the eggchamber until their siblings hatch, so that individuals emerge as part of a group and not singly (Carr and Hirth, 1961). We found that hatchlings indeed hatched during the 24 h period, but emerged from the nests only during the night. We also found mean temperature variations within the clutch and therefore it might be that there was variation within the nest in the time to hatching since the rate of embryonic development and consequently the duration of the incubation period is dramatically affected by the temperature (Yntema and Mrosovsky, 1980; Miller, 1985).

Emergence asynchrony for sea turtles was reported previously (Hendrickson, 1958; Witherington *et al.*, 1990; Hays *et al.*, 1992; Gyuris, 1993; Kaska, 1993; Peters *et al.*, 1994). We observed that hatchling emergence from green turtle nests was less spread than from loggerhead nests. This may be because there was less variation in the mean incubation temperatures of green turtle nests than loggerhead nests. When turtle eggs are kept at constant temperature, incubation duration is longer at cooler temperatures, and a 1 °C decrease adds about 5 days in incubation (Mrosovsky and Yntema, 1980). In natural conditions, our results suggest that 1 °C temperature variation within the clutch causes about 4 days delay in both hatching and emergence of hatchlings. Therefore we suggest that nests should not be excavated right after the first emergence since there may be some recently hatched eggs in the nest.

Cooling of sand temperatures at 15 cm. was suggested as a cue for the emergence of hatchlings (Hays *et al.*, 1992; Gyuris, 1993). We found that the time of emergence was not correlated with any fixed absolute temperature, and hatchlings emerged during the cooling period of the sand above the nest, suggesting that emergence is triggered by falling temperature rather than by a by a temperature threshold.

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FACTORS AFFECTING SIZE OF LOGGERHEAD AND GREEN TURTLE HATCHLINGS IN NORTHERN CYPRUS, EASTERN MEDITERRANEAN

Alison L. Loughran[1], Annette C. Broderick[1], Brendan J. Godley[1], and Robert W. Furness[2]

[1] Marine Turtle Research Group, [2] Ornithology Group, Division of Environmental and Evolutionary Biology, I.B.L.S., Graham Kerr Building, University of Glasgow, G12 8QQ, Scotland, U.K. A.Broderick@bio.gla.ac.uk

INTRODUCTION

The purpose of this study was to describe hatchling morphometrics of both species in northern Cyprus. Variation in the sizes of hatchlings among different sites was examined. In addition, an investigation into the roles of adult size and nest parameters in determining the size of *C. caretta* and *C. mydas* hatchlings was undertaken.

METHODOLOGY

Nesting: The beaches studied are shown on Map 1. The intensive study site was at Alagadi (76 and 77). These, together with two of the beaches on the west coast (82 and 83) and three at the north coast (71, 73 and 74) were monitored at night during the nesting season. The nesting protocol was as described in Broderick and Godley (1996).

Hatching: By a combination of measuring hatchlings at emergence or subsequent to excavation of the nest, morphometrics were collected. Straight carapace length, straight carapace width and weight of the hatchlings were measured. In addition, upon excavation of a nest, a sand sample was taken from the side of the egg chamber and was subsequently analysed to determine moisture content.

RESULTS AND DISCUSSION

A) Hatchling morphometrics:

The mean hatchling size for live *C. caretta* and for dead full term *C. caretta* hatchlings are shown in Table 1. A paired t-test showed that there was no significant difference between live and dead hatchlings in any of the parameters measured ($p > 0.05$ for all measurements). In a study by Peters and Verhoeven (1992), in Turkey, it was found that there was a significant difference between the sizes of live and dead full term hatchlings and suggested that smaller hatchlings were weaker and experienced more problems when trying to emerge from the nest. Their analysis, however, consisted a smaller sample size and did not take into account the possible effects of pseudoreplication (Hurlbert 1984).

The mean hatchling sizes for live and dead full term *C. mydas* hatchlings are also shown in Table 1. A paired t-test showed that there was no significant difference in any of the size parameters between live and dead full term hatchlings ($p > 0.05$ for all measurements).

B) Variation among nesting sites:

An investigation into the possible geographical variation in hatchling sizes was undertaken. Data were assigned to one of three areas depending on where the nests were laid (see Map 1). An ANOVA showed that no significant difference existed in the mean straight carapace lengths, straight carapace widths and PCA (hatchling size) of *C. caretta* hatchlings among the three areas ($p > 0.05$ for all measurements). A similar analysis showed that there was no significant difference in the sizes of *C. mydas* hatchlings from different areas ($p > 0.05$ for all measurements).

The Mediterranean nesting populations have been shown to be reproductively distinct from those out with the region. Additionally, the Cyprus *C. caretta* population has been shown to be genetically distinct from that of Turkey and of Greece. This difference is mirrored by differences in adult sizes (Broderick and Godley 1996). The fact that no differences were found in hatchling morphometrics among regions in Cyprus may be an indication of a relative lack of

Table 1. Morphometrics of full term C. caretta and C. mydas hatchlings.

Species	Hatchling measurement	Mean	SD	N	Min	Max
C. caretta (live)	Straight carapace length	39.97	2.67	2064	24.9	49.3
	Straight carapace width	30.37	2.37	2064	20	39.7
	Weight	15.29	3.97	1482	9.4	21.4
C. caretta (dead)	Straight carapace length	38.78	2.17	68	33.7	43.8
	Straight carapace width	29.00	2.33	68	25	35.5
	Weight	14.32	2.45	56	6.6	20
C. mydas (live)	Straight carapace length	45.68	1.68	1274	39	51.4
	Straight carapace width	35.03	1.80	1274	28.2	41
	Weight	19.92	2.18	1011	9.5	27.81
C. mydas (dead)	Straight carapace length	44.70	3.03	34	37.6	50
	Straight carapace width	33.33	2.50	34	26.4	37.5
	Weight	18.59	3.56	21	11.1	23.7

population structuring at a local level.

C) Factors affecting hatchling size:

Straight carapace length, straight carapace width, PCA (hatchling size) and body weight, were analysed with a number of variables which were thought plausible candidates as those influencing hatchling morphometrics. These variables are shown in Table 2. Forward stepwise multiple regression (p to enter, $p < 0.05$) were employed to prevent multiple testing thus reducing the chances of Type I statistical error.

C. caretta: It was found that when curved carapace length and curved carapace width was used to represent adult size, and also when PCA (adult size) was used instead, moisture content and hatch date had a significant influence on straight carapace length of *C. caretta* hatchlings:

$$\mathbf{SCL\,(mm) = 0.61\,MC - 0.11\,HD + 49.53}$$
$$(r^2 = 0.37).$$

With regards to straight carapace width, it was found that when adult size was included in the analysis, moisture content had a significant influence:

$$\mathbf{SCW\,(mm) = 0.22\,MC + 29.35}$$
$$(r^2 = 0.20).$$

For PCA (hatchling size), similar results were found. Moisture content significantly influenced PCA (hatchling size) when adult size was included in the analysis:

$$\mathbf{PCA\,(hatchling\ size) = 0.189\,MC - 1.012}$$
$$(r^2 = 0.22).$$

No variables were found to have a significant influence on hatchling body weight.

Moisture content, therefore was found to influence straight carapace length, straight carapace width and PCA (hatchling size), whereby wetter substrates resulted in larger hatchlings. This was similar to the findings of McGehee (1990) for *C. caretta.* Hatching date was also found to have a significant effect on straight carapace length, whereby hatchlings got smaller as the season went on. This could be explained either by resource allocation by the females or progressive drying of the substrate.

C. mydas: None of the variables investigated were found to have a significant influence on hatchling size. It is unlikely that none of the factors influence hatchling size, but rather the lack of significance is due to the small sample size that resulted from taking the possible effects of pseudoreplication (Hurlbert 1984) into account.

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Table 2: Multiple Regression Variables

VARIABLE	UNITS
Curved carapace length of adult	Cm
Curved carapace width of adult	Cm
PCA adult	Principal component of CCL and CCW
Clutch size (CS)	total no. of eggs
Hatching success (HS)	%
Depth to the top of the egg chamber	Cm
Depth to the bottom of the egg	Cm
Incubation period (IP)	Days
Moisture content (MC)	%
Date hatched (HD) (no. days after 1st	Days
Date laid (LD) (no. days after 1st May)	Days

AN INVESTIGATION INTO THE POSSIBLE EFFECTS OF PHYSICAL FEATURES OF NESTING BEACHES ON THE NEST SITE SELECTION OF *C. MYDAS* AND *C. CARETTA* IN NORTHERN CYPRUS, EASTERN MEDITERRANEAN

Michael J. M^c^Dermott[1], Brendan J. Godley[1], Annette C. Broderick[1], Vedat Ediger[2], and Robert W. Furness[3]
[1] Marine Turtle Research Group, [3]Ornithology Group:
[1 and 3] Division of Environmental and Evolutionary Biology, Graham Kerr Building, University of Glasgow, Glasgow, G12 8QQ, Scotland, U.K. A.Broderick@bio.gla.ac.uk
[2] Institute of Marine Science, Middle Eastern Technical University, Erdemli, Turkey.

INTRODUCTION

Both *C. mydas* and *C. caretta* are known to nest in substantial numbers on the beaches of northern Cyprus (Broderick and Godley 1996). In this study we attempted to discover if any physical factors exert an effect on the selection of nesting beaches by either species.

MATERIALS AND METHODS

A detailed account of the methodology is given in M[c] Dermott (1998).

A) The physical parameters considered for each beach were:

1) Beach length,
2) Beach width,
3) Beach gradient,
4) Beach aspect (beach compass orientation),
5) Sand particle size,
6) Sand colour,
7) An index of digability (to mean depth of loggerhead and green turtle egg chambers), and
8) An index of water logging (at mean egg chamber depth of both species).

B) Measurement of biological parameters:

Collection of nesting data was undertaken according to the methodology of Broderick and Godley (1996). The biological parameters on each beach measured with regard to each species were:

1) Nesting density,
2) Number of nesting activities,
3) Adult emergence success (%), and
4) Number of nests

RESULTS AND DISCUSSION

Descriptive results regarding physical parameters and biological parameters can be seen in Tables 1 and 2, respectively. Stepwise multiple regression analysis (Pin <0.05, Pout >0.10) was undertaken to investigate which physical factors exert a significant effect on the biological parameters.

Factors affecting the total number of C. caretta nests:

Beach length was shown to exert the most powerful effect (t = 2.715, P = 0.011, n = 36). Orientation (northerly, easterly, southerly or westerly) was also shown to be significant on the next step (t = - 2.197, P = 0.036, n = 36):

Number of C. caretta nests =
11.546 + (0.1 * L) + (-3.15 * O) [R^2 = 0.30]

- Beach length is primarily responsible for the number of nests. This was previously shown by Mortimer (1982) for *C. mydas* on Ascension island.
- Table 3 illustrates the higher numbers of *C. caretta* nests and nest density on northerly facing beaches.

Factors affecting the nesting density of C. caretta:

Orientation had a significant effect on the nesting density of C. caretta (t = - 2.486, P = 0.019, n = 36).

Density of C. caretta =
32.56 + (-7.26 * O) [R^2 = 0.17]

- The beach orientation is primarily responsible for the nesting density with high density on northerly facing beaches (Table 2).

Factors affecting the number of C. mydas nests:

Beach width was found to exert a significant effect (t = 3.156, P = 0.004, n = 36):

Number of C. mydas *nests =*
*- 2.665 + (0.356 * MW) [R^2 = 0.243]*

- Nests on wide beaches may have less chance of being inundated by storm induced wave action.

Factors affecting C. mydas nesting densities:

Digability to C. mydas depth was shown to be significant, (t = 3.085, P = 0.043, n = 36). Sand colour was also found to exert a significant effect, (t = - 2.697, P = 0.011, n = 36),

Table 1. Descriptive statistics of the physical parameters measured.

Physical Parameter	Unit of Measurement	Mean ± sd	Range
Length (L)	M	915 ± 912	134-4750
Mean width (W)	M	19.5 ± 912	5.4-42.5
Mean slope (S)	Degrees	4.05 ± 1.64	1.5-8.45
C. mydas digability (CmD)	Ordinal Count	11 ± 9.73	0-29
C. caretta digability (CcD)	Ordinal Count	21.22 ± 9.73	0-36
C. mydas waterlogging (CmW)	Ordinal Count	5.25 ± 4.99	0-18
C. caretta waterlogging (LW)	Ordinal Count	1.08 ± 1.76	0-9
Orientation (O)	Degrees	-	1-4
Colour (C)	Munsel colour chart	-	1-11
C. mydas sand (Phi), (CmS)	Phi units	1.73 ± 0.41	0.38-2.29
C. caretta sand (Phi), (CcS)	Phi units	1.74 ± 0.40	0.56-2.54

Table 2. Descriptive statistics of the biological parameters measured.

Biological Parameter	Mean ± sd	Range
Total Nests	12.61 ± 49.0	0.0-49.0
Total Activities	42.56 ± 43.82	43.82-182.0
Total Density	0.02 ± 0.04	0.0-103.7
No. *C. mydas* Activities	16.97 ± 31.81	0.0-172.0
No. *C. caretta* Activities	25.58 ± 31.81	0.0-159.0
No. *C. mydas* Nests	4.22 ± 6.65	0.0-33.0
No. *C. caretta* Nests	8.39 ± 10.29	0.0-40.0
C. mydas Density	7.58 ± 23.13	0.0-134.0
C. caretta Density	12.76 ± 20.02	0.0-103.7
% Emergence Success *C. mydas*	33.0 ± 25.79	0.0-100.0
% Emergence Success *C. caretta*	33.61 ± 21.48	0.0-100.0
Proportion of nests *C. mydas*	0.35 ± 0.36	0.0-0.94
Proportion of Nests *C. caretta*	0.65 ± 0.36	0.0-1.0

Table 3. Mean number of nests and the mean nesting density of C. caretta in relation to the beach compass orientation, (1 = northerly, 316 to 45, 2= easterly, 46 to 135, 3 = southerly, 136 to 225, 4 = westerly, 226 to 315).

Rank Orientation	n	Mean No. Nests	sd	Mean Nesting Density	Sd
1	10	38.1	31.40	28.65	31.4
2	5	4.46	32.39	23.46	3.13
3	11	5.73	5.22	4.46	6.49
4	10	8.75	11.14	8.75	11.14

Table 4. Mean number of nests and the mean nesting density of C. mydas in relation to the ranked colour of beach sand, (1 is the darkest).

Rank colour	n	Mean No. Nests	sd	Mean Nesting Density	Sd
1	3	7.6	9.29	47.17	75.74
2	3	1.3	1.53	4.20	6.03
3	1	0	2.12	0.00	0.00
4	1	12	-	11.43	11.43
5	8	1.75	2.64	2.58	3.74
6	5	2	2.35	5.82	6.50
7	7	3.43	4.61	2.13	3.09
8	2	0.00	0.00	0.00	0.00
9	2	6.5	0.71	0.02	0.01
10	2	22.5	3.82	21.30	30.12
11	1	7	-	0.00	0.00

density was in general higher on beaches with darker coloured sands. The median sand grain size at C. mydas depth was also shown to exert a significant effect, ($t = -2.583$, $P = 0.015$, $n = 36$):

Density of C. mydas =

$$50.051 + (1.496 * CmD) + (-4.169 * C) + (-20.858 * CmS) \quad [R^2 = 0.499]$$

- The digability at *C. mydas* nesting depth is the primary factor responsible for the nesting density, with the sand colour and the median grain size also playing a role.
- Table 4 shows the number and density of *C. mydas* nests in relation to sand colour the beaches in the study.

This preliminary investigation has highlighted features that are worthy of further study to enable a fuller understanding of nest site selection in Mediterranean sea turtles.

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INFESTATION OF MARINE TURTLE NESTS BY DIPTERAN LARVAE IN NORTHERN CYPRUS, EASTERN MEDITERRANEAN, 1997

Andrew McGowan[1], Annette C. Broderick[1], Brendan J. Godley[1], E. Geoffrey Hancock[2], and David C. Houston[3]
[1] Marine Turtle Research Group
[2] Hunterian Museum and Art Gallery (Zoology Museum)
[3] Ornithology Group, Division of Environmental and Evolutionary Biology, Graham Kerr Building, University of Glasgow, Glasgow, G12 8QQ, Scotland, U.K. A.Broderick@bio.gla.ac.uk

INTRODUCTION

In the Mediterranean there have been only two reported cases of insect infestation of marine turtle nests (Baran and Turkozan 1996, Broderick and Hancock 1997). However, there have been several studies reporting the presence of insect larvae particularly from two families of diptera (Phoridae and Sarcophagidae) infesting marine turtle nests (Andrade *et al.*, 1992, Bjorndal *et al.*, 1985, Fowler 1975, Lopes 1982, Vasquez 1994).

METHODOLOGY

All data regarding turtle nesting and hatching were collected following the protocol of Broderick and Godley (1996). Insect larvae were collected during excavation of turtle nests, placed in jars and returned to the field laboratory for rearing. Upon adult emergence, flies were left for 24 hours before being euthanased using ethyl acetate, fixed, and returned to the U.K. for identification. For a full description of the methodology employed refer to McGowan (1998).

RESULTS AND DISCUSSION

Levels of Infestation:

During the 1997 season, a total of 33 *C. caretta* and 11 *C. mydas* nests were recorded as being infested. This represented 17% and 21% of successfully assessed *C. caretta* and *C. mydas* nests respectively.

Insects infesting marine turtle nests:

For a full list of insects previously recorded infesting *C. caretta* and *C. mydas* nests in the Mediterranean refer to Baran and Turkozan (1996) and Broderick and Hancock (1997). The insect species that were found infesting *C. caretta* and *C. mydas* nests in northern Cyprus in 1997 are shown in Table 1. One species of Sarcophagidae (*Sarcotachina* ? (nov.)) has not as yet been identified, possibly a previously undescribed species, and was the most abundant. It was not uncommon, however, to find larvae from more than one species present in the same turtle nest.

Temporal distribution of infestation:

The temporal distribution of hatched nests of both species indicating the distribution of those that were infested are shown (*C. caretta*, Figure 1; *C. mydas*, Figure 2). The temporal pattern of infestation was quite clearly different between the two turtle species. Infestation was present during all the weeks that *C. caretta* nests hatched and the temporal distribution of infestation mirrors that of hatching to some degree. However, infestation did not occur during the

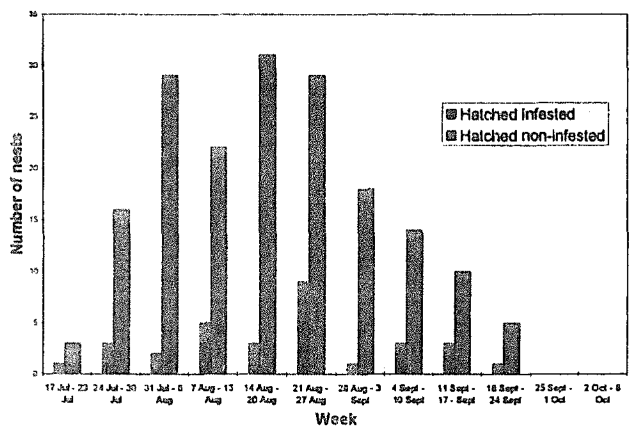

Figure 1. Graphic of the temporal distribution of hatching and infestation of C. caretta nests in Northern Cyprus

Table 1. Frequency of insect species recorded in C. caretta (n = 27) and C. mydas (n = 10) infested nests in 1997.
**These species also recorded by Broderick and Hancock (1997)*

Order	Family	Species	C. caretta Nests (%)	C. mydas Nests (%)
Diptera	Sarcophagidae	*Sarcotachina ? (novum)*	16 (48. 5)	6 (54. 5)
		*Parasarcophaga argyrostoma**	3 (9. 1)	1 (9. 1)
		Parasarcophaga tibialis)	1 (3)	-
		*Wohlfahrtia nuba**	2 (6. 1)	2 (18. 2)
		Phyllotelles pictipennes	1 (3)	1 (9. 1)
	Muscidae	*Atherigona orientalis*	1 (3)	-
	Chloropidae	*Eutropha fulvifrons*	1 (3)	-
	Ephydridae	*Hecamede albicans*	2 (6. 1)	-
	Phoridae	*Megaselia scalaris**	3 (9. 1)	2 (18. 2)
Coleoptera		*Cardiophorine species*	2 (6. 1)	-
		Agriotine species	1 (3)	-

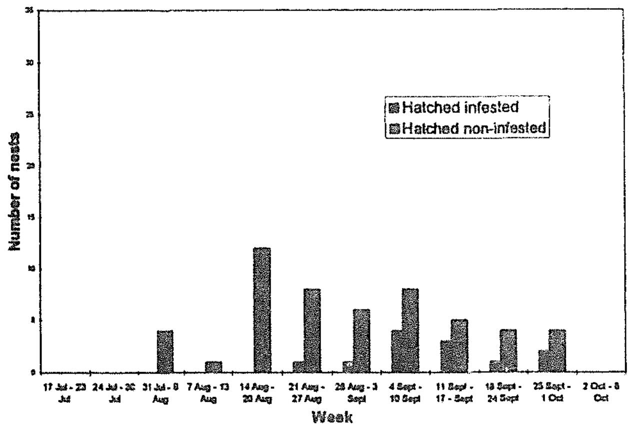

Figure 2. Graphic of the temporal distribution of hatching and infestation of C. mydas nests in Northern Cyprus.

first 3 weeks that *C. mydas* nests hatched.

Which parameters predispose nests to infestation?

For a description of all the variables that were considered see McGowan (1998). As sample sizes were small and the data were not normally distributed, Mann-Whitney U-tests were used for analyses. The number of days over which a nest hatched was significantly different between infested and non-infested *C. caretta* (W = 425.5, p = 0.002) and *C. mydas* (W = 49.5, p = 0.0067) nests. This indicates that the more days a nest takes to hatch then the greater the chances are that the nest will become infested. Dipteran larvae are known to attack live hatchlings (Vasquez 1994) and this poses a dilemma for conservation projects which do not excavate turtle nests early after the first signs of hatching.

The number of dead-in-shell eggs present in a nest was significantly different between infested and non-infested *C. caretta* nests (W = 439, p = 0.014) with infested nests having more dead-in-shell eggs present. A comparison between the number of dead hatchlings in infested and non-infested *C. caretta* nests was also significantly different (W = 424, p = 0.019), with more dead hatchlings being found in infested nests. This difference was even more marked when a comparison was made of the total number of dead (embryos + hatchlings) in infested and non-infested *C. caretta* nests. The result was highly significant (W = 448, p = 0.008) with infested nests having an increased number of total dead. These results strongly suggest that the amount of decaying tissue matter present in a nest may influence infestation. None of these three variables were different between infested and non-infested *C. mydas* nests, however, sample sizes were very small. Regression analyses showed no relationships between duration of hatching and number of dead embryos, dead hatchlings or total dead. This suggests that decaying tissue matter increases the chances of infestation was independent of the demonstrated effect of hatching duration.

Is infestation a problem?

The hatching success, on average, of infested *C. caretta* nests was 65.4% compared to 61.5% for non-infested nests and was not significantly different between the two groups (W = 292.5, p = 0.509). The hatching success of infested *C. mydas* nests (88.2%) is almost identical to that of non-infested *C. mydas* nests (89%) and was not significantly different (W = 41.0, p = 0.943). These results indicate that infestation does not decrease hatching success and appears to have no detrimental effects on viable eggs. However, one moribund hatchling was found to be infested upon excavation and thus, insect larvae may exert a deleterious effect.

In conclusion, insect infestation does not appear to be posing a significant threat to the reproductive success of marine turtle nests in northern Cyprus. There are however a number of factors which may predispose marine turtle nests to infestation such as the number of days over which a nest hatches, and the amount of decaying matter present in a nest. It is likely that the actual hatching process may be the cue used, in many cases, to allow flies to locate nests. More studies of this type are required before this can be fully understood.

ACKNOWLEDGEMENTS

Dr G. Ruxton (University of Glasgow) for the statistical advice, Mr John Deeming (National Museum of Wales), Prof R. Henry L. Disney (University of Cambridge) and Dr Roy Crowson (University of Glasgow) for the identification of all the insects, the members of G. U. T. C. E; travel support from The David and Lucile Packard Foundation to attend the Symposium.

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SEA TURTLES IN SOUTHERN VERACRUZ, MEXICO: A PROPOSAL

José Luis Miranda
Pronatura Veracruz Apartado Postal 399, Xalapa Veracruz 91069. México. verpronatura@laneta.apc.org

One of the most important efforts in the conservation of sea turtles world wide is the preservation of specific areas that the turtle populations use for feeding, reproduction and nesting. It is well known that the development of tourism centers results in contamination and the destruction of sea turtles habitats. This effect is increasing daily and is putting the population of these chelonians on the brink of extinction. In the Mexican state of Veracruz, which has almost 784 km of littorals, beginning over 15 years ago, work has been carried out to aid in the conservation of sea turtles and their habitats (Ojeda. 1993). However most of this work has been conducted in the north of the state To date no conservation efforts have been made nor studies conducted concerning the reproductive knowledge of these species in the south of Veracruz The southern region encompasses the coastal ecosystems between the town ofAlvarado to the city of Coatzacoalcos (18° 46'N, 95° 46'W and 18° 09'N, 94° 96'W), a distance of some 180 km There is some knowledge in southern Veracruz referring to the presence of some nesting sea turtle species such as : loggerhead (*Caretta carreta*), Green (*Chelonia mydas*), kemps ridley (*Lepidochelys kempii*), one of the worlds most endangered species, hawksbill (*Eretmochelys imbricata*) an probably leatherback (*Dermochelys coriacea*), (Carr, *et al.*, 1982) (Hildebrand. 1987) and (Vogt, *et al.*, 1996). The decline of the species was brought about by decades of harvesting of females and the over exploitation of eggs For this reason Pronatura Veracruz is interested in examining these beaches in order to evaluate the nesting activities of female sea turtles of the fore mentioned species In this way Pronatura will be able to propose programs for the conservation of the main potential beach sea turtle nesting sites

The present study is expected to be conducted during two nesting seasons, over a total duration of 21 months, starting in the month of April 1998 and it concluding in December of 1999.

OBJECTIVES

- Verify the activity of the sea turtles species that exists for this area in the literature.
- Determine the principal nesting zones in the south of the state.
- Determine the densities (nest/beach, nest/km) for species in the zone.
- Determine the principal causes of the loss of nests in the zone and verify the possible causes of death of females.
- Decide on the necessity of installing a camp in order to protect and prevent damage to the nesting sites during the seasonal nesting periods
- Propose the most adequate strategies for the conservation and protection of the sea turtles in this zone

MARINE TURTLES NESTING MONITORING IN CELESTÚN, YUCATÁN SEASON 1997

Emma Miranda Ruelas.
Pronatura Península de Yucatán, A. C. México. ppy@pibil.finred.com.mx

Will present the results about hawksbill turtle nesting monitoring on Celestún, Yucatán México. The patrols covered 24 km of beach from northern rim of the town of Celestún to Coloxché Point on the reserves border. The activities on the nesting beach were carried out between April and September 1997. A total of 191 turtle hawksbill (*Eretmochelys imbricata*) nests were registered and left to incubate where they were found Seven nest were relocated near of the nesting site and four were relocated at corral A 20.8% of total were disturbed or depredated by dogs and raccoons, 5.4% was stolen and 1% was flood. The maximum number of nests was registered in May and June with 67 and 74 nests respectively. The average hatchling success *in situ* nests was 89.1% and emerge success was 85% Approximately 16,004 hatchlings emerged in a sample of 131 nests

TEMPORAL AND SPATIAL DISTRIBUTION OF THE NESTING ACTIVITY OF *CARETTA CARETTA* AND *CHELONIA MYDAS* IN AKUMAL, QUINTANA ROO

Luis Manuel Ortiz Mejia, Jesús Rosiles Nieto, and Viridiana Sarabia Miranda
Centro Ukana I Akumal A.C.Carretera Puerto Juárez-Tulum km 104, Akumal Q. Roo Apartado Postal # 127, Playa del Carmen, Q. Roo C.P. 77710, México. *CEA94@mail.caribe.net.mx*

Two species of sea turtles nest in Akumal, Quintana Roo: loggerhead (*Caretta caretta*) and green (*Chelonia mydas*). The turtle's nesting activities were compared among the beaches of Akumal, each with different degree of development, nighttime lighting, and recreational activity. Comparisons were made among the time also. Highly significant differences were found when each beach was compared to the other, both in the distribution of nesting activity and hatchlings' survivor, and among the time. In order to minimize the negative impact that tourist development has over the sea turtles and their nesting beaches, management recommendations were proposed.

PERMANENT PROTECTION PROGRAM FOR THE MARINE TURTLE THAT ARRIVE ON THE BEACHES OF MAZATLAN.

Martha Leticia Osuna Madrigal
Acuario Mazatlan en la Ciudad de Mazatlan, Sinaloa, México. Acuario@red2000.com.mx

Program established by two Projects: I. "Evaluation of the turtles that nest in the beaches of Mazatlan" and II "Monitoring and caring for the nests in the Laboratory at the Mazatlan Aquarium".

This Program was formally implemented by the Mazatlan Aquarium in 1991 to Protect and Conserve the olive ridley turtle (*Lepidochelys olivacea*), species who, based on previous data, nest in zones on beaches exposed to city planning between Playa Cerritos and Playa Olas Altas (28 km. length) at the City and Port of Mazatlan.

From the beginning the Program established its Goals and Objectives, that have changed in priority, depending on the observations during these years.

Presently the activities during the year are based on the follow points.

GOALS.

Program. Sensitize the citizens and visitors about the necessity to collaborate to profit conservation and protection of the sea turtles and their habitat.

Project I. To help recuperate the females sea turtles and their nests.

Project II. To obtain high survival percentages of hatchlings in the Laboratory.

OBJECTIVES

Program. To infuse respect of citizens and visitors to the Environment.

Project I. To evaluate the alteration in the behavior of nesting turtles on beaches exposed to City planning.

Project II. To determinate the rate of survival of nests found at the beaches and hatchlings at the Laboratory.

The Program follows a plan of work for whose performance takes up a team composed for Governmental dependencies, Universities, Institutions, Companies, Hotels, Non Governmental Organizations, Citizens and financing from the Private sector, they all make possible, along with our staff, the continuity of the permanent activities in the protection of the olive ridley turtles that arrive on the beaches of Mazatlan with the rescue of the nests for their incubation in the Laboratory at the Mazatlan Aquarium, that way we help to conserve this species.

YEAR	TOTAL OF TURTLES REPORTED	TOTAL OF RESCUED NESTS	TOTAL OF EGGS INCUBATED	TOTAL OF FREED SPRING (HATCHINGS)
1991	26	13	1160	522
1992	33	14	1372	961
1993	48	37	3345	2080
1994	75	71	7070	4766
1995	82	79	7434	5635
1996	82	77	7162	4599
1997	110	107	10033	6936

* NOTE.
The above reported results did not include the following:
1) Turtles who got to shore but did not nest for some reason.
2) Turtles which did nest and were not reported, and whose knowledge of the nest was because of the hatchlings at shore, encounter which was reported.
3) Poached nests, which were reported afterwards, seldom done at the right moment due to fear.

We can assert that implement the Program make possible inform the results obtained in the period of time since 1991 so for February 1998, which at once are exposed.

This Program remained the necessary time with changes on basis at circumstances, which will be mentioned by mean of Goals and Objectives as today.

ACKNOWLEDGMENTS

Mr. Harold Cook American Citizen who has rescued more 50% of the total nests during all this years.

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LAS TORTUGAS MARINAS EN EL PARQUE NACIONAL ISLA CONTOY, QUINTANA ROO, MEXICO

Felipe Angel Omar Ortiz Moreno and Verónica Juárez Rivera
Parque Nacional Isla Contoy. Bld. Kukulkan km 4.8 ZH. Cancún, Q. Roo,. CP 77500, México.

Isla Contoy se decreta Parque Natural para la protección de tortugas marinas en octubre de 1986. Esto es debido, a que en sus playas llegan a anidar cuatro de las ocho especies de tortugas que existen en el mundo (*Eretmochelys imbricata, Caretta caretta, Chelonia mydas* y *Dermochelys coriacea*). Los estudios realizados tienen como finalidad aportar elementos de juicio para la conservación y manejo de las tortugas marinas del Parque Nacional Isla Contoy. El objetivo principal del monitoreo fue conocer las playas que son utilizadas como zona de anidación de las tortugas, además de determinar la frecuencia de anidación por especie y por playa, calcular el porcentaje de avivamiento y realizar actividades de marcaje en las hembra desovantes. Para lo cual se monitoreo todos los días las playas de barlovento y sotavento, se tomaron medidas de rastros y camas, se balizo los nidos que se encontraron. Se realizaron recorridos nocturnos cada tercer día. Y a las hembras que arribaron al Parque se les marco. La temporada de arribamiento de tortugas inicia en el mes de Abril con la llegada de *Eretmochelys imbricata* y termina en el mes de octubre con el arribamiento de *Chelonia mydas* y *Caretta caretta*. Se detectaron 22 nidadas exitosas de *Eretmochelys imbricata* con un porcentaje de avivamiento de 93.62%, para *Caretta caretta* se detectaron 23 nidadas exitosas con un porcentaje de avivamiento del 97.32%, para *Chelonia mydas* se localizaron 37 nidadas exitosas con un porcentaje de avivamiento del 97.28%. Se marcaron un total de 4 hembras de *Carettta caretta*, 6 de *Chelonia mydas* y además un juvenil de *Eretmochelys imbricata*. Las playas con mayor frecuencia de anidación son las de la zona de barlovento.

WHY DO MARINE TURTLES NEST IN SUB-OPTIMAL OR UNSTABLE BEACHES ADJACENT TO TIDAL INLETS?

Randall W. Parkinson[1], Llewellyn M. Ehrhart[2], Christopher Cornelisen[3], and Jean-Philippe Magron[1]
[1]Florida Institute of Technology, 150 West University Blvd., Melbourne, Florida 32901-6975 U.S.A.
[2]Department of Biology, University of Centra Florida, P.O. Box 162368, Orlando, Florida 32816-2368 U.S.A.
[3]Massachusetts Coastal Zone Management, 100 Cambridge Street, Boston, Massachusetts 02202 U.S.A.
rparkins@winnie.fit.edu

A comprehensive marine turtle monitoring program reveals persistent differences in reproductive success recorded on updrift and downdrift barrier island shorelines proximal to Sebastian Inlet, Florida, U.S.A. This region of the eastern Florida peninsula has been documented historically to contain high density nesting beaches and is located within the boundaries of the Archie Carr National Wildlife Refuge. However, loggerhead reproductive success on downdrift (south) beaches located within several kilometers of the inlet has remained significantly lower than updrift beaches throughout the duration of this study (1994-present). These differences were initially attributed to the effects of beach nourishment; ~100,000 cubic yards of sand were placed on the south beach in 1993. However, statistically significant biological (i.e., nesting success, hatch rates) and physical (i.e., scarp formation, moisture content) differences have persisted long after the fill material was removed by natural processes. We suspect the physical characteristics and instability of downdrift beaches may be a consequence of distinct hydrodynamic processes that are associated with most tidal inlets. It is puzzling why marine turtles would nest on beaches that promote lower reproductive success. This observation may simply be a consequence of the ephemeral nature of barrier island tidal inlets. From a geological perspective, tidal inlets are temporary features, persisting for no more than several hundred years. Inlets open and close randomly and without regard to the nesting marine turtle population. Hence, gravid females may return to nest on a beach that has subsequently been rendered sub-optimal by a recent inlet opening. However, the long-term effects on the nesting population are probably insignificant because inlet closure occurs long before nest-site selection behavior results in the avoidance of these beaches.

MONITORING AND NEST PROTECTION OF THE LOGGERHEAD COLONYNESTING IN KYPARISSIA BAY, GREECE, DURING 1997

Alan Rees, Michalis Michalopoulos, and Dimitris Margaritoulis
The Sea Turtle Protection Society of Greece, P.O.Box 51154, GR-14510 KIFISSIA, Greece. *stps@compulink.gr*

A major nesting area of the loggerhead turtle *Caretta caretta* in Greece is found along the 44-km Bay of Kyparissia, at the western coast of Peloponnesus. Pilot monitoring in the 1980s has revealed that most of the nests (more than 85%) are made in the southernmost 10-km part of the bay. Unlike the nesting regions of Zakynthos and northern Crete, development of the beach area is not a major problem. Nests suffer greatly from predation by foxes and dogs as well as from inundation caused by the strong prevailing northwestern wind which brings waves high up the beach in summer. To counter these stresses on the nesting population, for several years an active management program has been carried out by the STPS. Activities include fencing of nests, relocation of clutches to avoid inundation and a public awareness program aimed at limiting damage caused by residents and visitors to the area. The present poster describes the work carried out during the 1997 nesting season.

THE CULEBRA LEATHERBACK PROJECT: A CONSERVATION AND RECOVERY PROGRAM FOR TURTLES

Marelisa Rivera
U.S. Fish and Wildlife Service, P.O. Box 491, Boqueron, Puerto Rico 00622, U.S.A.

The U.S. and Wildlife Service has conducted the Culebra Leatherback Project for approximately 13 years through contracts, cooperative agreements and Service's employees. The principal beaches for the monitoring of leatherback sea turtle (**Dermochelys coriacea**) nesting activities have been Brava and Resaca beaches, two of the most important nesting beaches for leatherbacks in Puerto Rico. Night patrolling with visitors and volunteers are conducted from April to July, after July, the beaches are visited during mornings and afternoons for the excavation of nests. Generally the excavation ends in August. Data is collected on nesting habitat, number of eggs, physical characteristics of the female turtles, and tagged with flipper and PIT tags. The hatching success is calculated after excavating the nests. In the last years, a mean of 24 per year has nested in Brava and Resaca beaches, constructing a mean of 156 nests per year with a mean hatching sucess of 74%. However, in 1997, record numbers of leatherback sea turtle nesting activities (81 female turtles and more than 300 nesting activities) were reported on Brava and Resaca beaches in the Culebra Island. This project has yielded comprehensive information on the nesting biology of the leatherback that has contributed greatly to the understanding of this species in Puerto Rico and the U.S. Caribbean.

MAMMALIAN PREDATION ON BOCA RATON'S BEACHES: A YEAR WITHOUT CAGES

K. Rusenko, C. Pfistner, D. Fowler, and A. Barker
Gumbo Limbo Environmental Complex, 1801 N. Ocean Blvd., Boca Raton, FL 33432 U.S.A.

INTRODUCTION

Since 1976, Boca Raton's Sea Turtle program has caged all Sea Turtle nests in an effort to reduce predation by raccoons (*Procyon lotor*) and foxes (*Urocyon argenteus*). During the 1996 nesting season a study was initiated to determine if caging was an impediment to mammalian predators. Evidence collected indicated that cages actually attracted predators leading to repeated successful attacks on caged nests during the first seven to nine days of incubation. Throughout the 1997 Sea Turtle Nesting Season no cages were placed over nests for the first time in twenty years. Instead, all nests were double-staked (dune and nest site stakes) and predation events were recorded during daily beach surveys. Significant changes in predation patterns occurred in the absence of cages. As in previous years, most attacks on sea turtle nests occurred in the city parks where high populations of raccoons apparently exist. Although the number of nests attacked this year was twice as many as last year, the percentage of nests totally destroyed is essentially the same. Foxes, not raccoons, were responsible for the majority of attacks on staked nests. Raccoon attacks were predominant in city park zones whereas fox attacks occurred in all zones. Significantly fewer nests were attacked in the first days of incubation this season as compared to last days of incubation. The lowest predation rates were found in zones that contained condominiums, indicating that garbage control may be equivalent to predator population control.

METHODS

During the 1997 nesting season new sea turtle nests were marked with a dune stake and a nest stake (double-staked nests) that was placed randomly about the egg chamber, no cages were used throughout the season. Each nest was checked daily on the routine morning survey and predation attempts or successful attacks were recorded by date, nest number, and attacking species. All evidence of the attack was erased for continued monitoring. If an attack was successful, the number of days of incubation were recorded and compared to the incubation period of nests that had not been attacked generating a percentage of incubation time that was used to compare the timing of the first successful attack throughout the nesting season.

Nest contents were quantified 72 hours after hatchout or after 70 days of incubation according to the Florida Department of Environmental Protection guidelines. From this information, three predation types were recorded. Nests that had no remaining eggshells or eggs were considered to be totally predated, nests that had countable shells and eggs were considered partially predated, and nests that were attacked during emergence with evidence of hatchling tracks were considered as hatchout predation. During the 1996 nesting season, cages were used and predation data was collected in the same manner as the 1997 nesting season therefore allowing easy comparison of data from these two seasons.

RESULTS

The majority of attacks were found in zones D, E, and F or the area of Red Reef Park through South Beach Park. This pattern was also seen during the 1996 nesting season. Significant increases in attacks were recorded in Zones B, C, G, and H.

The timing of attacks was very different from 1996 to 1997. During the 1996 season (with cages), approximately 27% of the attacks occurred in the first two weeks of incubation. During the 1997 season (without cages), only 7% of the attacks occurred during this time period with the majority of attacks occurring during the last two weeks of incubation.

Surprisingly, raccoons accounted for only 37% of the attacks in 1997 compared to 80% of the attacks in 1996. In 1997, foxes were responsible for 61% of the attacks on sea turtle nests. Fox attacks were largely spread over all zones whereas raccoon attacks were largely confined to zones D, E, and F. Although a population survey was not performed, there appeared to be no decrease in the raccoon population in the parks as determined by daytime sightings and the number of raided garbage cans. Foxes, however; may have experienced a population increase based on increased sightings on Turtlewalks and daytime sightings in the Parks.

Successful predation of nests by foxes were found in all zones except J. The majority of the attacks occurred in zones D, E, and F; however, major increases occurred in zones C, G, and H over the 1996 season. Successful raccoon attacks were strongly reduced in 1997 although the distribution of attacks by zone was similar with the majority occurring in zones D, E, and F.

The number of nests that were totally lost did not differ from 1995 to 1996 (each 9%) nor did the number of partially lost nests (each approximately 6%). The number of hatchout attacks increased from 1% in 1996 to 13% in 1997.

The hatch success results for unpredated nests found each nest contained an average of 106 hatched shells. Nests that were total losses had no hatched shells present, partially predated nests had an average of 71 (67% of unpredated nests) hatched shells, and hatchout predated nests had 100 (95% of unpredated nests) hatched shells. Significant numbers of hatchlings apparently escape from both partial and hatchout predated nests although an accurate mortality of emerged hatchlings is difficult to estimate.

DISCUSSION

Double-staking nests with no caging greatly changed the nature of predation in Boca Raton. During the 1997 season, there was a record low number of Loggerhead nests with most likely the same number of potential predators. Indeed, the percent of nests attacked in 1997 was 51% (549 total nests) compared to 26% (990 total nests) in 1996. Despite the high concentration of attacks in 1997, the percentage of total and partially predated nests was essentially no different from 1996. The increase in hatchout predations was possibly due to the inability of the predator to find the nest prior to emergence. Most of the attacks by both foxes and raccoons were inappropriately directed to the stakes regardless of whether they were located at a nest. Many attacks were directed to survey stakes or dune stakes indicating that the predator was relying on visual cues rather than smell. Data collected in 1996 indicated that the cage was indeed used as a visual cue to locate nests. The fact that very few nests were attacked during the first two weeks of incubation in 1997 compared to 1996 supports this view. In fact, 50% of the predations in 1997 occurred at hatchout and few nests were dug up at this time as judged by the near-normal number of hatched shells in these nests.

The most dramatic and unexpected difference from 1996 to 1997 was the near reversal of predator species with the dominance of the gray fox. The raccoons were not simply inept at finding a nest without a cage, they apparently gave up looking for nests during the 1997 season. Why this occurred is a puzzle, perhaps there was more garbage in the parks to attract them off the beach or the low density of nests in 1997 made beach patrols impractical for a pack of raccoons. It is important to note that raccoon attacks occur in zones with readily available garbage on the same side of the highway as the beach. For both 1996 and 1997, few raccoon attacks occur in areas where condominiums predominate or where the parks are across the highway from the beach. Attacks in zones D, E, and F may be due to an artificially high population of raccoons because of the large food source (garbage). Eliminating the availability of garbage in Red Reef and South Beach Parks may naturally reduce the raccoon populations and, as a result, reduce the number of predated nests in these zones.

In the upcoming year a more dynamic approach to predator reduction will be tried through the random placement of caged and double-staked nests in an effort to prevent predator habituation to any single form of deterrence.

LA TORTUGA MARINA EN BAHÍA DE BANDERAS

Susana Sánchez González, Sherman Hernández Ventura, José Juan González Ruíz, Rodrigo Moncayo Estrada, and Pablo Del Monte Luna

Estación de Biología Marina y Pesquera "Dr. Enrique Beltrán". Instituto Nacional de la Pesca. Secretaría de Medio Ambiente, Recursos Naturales y Pesca. Calle de la Tortuga #1, La Cruz de Huanacaxtle, Nayarit C. P. 63732. Apart. Post. 59, Bucerías, Nayarit, México. ebimap@pvallarta.icanet.net.mx

Por la geografía, clima y dinámica oceánica, la Bahía de Banderas es estratégica en biodiversidad y por su belleza en turismo. Esto permite una relación sociedad-naturaleza con posibilidades de generar desarrollo con la explotación de sus recursos naturales. En tal contexto el Instituto Nacional de la Pesca, a través de la Estación de Biología Marina y Pesquera, realiza un proyecto de investigación y protección de la tortuga marina en Nuevo Vallarta, una de las playas de mayor concentración de tortugas para el Pacífico Nayarita. Se cuenta con tres rubros de análisis: (1) si bien la protección y conservación de las tortugas marinas en México tiene un largo antecedente esta playa es estratégica para monitorear la evolución del programa nacional y obtener información acerca de diferentes aspectos, en este año se han logrado proteger 680 nidos con 57 482 huevos y 35 008 crías lo que implica una disminución del 20% con respecto al año anterior, lo que puede responder a "El Niño"; (2) Educación ambiental y ecoturismo con la posibilidad de alternar diversión, riesgo controlado y contacto con la naturaleza y en la búsqueda de una alternativa regional para obtener recursos para la gente local; (3) investigación con un análisis prospectivo de los depredadores ícticos potenciales de las crías de tortuga en el área de rompientes con una riqueza de 45 especies de los cuales 5 son los posibles candidatos. La presentación trata de exponer los avances en todos los rubros para dar a conocer las actividades elaboradas.

EFFECT OF HURRICANE PAULINE ON THE NESTING OF OLIVE RIDLEYTURTLE IN ESCOBILLA BEACH, OAXACA, MEXICO.

Laura Sarti[1], Juan Díaz[1], Manuel Garduño[1], Javier Vasconcelos[2], Ernesto Albavera[2], Cuauhtemoc Peñaflores[2], and René Márquez M.[3]

[1]Instituto Nacional de la Pesca, Pitágoras 1320, 5° Piso, Col. Sta. Cruz Atoyac. México D.F. 03310

[2]Centro Mexicano de la Tortuga, Mazunte Tonameca, Oaxaca

[3]Centro Regional de Investigaciones Pesqueras-Manzanillo. Playa Ventana S/N AP 591, Colima, 28200, México

INTRODUCTION

Escobilla beach, the main nesting site in Mexico for the olive ridley, was striken by hurricane Pauline on October 8, 1997, which affected the physonomy of the beach. The total number of nestings occurred to October 3 was 779,203 in 7 arribadas. The arribadas occurred from August 30 to September 18, (173,574 nestings), and from September 30 to October 3, (178,828 nestings) were directly affected by Pauline.

The main effects were erosion of the whole intertidal zone and deposition of large logs over a section of the middle zone of the beach. 10% of the total nestings are laid on the intertidal zone. All the eggs laid in this area were taken out to the surface. In the middle zone of the beach occurred the 75% of the nestings, from which 12.8% were estimated to be affected based on the area covered by the logs.

Hatchlings from the arribada from August 30 to September 18 began to emerge on October 15. Despite of being covered by logs, thousands of hatchlings found their ways to the surface. The ones that were not rescued died trapped by the logs.

Clutches from the second arribada laid in the zone covered by logs in the hurricane very likely didn't produce any hatchling due to decomposition processes of the wood, accumulated humidity and drop of temperature among other factors.

The olive ridley (*Lepidochelys olivacea*) sea turtle nests along the Mexican Pacific coast. The nesting season is from June to January, but, in Escobilla beach, the main nesting beach, it's possible to find nestings all the year. In this beach some days each month, under special climatic conditions, hundred of thousands of females nest at the same time. This phenomenon is known as"arribada". Since 1986 Escobilla beach is a protected area, however the protection activities and the evaluation of the arribadas have more than 20 years.

Escobilla is located in the Oaxaca State, in the Pacific coast of Mexico, between the 15° 43'50", 15°39' 52" N and 96° 42' 56", 96° 34' 38" W. The beach is 15 Km. long, and the arribadas occur mainly in the first 8 Km (NW-SE). Since the total ban in 1990, an important increase in the total estimated nesting activities has been reported, from the 210,000 activities occurred this year to 816,942 in 1997.

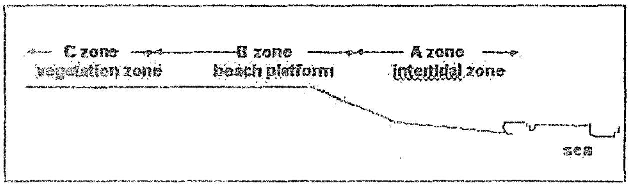
The clutches are deposited along the wide of the beach. 10% of them are deposited in the intertidal zone (zone A) 75% in the middle of the beach (berm and platform) (zone B) and 15% in the vegetation zone (posterior) (zone C).

On October 8, 1997, hurricane Pauline affected the nestings of two arribadas. Thousands of eggs were eroded by the high tides, and squashed by logs deposited on the beach.

METHODS TO EVALUATE THE EFFECTS ON THE CLUTCHES

The amplitude of Escobilla does not vary much along the beach. In the area were the arribadas are more common, the amplitude of the beach and the area covered with logs were measured in transects each 500 m. From the percentage of beach covered in ecological zone the total loss of nestings was estimated, assuming a total coverage of the beach with eggs in these areas.

Ecological zones to the width of the beach:



C ZONE	15% of the nesting are deposited in this zone
B ZONE	75% of the nestings are deposited in this zone
	zone totally covered by logs
A ZONE	10% of the nestings are deposited in this zone / zone totally covered by logs

S E A

RESULTS

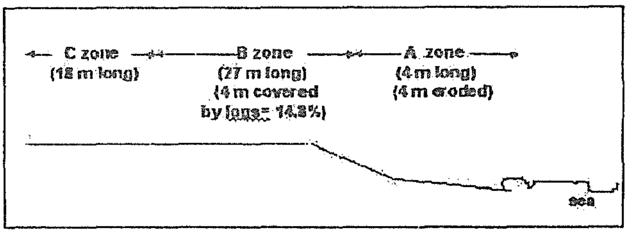
3 Transects were made. The results show:

a) zone A (intertidal zone) was totally lost by erosion.

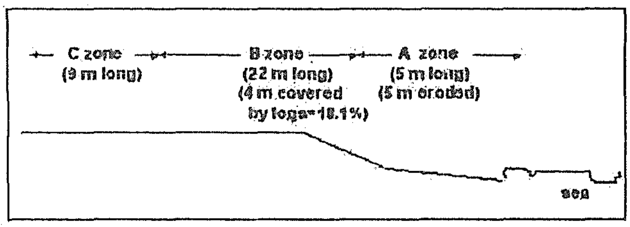
b) zone B (beach platform) was completely covered with logs only in 12.8% in average for the total zone. The area covered is in the vicinity of A zone.

c) zone C wasn't covered by logs or eroded.

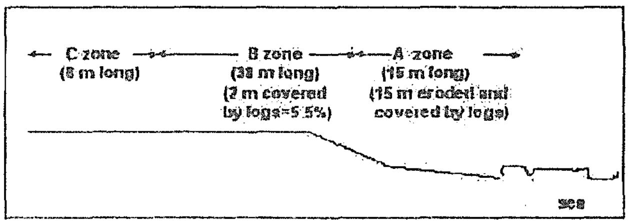
Transect 1. - Station 22



Transect 2. - Station 17



Transect 3. - Station 9



Arribada occurring on August 23-28 (Table 2)

It was estimated that 30,449 nests from this arribada were lost by the hurricane effects. In order to avoid that hatchlings emerged in zone C and the free part of zone B were trapped in the logs and debris, a 300 m-long plastic mesh was placed in front of this area (between the logs and zone C), and some hatchlings found trapped were rescued. Using this mesh, around 78,000 hatchlings were recovered and released to the sea.

Table 1. Arrivadas ocurring up to the hurricane date.

dates of arribada (1997)	estimated nestings	estimated eggs (100 eggs per clutch)
June 23-27	34,503	3,405,300
July 3-11	36,498	3,649,800
July 25-30	74,835	7,483,500
August 8-14	125,609	12,560,900
August 23-28	155,358	15,535,800
Aug. 30 - Sep.18	173,574	17,357,400
Sep. 30 - Oct. 3.	178,828	17,882,800

* emergences affected by overlapping of arribadas
** arribadas affected by hurricane Pauline

Table 2. Losses caused by Hurricane Pauline

DATES OF ARRIBADAS AFFECTED BY PAULINE	ESTIMATED NESTINGS	NESTINGS PER ECOLOGICAL ZONE			ESTIMATE OF NEST LOSS PER ECOLOGICAL ZONE			TOTAL OF LOST NESTINGS
		Zone A (10%)	Zone B (75%)	Zone C (15%)	Zone A (100%)	Zone B (12.8%)	Zone C (0 %)	
Aug. 23-28	155,358	15,535	116,517	23,306	15,535	14,914	0	30,449 *1
Aug. 30 - Sept. 18	173,574	17,357	130,181	26,036	17,357	16,663	0	34,020 *2
Sept. 30-Oct. 3	178,828	17,883	134,121	26,824	17,883	17,167	0	35,050 *3
TOTAL	507,760	50,775	380,819	76,166	50,775	64,279	0	115,054

Arribada occurred on August 30 - September 18 (Table 2)

The eggs form these arribadas were in a early/middle stage of development. It was possible to verify that some embryos (2-3 weeks old) were alive after the hurricane. Although there were not a representative sample, it could possible to assume that the excess of rain and the high tides were not enough to stop the embryo development in those stages or later ones.

Arribada occurring September 30 -October 3 (Table 2)

Pauline probably affected the eggs from this arribada in a very early embryo development stage. Thousands of clutches remained buried below the logs. The humidity down the logs, the low temperature by the shade, the pressure over the eggs, and later, the changes due to decomposition of the logs, caused for sure the death of the embryos from all the nests covered by logs.

Considering the losses caused by hurricane Pauline, we estimated that, from a total of 779,203 nestings occurred up to the date of the hurricane arrival (October 8, 1997), 115,054 (14.7%) were lost due to its effects.

HURRICANE RICK AND REMOVAL OF DEBRIS IN THE BEACH.

A month after hurricane Pauline, hurricane Rick hit the coast, bringing several tons of logs and debris that were deposited on the beach, completely blocking the path of the hatchlings to the sea and of the females to the nesting beach. Between Pauline and Rick no arribadas occurred, only a few isolated nestings. Local people helped in the task of removing logs from the beach. Motor chainsaws were used to cut the logs which were transported to the back part of the beach, avoiding the hatchlings being trapped and the death of the embryos due to change in incubation environment, and allowing the females from subsequent arribadas to nest successfully. While the cleaning activities were in process, the next arribada came to the beach. The females could climb the beach and lay their eggs with no problems. This arribada occurred in a wider area than usual, and it is assumed that the females tried to look for open areas to nest, spreading in a wider extension of the beach.

ACKNOWLEDGMENTS

We want to express our most sincere gratitude to all of you who where concerned about the fate of Centro Mexicano de la Tortuga and Escobilla beach, to the people that contributed with donations, support and encouraging words.

Thank you for everything!

15 YEARS OF CONSERVATION EFFORTS BY THE SEA TURTLE LABORATORY IN MEXIQUILLO BEACH

Laura Sarti, Ninel García, Carlos López, Ana Barragán, Francisco Vargas, Cristina Ordoñez, Leticia Gámez, Patricia Huerta, Arturo Juárez, Debora García, and Miguel Herrera
Laboratorio de Tortugas Marinas, Fac. de Ciencias, UNAM. Circuito Exterior, Ciudad Universtiaria, México D.F: 04510, México. lsm@hp.fciencias.unam.mx

Mexiquillo beach is one of the 5 major nesting beaches for the leatherback in Mexico and has been considered one of the most important world wide. This beach has had a continue monitoring program of the leatherbacks since 1982, when the Facultad de Ciencias of the National University started a research and training program, tagging females and counting nests, relocating eggs and other projects about the biology of the leatherback, as part of the undergraduate curriculum for the Biology major in this institution. Since that date, there has been 10 annual courses with an average of 25 students per course. These students were trained in all the aspects of running a project from preparation of the protocol and search for bibliographic references to analysis of collected data and preparation of a technical report. They also were trained in all the basic field procedures used with sea turtles. In this way and in good deal groups of students, with advise from the professors, have maintained the protection program in this beach for 15 years.

From the beginnigs of the program to 1992, beach patrolling was done on foot in the 4 Km with highest nesting density. From 1993 on, ATV's have been used, and due to the low nesting density, patrolling was incremented to the total 18 kilometers of the beach.

Since 1982 to date, 30,179 leatherback clutches have been recorder from wich 7,635 were protected, representing 441,860 eggs. From these, 184,770 hatchlings have been recruited to the population.

The olive ridley also nests in Mexiquillo. From this species, 5,059 nesting have been recorded, and 1,472 clutches were protected, which means 207,763 eggs that produced 75,542 hatchlings recruited to the population.

STATUS OF OLIVE RIDLEYS (*LEPIDOCHELYS OLIVACEA*) NESTING ACTIVITY AT SPORADIC HABITATS OF NORTHERN ANDHRA PRADESH COASTLINE, INDIA

Raja Sekhar, P.S.
Dept. of Environmental Sciences, Andhra University, Visakhapatnam-530 003 India

The Olive ridleys, *Lepidochelys olivacea* (Eschcholtz) have worldwide distribution, with significant mass nesting habitats at two different geographical locations. The Pacific coasts of Costarica, Mexico and the coasts of Northern Indian Ocean, India. Most of their nesting activity concentrated at mahanadi river mouth (Gahirmatha), and Rishikulya river mouth (Ekakulansi beaches) of Northern Indian Ocean. In winter months large number of Olive ridleys migrate from Indian Ocean to Mahanadhi river mouths for Mass nesting (Arribada) around January to March, after passing the coastlines of Tamilnadu, Andhra Pradesh and Orissa. While in migration many of the breeding populations selected nearby suitable beaches as their sporadic nesting activity. In recent years migratory turtles activity has been increased along the Northern Andhra Pradesh coastline (16 10' - 18 25' Latitudes and 81 35' - 84 10' Longitudes) utilized as their breeding and nesting habitats. The nesting concentrations are mainly at larger river mouths (Godavari) and at perennial minor river confluence points along the coastline (Tandava, Gostani, Nagavali and Vamsadhara). The nesting activities were estimated with the direct evidences, cited in nesting, incidental captures of breeding turtles by local fishermen and accidentally drowned turtles washed ashore. The crawls made by nesting turtles, freshly laid nests and disturbed nests are considered as indirect evidences. For the survey the entire coastline from river Godavari to river Vamsadhara (nearer to Orissa boarder of Rishilkulya river) has been divided into five zones. Inrelation to breeding concentrations with their relative importance values of suitable nesting sites are recognised at each zone for the protection to conserve as sporadic nesting habitats of oliveridleys.

HAWKSBILL SEA TURTLE NESTING ACTIVITY CENSUS AND RELATED CONSERVATION ACTIVITIES IN CULEBRA, PUERTO RICO

Teresa L. Tallevast[1] and Rosarito Morales[2]
[1]U.S. Fish and Wildlife Service, Culebra National Wildlife Refuge P.O. Box 190, Culebra, PR 00775-0190 U.S.A.
[2]Fanduca, Inc., P.O. Box 386, Culebra, PR 00775, U.S.A.

Although U.S. federal and Puerto Rico commonwealth laws have been implemented to protect sea turtles and their habitat in Culebra, P.R., degradation of habitat qualilty still ocurrs due to coastal development and marine activities. Diurnal surveys of beaches throughout the archipelago were initiated in 1993 to augment previously sketchy information on hawksbill nesting activity and acquire additional information necessary in the formulation of comprehensive coastal and marine management plans.

Surveys were conducted from August 1993 through October 1997. More than 280 hawksbill nesting activities were recorded, 78% of which occurred on beaches located in the Culebra National Wildlife Refuge. Nests located in other sites were subjected to erosion due to unregulated upland land clearing, off-road vehicular traffic, passage of livestock, and artificial lighting. Documented hatchling mortality occurred due to entrapment in cattle hoof prints.

Outreach programs targeting the community, visitors, and government personnel have been conducted to provide opportunities for the local populace to directly benefit from conservation and also encourage public support for development and enforcement of coastal zone planning to meet current and future needs.

AN ANALISIS OF PROTECTION TO THE SEA TURTLE AT CAMP MAJAHUAS, JALISCO, MEXICO.

J.A. Trejo-Robles[1], R.E. Carretero-Montes[1], F.J. Jacobo-Pérez[2], and J.C. Rodríguez-Salgado[3]
[1]Centro de Ecología Costera, CUCSUR. Universidad de Guadalajara. Gómez Farías # 82, San Patricio-Melaque, Jal. C.P. 48980. México. jtrejo@costera.melaque.udg.mx
[2]CUCBA-Universidad de Guadalajara.
[3]CUCOSTA-Universidad de Guadalajara.

INTRODUCTION

In the state of Jalisco at the Federal Reserve Zone known as Playón de Mismaloya is an important area of nesting of the marine turtle specially and in a major abundance of olive ridley (*Lepidochelys olivacea*) although they are registered as *Chelonia agassizii*, *Dermochelys coriacea* and esporadically *Eretmochelys imbricata*. In 1997, like every year since 1982 the Universidad de Guadalajara has in fact developed the activities for the protection and conservation the sea turtle in this zone.

Majahuas (19°49'53"L.N., 105°21'6"L.O.) is one of the four camps that operate on this reserve. The beach that corresponds to this camp embrases an extension of 12 km and is characterized for being (50m) wide and varies according to the dynamics of the waters as influenced by the tides and the formation of stone walls. This creates small dunes, spinny thicket, low vegetation and palms that border the zone. The nestings in this area are the higest that are registered in the Playón de Mismaloya zone. The camp is limited on the continent end by the Majahuas swamp, which has an opening with the ocean on the north side and is permanent during the nesting season. This creates for the formation of two hig tides and two low tides.

The Majahuas beach has a very low index of human corruption, however, it has its natural predation specially in the winter season where we can observe the attack on the turtle eggs nests and in some cases even at their place of incubation. The hatcheries that is initialy 20X20 m and is afterwards enlarged in accordance with the need, is located 1 km from the camp being the best place due to the beaches characteristics and for being the zone best suited for the eggs safety.

METHODS

The practices of conservation and protection at Majahuas include nightly paths and an occasional one in the day through the beach in order to realize the activities that do correspond to the collection, transportation and planting of eggs on to the protected areas of incubation (hatcheries). Daily starting at 21:00 to 06:00 hours of the following day three alternating groups of persons run though the beach loocking for nests and do transport them to the protected área where they are then planted. If the gathering is more than eigthy eggs they are divided into two parts for their incubation and later through the hatching and release through the night at 2 to 3 kilometers from the camp.

Table 1. An evaluation of the aplyed effort to the protection activities at Majahuas camp from July- December.

ACTIVITIES	JUL	AUG	SEP	OCT	NOV	DEC
DAYS IN CAMP	15	31	30	31	30	13
PATROLLED DAYS	15	30	28	30	29	12
PATROLLED HOURS	135	270	252	270	261	108
PATROLLED KILOMETERS	1080	2160	2016	2160	2088	864
EFFECTIVE WORK HOUR	240	480	448	480	464	192
NEST COLLECTED/MONTHS	44	303	240	131	117	17
NEST COLLECTED/DAY	2.93	10.10	8.57	4.37	4.03	1.42
HOURS/NEST	3.07	0.89	1.05	2.06	2.23	6.35

Pertaining to the recently created Quelonius: Universitary Program of the Conservation of the Marine Turtle, whose main function is to integrate the three university Centers to work in recourse with objetives of jointly combine efforts and apply them to one final common end.

RESULTS

To achieve activities during the season of 1997 (July through August) in Majahuas camp, tree branches of the University of Guadalajara: The Science Biology Agriculture and Livestock Industry Campus, Coast line campus and south coastline campus were together to develop the Sea Turtles Conservation Program: Quelonius. During this entire season there were four researchers from differents campus, also the participation of Fishery Cooperative Society of Roca Negra and the City Hall of Tomatlán, Jalisco; besides during the season 333 students from diferents high schools and campus of the same University were volunteers, who dedicated walking and watching the 8 kms of beaches

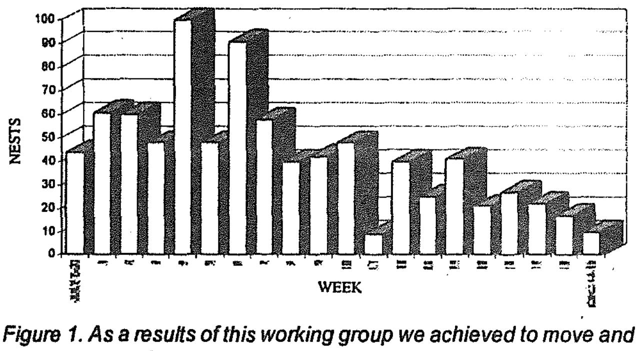


Figure 1. As a results of this working group we achieved to move and protect a total of 852 nests. The average was 49 nests per week

south of the camp.

In July through December of 1997 they were watching 144 days, 9 hours per day with a total amount of 72 km

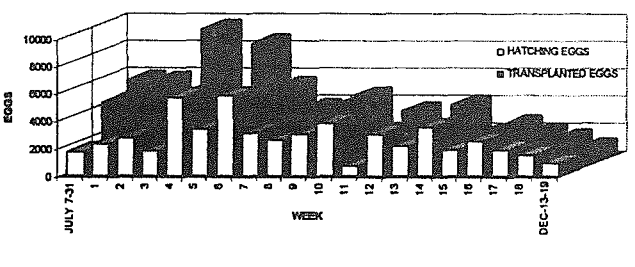


Figure 2. The total of eggs hatched were 83,139 with an average of 4,156.95 eggs per week.

per day.

The evaluation of the aplyed effort in the protection activities let us know a value exactly of the work at sea

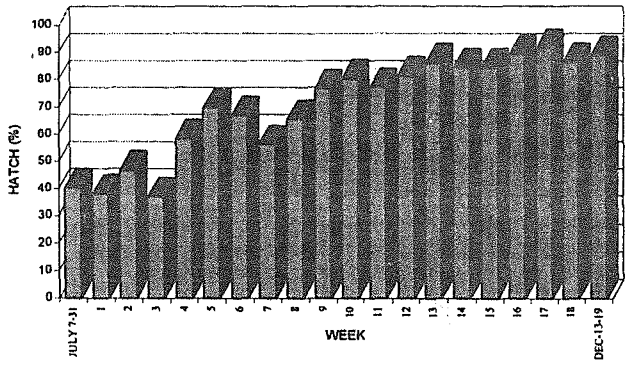


Figure 3. The hatch average obtaining was 66,12% in the entire season

turtle camp Majahuas (Table 1).

As results of this working grup (Figure 1) we achieved to move and protect a total of 852 *Lepidochelys olivacea* nests, besides of 30 that were left *in situ*. The average was 49 nests per week. The figure 2 show us the total eggs transplanted at the hatcheries.

The hatching appeared on the third week of September and the rates were discauraging with 50.52%, however during the season, these enhance to reach 88.93% in the last weeks, obtaining 66.12% in the entire season (Figure 3). These results could be for high tides during September and October where the hatching corrals was completely under water, some times high tides were twice by day (11:00 and 18:00 hours) (Figure 4).

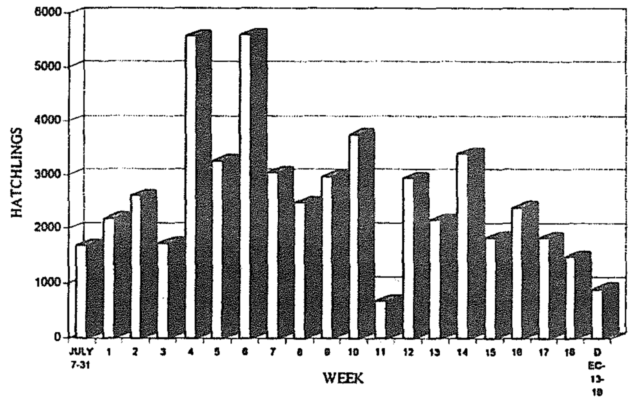


Figure 4. 58,819 hactlings were put in the ocean with an average of 2,964 per week.

NOURISHED BEACHES AND MARINE TURTLE NESTING IN FLORIDA: AN EVALUATION OF RECENT PROJECTS.

Robbin N. Trindell[1], David Arnold[1], Karen Moody[1], and Beth Morford[2]

[1] Florida Department of Environmental Protection, Bureau of Protected Species Management, 3900 Commonwealth Boulevard, Tallahassee, FL 32399, U.S.A. Trindell_r@epic6.dep.state.fl.us

[2] Florida Department of Environmental Protection, Bureau of Protected Species Management, Tequesta Field Laboratory, 19100 SE Federal l Highway, Tequesta FL 33469, U.S.A.

Beach nourishment is a crucial tool for restoring and maintaining sandy beaches in Florida under existing sea level and sediment transport regimes. Preliminary results suggest that not all renourished beaches are created equal in terms of marine turtle nesting habitat, and utilization of a nourished beach changes with time since fill placement. We reviewed information submitted for recent nourishment projects (1987 or later) as a requirement of marine turtle protection conditions in Florida Department of Environmental Protection beach nourishment permits. In particular, we summarize information on nest numbers, false crawl numbers, nest success, and hatch success for loggerhead (*Caretta caretta*) nests as well as compaction (measured as shear resistance) and escarpment monitoring. Marine turtle nest success declined on beaches the nesting season following fill placement. Although hatch success for those nests that were deposited and did not wash away did not appear to decline, hatchling production could be reduced due to nests lost to erosion and to a decrease in nesting success.

METHODS

Information on marine turtle nesting (loggerhead turtles only) was excerpted from reports prepared by marine turtle permit holders for given project areas. In some instances, nesting data for the fill placement site were combined in the report with nesting information on adjacent beaches outside the project area. Reports in which nesting information for the fill area alone could not be identified were not utilized.

Nest success equaled the proportion of nests per number of emergences; hatch success equaled the proportion of hatched eggs per total clutch. Nest inventories were conducted after hatchlings had emerged from the nest or, if there were no signs of hatchling emergence, after day 70. The numbers of hatched eggs, unhatched eggs, live pipped egg and live and dead hatchlings were counted. Sand compaction, as inferred by shear resistance, was monitored by sampling with a cone penetrometer pushed into the sand at various locations throughout the project area. Results were submitted for three separate layers of the beach fill, 0 to 6", 6 to 12", and 12 to 18", in values of kilograms per square centimeter or pounds per square inch (psi). Compaction was typically provided to DEP in correspondence or an annual report format. Fill placement projects must also be surveyed for the formation of escarpments that could interfere with marine turtle nesting.

Where sufficient data were available, SAS statistical procedures, including ANOVA with multiple comparisons and Nonparametric Analysis of Variance, were utilized. All data were first tested for normality and heteroscedascity. Parametric statistics, with $p = 0.05$, were utilized for all data but those with gross departures from normality ($p < 0.01$). Compaction data are discussed but not analyzed statistically due to the large variability reported for individual beaches and the fact that the upper limits of shear resistance could not be reliably assessed with the cone penetrometer. Escarpment data were not analyzed statistically because scarps, although reported, were not quantified sufficiently over spatial or temporal dimensions to allow for relevant comparisons to be made.

Analysis of nest success was complicated by discrepancies in data collection and reporting for different projects. For example, only 4 projects had nesting information for the year preceding fill placement and the first and second nesting seasons subsequent to fill placement. These data were treated separately for analysis of nesting patterns after fill placement. To increase sample size, data from different projects were pooled for assessment of nest and hatch success. Construction activity on the beach during nesting season could also reduce nest success rates independent of substrate suitability. Therefore, nesting information from projects where nourishment occurred during the nesting season were omitted from certain analyses as noted.

RESULTS

A total of 27 projects was reviewed for information on marine turtle nesting, compaction, and escarpment formation (Table 1). Approximately 88% of these projects involved beach restoration or nourishment, and 11 % were maintenance dredging projects. Nineteen projects involved hydraulic fill placement; four involved truck-hauled material from upland sand sources; and two were sand by-pass projects. Fill placement occurred outside the project site nesting season (66%), during the main portion of the nesting season (18%) and the early and late nesting season (14%). Tilling was reported for 60% of the projects There was an insufficient number of projects with different fill placement methods to test for the effect of this factor on marine turtle nesting parameters. For two of the truck haul projects, the fill material had disappeared by the year following placement.

Table 1. Summary of Project Beaches and Marine Turtle Nesting Data

Project	Date	Nest Success			Hatch Success		
		NS-1	NS+ 1	NS+ 2	NS-1	NS+ 1	NS+ 2
Amelia Island	1994	--	*	--	--	X	--
Anna Maria Island	1993	--	--	--	X	X	--
Bonita Beach	1995	X	X	--	X	X	X
Cape Canaveral	1995	--	X	X	--	X	X
Captiva Island	1996	--	X	X	--	X	X
Cocoa Beach	1996	--	X	--	--	--	--
Delray Beach	1987	--	--	--	--	--	--
Ft. Myers	1996	X	X	--	--	X	--
Gulf Pines	1996	--	X	X	--	X	X
Hutchinson Island	1996	X	X	X	X	X	--
Indian Shores	1993	*	*	*	--	X	X
Knight Island	1994	X	X	X	--	X	X
Longboat Key	1993	*	*	*	--	X	X
Jupiter Island	1995	--	X	--	--	X	--
Marco Island	1991	X	X	X	X	X	X
	1995	--	--	--	--	--	--
	1996	--	--	--	--	--	--
Midtown Beach	1996	--	--	--	--	--	--
Naples	1996	X	X	--	--	X	X
Parkshore Beach	1996	X	X	--	X	X	X
Sanibel	1996	--	X	X	--	X	X
St. Lucie Inlet	1986	--	--	--	--	--	--
Sebastian Inlet	1990	--	X	X	--	X	X
	1993	--	--	--	--	--	--
Vanderbilt Beach	1996	X	X	--	X	X	X
Venice Beach I	1994	X	X	X	X	X	X
Venice Beach II	1996	X	X	--	X	X	--

X = Used in analysis indicated by column heading
-- = Data unavailable or not utilized in analysis
* = Data not utilized due to fill placement during nesting season
NS = Nesting Season

NEST SUCCESS

Prior to fill placement, marine turtle nest success averaged 41.3% (± 4.15 standard error) for the 10 projects with nest survey information for the preceding nesting season. Nest success after fill placement averaged 30.9% (± 2.08 se) for 15 of 17 projects with post-construction survey data. This decrease in nest success occurred for 8 out of the 10 projects with information on nesting success the nesting season before fill placement. By the second nesting season after fill placement, pooled sample nest success increased to 44% (± 5.79 s.e.; n=9).

Statistical analyses were conducted for those projects with nesting information for all three years (n = 4) and for pooled data. Pooled data included all projects with nesting information before and after fill placement; projects with fill placement activities during the nesting season were excluded from the analysis due to the potential for interference with nest success due to project construction. Analyses of pooled data confirmed a significant effect of time on nest success ($p = 0.01$, $F_{2,35} = 5.06$, ANOVA). Nest success the nesting season following fill placement was significantly less than the previous year. By the second nesting season post- nourishment, nest success increased as noted above and was not significantly different from nest success the year prior to fill placement. Analysis of four projects with complete data sets also documented a significant effect of time on nest success ($p=0.04$, $F_{2,11} = 4.72$, ANOVA), as nest success declined from 51.2% (± 0.75 se) to 26.2% (± 3.19 se) following fill placement. Nest success for these projects increased to only 32.7% (± 9.8 se) the second year after fill placement.

HATCH SUCCESS

Preliminary analysis of hatch success for *in-situ* nests was conducted for 20 projects; nests lost to erosion were not included. Eight projects reported hatch success information for the nesting season preceding fill placement. Twenty projects included hatch success information for the nesting season following fill placement, and twelve projects included information for the second nesting season following fill placement.

Hatch success for pooled data declined subsequent to fill placement for three projects, and was less than 50% following fill placement for 6 projects. However, this decline in hatch success was not statistically significant ($p = 0.86$, $F = 0.15$, Nonparametric Analysis of Variance). Hatch success on project beaches prior to fill placement averaged 66% (± 8.85 se, n = 8). Hatch success following fill placement averaged 72% (± 4.4 se, n = 20) for the first and second year post-fill placement (70% ± 4.24 se, n = 13).

CONCLUSIONS

Placement of fill material during beach restoration impacts nesting marine turtles on all segments of Florida's coastline. Marine turtle nest success declined on beaches the nesting season following fill placement. Although hatch success for those nests that were deposited and did not wash away did not appear to decline, overall hatchling production could be reduced due to loss of nests as the construction profile of the fill project adjusts to the design profile and to a decrease in nesting success. Additional review is needed to determine if a decrease in hatchling production on restored beaches contributes to a decline in regional hatchling production.

We were not able to reach significant conclusions about the shear resistance of beaches subjected to sand placement; however, high cone penetrometer readings and escarpments were reported from many sites. Alternative methods should be investigated for assessing compaction and substrate suitability for nesting turtles on beach fill sites. Tilling should continue for a minimum of three years on all sites that receive fill.

REPORT ON THE KILLING OF *DERMOCHELYS CORIACEA* IN LAGUNA DE LA RESTINGA NATIONAL PARK, MARGARITA ISLAND, VENEZUELA

A. Trujillo[1], G. Hernández[2], E. Ruiz[3], and J. Díaz[3]
[1] PROVITA, Apdo. Postal 47.552, Caracas 1041-A, Venezuela, Telefax: (5895) 93707, provita2@telcel.net.ve
[2] Ministerio del Ambiente y de los Recursos Naturales Renovables, La Asunción, Isla de Margarita, Venezuela, Telf: (5895) 420382, Fax: (5895) 420895
[3] Escuela de Ciencias Aplicadas del Mar, Universidad de Oriente, Apdo. Postal 147, Isla de Margarita, Venezuela, Telefax: (5895) 93445

The largest protected area on the Island of Margarita is Laguna de La Restinga National Park (10° 50' N, 64° 17' W), which has an area of 18,862 ha. The park is noted for its complicated system of lagoons and sublagoons. In the north it is separated from the Caribbean Sea by a sand bar, or "restinga", 21 km long. There have been occasional reports of sea turtles nesting on this sand bar (Gómez *et al.*, 1996). In October 1997, we found a "cardón" (*Dermochelys coriacea*) skull (13 cm wide), as well as a juvenile of the same species in an advanced stage of decay.

On April 28th 1996, after receiving a report from tourists, we went to La Restinga where we found a mature cardón at the most western part of the sand bar. It was in stage of advanced decomposition, so only three morphometric measures were taken: curved carapace length = 157 cm; total length = 170 cm; curved carapace width = 112 cm. A piece of rope was tied to the right front limb. Apparently the turtle was captured after nesting, when it was trying to return to the sea and it was tied to an enormous rock. About 19 m away from the turtle, and 10 m from the beach vegetation, we found a nest that had been dug out, with 30 egg shells strewn around. This is the third documented report of *D. coriacea* from this beach. Apparently neither turtle meat nor eggs had been eaten, indicating that the people involved were not from the area, and it is unclear why the animal had been tied up, or the eggs dug out. The fact that turtles are killed in the Laguna de La Restinga National Park shows that the park authorities lack effective means of protection.

ACKNOWLEDGMENTS

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SEA TURTLE NESTING AND HATCHING SUCCESS AT MACHALILLA NATIONAL PARK, ECUADOR

Andrés Vallejo E and Felipe Campos Y.
Centro de Datos para la Conservación, P.O.Box 17-11-6025, Quito - Ecuador. avallejo@uio.satnet.net

From August 1996 to June 1997, the CDC carried out a study concerning sea turtle nesting and hatching success in beaches at Machalilla National Park, at the Ecuadorian coast. Nesting species registered were *Chelonia mydas* agassizi and *Eretmochelys imbricata*. It is expected that *Dermochelys coriacea* also does nest in the area. The most important nesting beaches were Playa Dorada and La Playita. During the winter (December, January and February) was registered the highest nesting activity, but the single month in which more nests were found was August. This could be an usual trend, or on the contrary, be an odd year. About half of the nests found hatched with success, while the rest were destroyed, spoiled or have an unknown fate. No relation was found between level of domestic animals and human presence at the beaches, and the nesting relative frequency on them.

MONITORING OF MARINE TURTLE NESTING IN ISLAHOLBOX, QUINTANA ROO, MEXICO, 1997 SEASON

José Alfredo Villegas Barrutieta
Pronatura Península de Yucatán, A.C., México. pronatyuc@laneta.apc.org

Holbox Island is located north of the Yucatan Peninsula in the State of Quintana Roo, between parallels 21° 30' and 21° 37' North and meridians 87°24' and 87°03' East. It stretches 36 kilometers in length from East to West (Galicia and Garza, 1989); and is bordered on the north and west by the Gulf of Mexico and on the east by the Caribbean Sea and the Yalahau Lagoon. The eastern point of the island is separated from Cape Catoche by the Boca de Santa Paula.

According to monitoring carried out over the past eight years, it can be stated that Holbox is the only beach in the state with over 200 nests per season spread over 24 kilometers. This makes it the most significant nesting area in the State of Quintana Roo. Cape Catoche also lies adjacent to this beach (approximately 6 km). According to the annual prospective patrols it is estimated that at least one quarter of the total number of nests can be located here, as well as in past years being the area with the largest number of shells found.

METHODS

Nightly patrols were made of the nesting beach. The presence of beach patrols also varied according to nesting activity, and occurred from 8:00 p.m. to 11:00 a.m. In some occasions, only one run was made from Mosquito Point to Sta. Paula, where the inspectors then waited for dawn before returning to the town. Nightly inspections were scheduled to try to coincide with females' nesting activities so they could be marked (during or shortly after laying). Three shell curvature measures (described by Pritchard *et al*, 1983) were taken using a tailor's tape measure. The majority of turtles were marked in the first or second scale of the front right fin. Metal markers were also attached with the series BA101 to BA200, as well as two markers with the AM series from 1996. After the data was recorded, inspectors waited until the females returned to the sea after laying.

The nests left to incubate *in situ* were staked out with 60 cm. stakes numbered progressively. The stakes were placed no further than two meters from the nest, and the majority were placed just a few centimeters away to facilitate nest location after emergence. Locations were recorded in the field notes according to kilometer and zone ecology, using four zones as reference:

Zone A (area close to the sea): Beginning at wave break point to the high-tide line, marked by an accumulation of seaweed. **Zone B-1** (medium inland area): the bottom half of the middle area corresponding to the entire area from the seaweed line to the beginning of bushy vegetation. **BS Zone** (medium high zone): Top half of the middle area corresponding to the area from the seaweed line to the beginning of bushy vegetation, which may or may not include the dune. **Zone C** (vegetation and dune): From the beginning of bushy vegetation inland, over the dune and toward heavier vegetation.

Nests found close to tide level and likely to be flooded were relocated close to the dune, and the new position recorded. Some nests considered in danger of depredation by raccoons were also relocated. The time limit for relocation was maximum six hours after laying.

After the hatchlings had emerged, the distance from the nest to maximum tide level (NMM for its initials in Spanish) was measured. This measurement began at the last print visible in the seaweed accumulated by the high tide. After 58 days of incubation, nests due to hatch were inspected visually each morning. Contents were analyzed during the morning inspections once the hatchlings had left the egg chamber. Nest size was calculated by adding the number of shells, rotten eggs, eggs with no apparent embryonic development, and eggs with dead embryos. The number of live and dead hatchlings on the surface, number of live and dead hatchlings in the nest, and number of live and dead hatching were also noted. These last were live and dead hatchlings found breaking or coming out of the shells in the nest. Any hatchlings found still inside the nest were liberated at this time.

Any unrecorded nests found with emerged hatchlings were analyzed, classified as an unstaked nest, their contents analyzed, and then correspondingly staked out. Any nests that could not be confirmed as having eggs were recorded as unconfirmed nests, and inspectors awaited emergence of hatchlings as confirmation.

RESULTS AND DISCUSSION

Hawksbill Turtle

Activities in the nesting beach took place from May 9 to October 12, 1997. The nesting season began in early April and lasted until October, reaching its maximum density in June with 101 nests. We worked 24 kilometers of beach, from Punta Mosquito to Sta. Paula, performing nocturnal and morning patrols. Forty nesting females of the Hawksbill turtle (*Eretmochelys imbricata)*, were marked. The number of turtles captured during nesting has increased each season. This year a major effort was made with only one vehicle. As a result, it was calculated that 39.2% of the total females were marked, representing an increase of 13% in relation to last year. The timely arrival of markers contributed to this significantly. 306 *in situ* nests were registered; of which 8.3% were affected by raccoons, 2.6% were looted by humans, and 2% were affected by flooding and high tides.

The nesting density for this season diminished 21% in relation to last year. At the moment there is no explanation of this decrease in nesting. However, this decrease bears no relation to the losses suffered this season to robbery (2.6%) since in spite of inspections beginning in May, a large number of nests were not recorded at the beginning of the season. On the other hand, this decrease is proportionally similar to decreases recorded in other Hawksbill turtle nesting camps on the peninsula. Only 7.2% of losses were recorded due to depredation by raccoons. These predators continue to present only a partial threat, since in some nests they eat only hatchlings that have left the egg chamber and are trying to reach the sea. However, it has not been possible to estimate how many survived this threat. Of the 14 nests we relocated, three (1.1%) were affected by raccoons.

The average hatch success and emerge success is shown in Table 1. Hatch and emerge percentages of *in situ* nests have remained constant each season. We should clarify here that the emerge percentages obtained may not reflect the amount of hatchlings actually liberated, considering that during the inspection of the nests, all hatchlings found live are liberated, but are not included in the emerge percentage. In this case, an additional 523 hatchlings were liberated.

Table 1. Fecundity, hatchling and emerged percentage and incubation period of in situ, relocated in the beach and relocated at corral nests of hawksbill turtle (Eretmochelys imbricata) in Isla Holbox, season 1997.

Nests *in situ*	n	Avarage	Std Des	Maximum	Minimum
Fecundity	242	133.9	19.6	179	81
Hatchling (%)	242	91.2	11.8	100	26
Emerged (%)	242	85.5	19.6	100	0
Incubation period	155	63.5	3.74	73	55
Nests relocated beach					
Fecundity	11	136	27.7	165	86
Hatchling (%)	11	71.8	17.8	98.1	48.5
Emerged (%)	11	63.2	25.1	96.2	38.8
Incubation period	7	58	2.3	62	55

Of the 33,746 eggs contained in 243 nests, we calculated that 29,502 hatchlings emerged. This season, beach patrols were not made to Cape Catoche, due to the fact that an entrance was dredged for the river from Sta. Paula to the sea.

Table 2. Fecundity, hatchling and emerged percentage and incubation period of in situ nests of green turtle (Chelonia mydas) in Isla Holbox, season 1997.

Nests *in situ*	n	Avarage	Std Des	Maximum	Minimum
Fecundity	10	113.3	39.8	175	40
Hatchling (%)	10	81.6	19.4	100	46.8
Emerged (%)	10	64.76	38.6	98.0	0
Incubation period	6	64.8	1.33	66	63

This year only one dead adult Hawksbill turtle was observed on the nesting beach, in comparison with last year when three were found. It still has not been determined if the turtle deaths are caused by the use of shark nets.

Green Turtle

Three green turtle nesting females of the (*Chelonia mydas)* were registered, as well as 15 nests *in situ* and one relocated. In spite of a low registered number of nests for this specie, a nest content analysis was performed in ten of them when patrolling was extended in mid-Octobe. It is probable that there was nesting by this specie after this date, although sporadic. The hatch and emerge percentages are presented in Table 2. Their presence close to the beach has been recorded by comments from fishermen, who state that they have observed numerous green turtles in the area of Cape Catoche, principally during the mating season when the so-called "encaramados", or male-female copulation, is observed. In ten of the first nests we calculated 1133 eggs, of which 932 hatchlings were liberated. No dead members of this specie were found on the beach.

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A FIFTEEN YEAR REVIEW OF COLD-STUNNED SEA TURTLES IN NEW YORK WATERS

Eileen Gerle[1], Robert DiGiovanni[2], and Robert P. Pisciotta, D.V.M.[3]
[1]Suffolk County Cornell Cooperative Extension Marine Program, 3690 Cedar Beach Road, Southold, New York, 11971, U.S.A. egerle@cce.cornell.edu
[2]Riverhead Foundation for Marine Research and Preservation, 431 East Main Street, Riverhead, New York, 11901, U.S.A.
[3]North Fork Animal Hospital, 58605 Route 25, Southold, New York, U.S.A.

Cold-stunned sea turtle data were reviewed for the period 1982-1997 to evaluate location and number of strandings per season, species composition, sex, straight line carapace length (SCL), and percent mortality. Advances in treatment protocol, meteorological data, and sea surface temperatures were also reviewed. Data were assessed for trends or changes as compared to the published literature.

INTRODUCTION

New York's coastal waters provide juvenile habitat for loggerheads (*Caretta caretta*), Kemp's ridleys (*Lepidochelys kempii*), and green turtles (*Chelonia mydas*), whereas leatherbacks (*Dermochelys coriacea*) frequent offshore waters (Morreale and Standora 1993). Based on stranding data obtained during the study period, these species account for 36.2%, 33.6%, 3.8% and 26.3% of marine turtles in the area, respectively. Risks to sea turtles at this latitude include hypothermia, boat collisions, entanglement in fishing gear, and ingestion of marine debris. Sea turtle salvage data for the New York Bight reveal that hypothermia is the leading cause of strandings and mortalities of marine turtles, impacting 36.2% of all turtles that beach here (Gerle and DiGiovanni, 1998).

MATERIALS AND METHODS

The New York State Marine Mammal and Sea Turtle Stranding Program maintains data on all marine turtles stranded in the area. Live turtles receive complete physical exams and, as condition permits, dead turtles are necropsied to determine gender and cause of death. Species, date, location and cause of stranding, SCL, width, plastron length, weight, sex and condition of turtles are recorded. Recovery of hypothermic turtles is facilitated through a volunteer beach patrol network established in 1986.

Revised treatment protocol, as described by Pisciotta *et al.* (1996), has been initiated. Class III and IV animals, turtles exhibiting little or no response to external stimuli (Sadove *et al.*, in review), now receive drug therapy which includes the administration of Dopram to stimulate respiration, and epinephrine, atropine and calcium gluconate to stimulate cardiac response. All classes of turtles are warmed more aggressively than in the past, using warm enemas and heat blankets in combination with the standard use of heat lamps to raise the body temperature an average rate of 2.5oC every 15 minutes. Class III and IV animals also receive warm IV fluids. In addition, non-responsive turtles are intubated and checked for a heartbeat using a Doppler Monitor before treatment is discontinued.

RESULTS

Since 1980, the New York State Stranding Program has recovered 809 turtles. As of 1982, 293 turtles stranded due to hypothermia, of which 3 stranded cold-stunned a second time following rehabilitation and release. Thus 290 individual turtles have stranded cold-stunned to date. Of these, 83 (29%) were *C. caretta*, 190 (66%) were *L. kempi*, and 17 (6%) were *C. mydas* (Figure 1). Gender was determined for 145 turtles; 72% were female, 28% male.

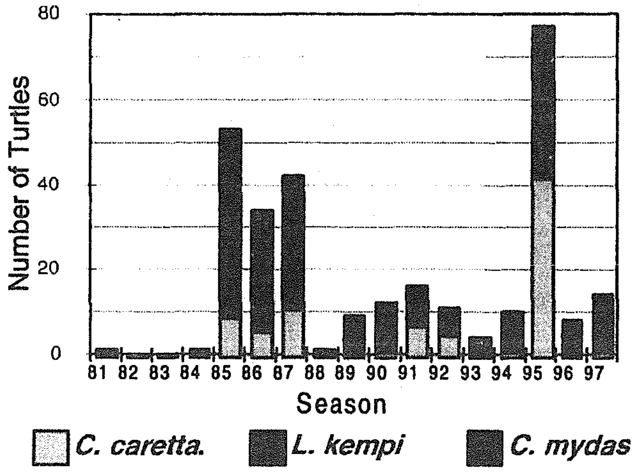

Figure 1. Species by season

The largest numbers of turtles were recovered during the 1985/86, 86/87, 87/88 and 95/96 seasons, which yielded 53, 34, 42 and 77 turtles respectively (Figure 1). These totals are all well above the trimmed mean of 13 turtles per season. We have defined the cold-stunning season as extending from 1 November through 30 April, however, 89% of all hypothermic turtles were recovered between 21 November and 30 December, with a peak between 1 December and 20 December.

Hypothermic turtles ranged greatly in size. The mean SCL for *L. kempii* was 29.66 cm (range = 22.1 - 40.3 cm; SD = 3.5), for *C. caretta*, 47.96 cm (33.1 - 61.6 cm; SD = 5.9), and for *C. mydas*, 31.56 cm (24.9 - 40.1 cm; SD = 4.5).

Cold-stunned turtles tend to strand on north facing beaches along the eastern bays of Long Island and Long Island Sound. The largest concentration of strandings occurs on the easternmost north shore (Figure 2). Sea surface tem-

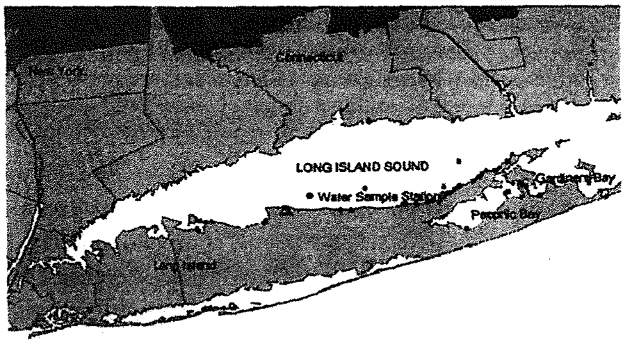

Figure 2

curs on the easternmost north shore (Figure 2). Sea surface temperature data for this area is patchy (CTDEP, 1997), as seen in Table 1. However, with one exception, the 1994/95 season, temperatures during the peak period were <10°C. This finding concurs with those of Morreale *et al.* (1992).

Of the 293 cold-stunned strandings, 198 turtles stranded dead, 95 stranded alive, and 54 (56.8%) survived due to rehabilitation efforts. Mortalities totaled 239 or 81.6% of all hypothermic strandings. Kemp's ridleys suffered the highest incidence of mortality, as 83.9% were recovered dead or subsequently expired, whereas loggerheads exhibited 78.3% mortality and green turtles, 70.6%.

Table 1. Sea surface temperatures obtained from a monitoring station in Long Island Sound. See Figure 2 for location. Shading denotes peak period.

SEA SURFACE TEMPERATURES(°C)								
SEASON	Nov. 1-10	Nov. 11-20	Nov. 21-30	Dec. 1-10	Dec. 11-20	Dec. 21-30	Dec. 31-Jan. 9	Jan. 10-19
1991/92	-	12.6	-	-	-	-	5.3	-
1992/93	14.1	-	-	-	8.5	-	-	4.4
1993/94	14.4	-	-	-	8.8	-	-	2.8
1994/95	15.0	-	-	10.5	-	-	4.7	-
1995/96	-	-	-	9.1	-	-	-	1.5
1996/97	14.4	-	-	9.5	-	-	-	-

DISCUSSION

Morreale *et al.* (1992) published a study of cold-stunned turtles for the years 1985-1987. A comparison with this study shows similar findings with regard to mean SCL, gender and mortality rate (Table 2). Both studies reveal that ridleys succumbed to hypothermia most frequently, however, loggerheads and green turtles accounted for a larger proportion of turtles over the 15 year study.

The slight, recent decline in mortality rate may be the result of the initiation of advanced treatments which have resulted in an increased survival rate of Class III and IV turtles. Prior to the use of these treatments, no Class IV animals had ever been revived.

The concentration of strandings on eastern Long Island Sound beaches may be attributed to the tendency for surface currents in that area to travel in an east to west direction in the fall and winter (Schmalz *et al.*, 1994), a phenomenon that would tend to trap floating, torpid turtles within the Sound. Thus hypothermic turtles encountered in New York waters may be part of a population of animals that summer within Long Island Sound. The possibility also exists that turtles emigrating from New England waters may be swept into the eastern portion of the Sound and strand on New York shores (S. Morreale, pers. comm.). With one exception, turtles tagged and released within the Peconic Bay System were not included in the specimens that stranded cold-stunned in this area.

CONCLUSION

As the trends established by Morreale *et al.* (1992) remain constant to date, species composition, size class, male/female ratio, and peak period and location of strandings can be anticipated for any given year. Yet, it is not known if turtles stranding cold-stunned on New York shores are a subset of the population that summers here, or are of a transient population. Also, why do some turtles remain in the Northeast and succumb to hypothermia? Further work is needed to answer these questions and to continue refining medical treatments to increase survivability of Class III and IV animals.

ACKNOWLEDGMENTS

Table 2. A comparison of the present study with the study by Morreale et al.,(1992) for the years 1985-1987.

	PARAMETER ASSESSED								
STUDY	Species Composition			Gender		Mean SCL (cm) Lk Cc Cm	Mortality Rate	Peak Period
	Lk	Cc	Cm	Male	Female			
Morreale et al.(1992)	74%	22%	4%	29%	71%	29.4 49.3 32.7	82.3%	21 Nov. - 30 Dec.
present study	66%	29%	6%	28%	72%	29.66 47.96 31.56	81.6%	21 Nov. - 30 Dec.

biologists, too numerous to list here, who have collected data, and the beach patrol volunteers, local citizens and police officers who aided in the recovery of turtles. Thanks also to the New York State Department of Environmental Conservation "Return a Gift to Wildlife" Program, which helps fund the stranding program.

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PATTERNS OF EMERGENCE OF HATCHLING LOGGERHEAD AND GREEN TURTLES IN NORTHERN CYPRUS, EASTERN MEDITERRANEAN.

Fiona Glen[1], Brendan J. Godley[1], Annette C. Broderick[1], and Robert W. Furness[2]
[1] Marine Turtle Research Group, 2Ornithology Group
[1 and 2]Division of Environmental and Evolutionary Biology, Graham Kerr Building, University of Glasgow, G12 8QQ, U.K.
A.Broderick@bio.gla.ac.uk

INTRODUCTION

Emergence of marine turtle hatchlings occurs mainly at night for both *C. caretta* and *C. mydas*, (Bustard 1967, Gyuris 1993, Hays *et al.*,1992, Hendrickson 1958, Mrosovsky 1968, Witherington *et al.*,1990), although diurnal emergence has been reported for both species (Bustard 1967, Mrosovsky 1968, Witherington *et al.*,1990). Previous studies have related emergence of *C. mydas* and *C. caretta* hatchlings to temperature through the sand column, proposing that emergence of hatchlings is triggered by a negative temperature gradient occurring at sand depths shallower than 15cm (Hays *et al.*, 1992). The aim of this project was to study the temporal emergence patterns of *C. mydas* and *C. caretta* hatchlings on Alagadi, a beach on the north coast of Cyprus and to compare the patterns observed to relevant temperature cues. Variation in hatchling phenotype among nights of emergence was also studied.

METHODOLOGY

The temporal emergence patterns of *C. caretta* and *C. mydas* hatchlings were recorded from July until September, 1997. Upon emergence from the nest, hatchlings were caught using a wire cage placed around each nest. Time of emergence was noted upon complete emergence of each hatchling. Weight, straight carapace length, straight carapace width and transit time (time taken to cross a one metre circle) were noted for every hatchling observed. Sand temperature at depths 10, 15, 20, 25, 30 and 35cm were recorded throughout the hatching season in order to give the range of absolute temperatures at each depth through the sand column. Using the absolute temperatures obtained, a Dt gradient through the sand column was calculated by subtracting the temperatures recorded at shallower depths from those deeper. Nests were excavated 48 hours after the last emergent hatchling was observed. For full details of methodology refer to Glen (1998).

RESULTS

Temporal pattern of hatchling emergence.

Both species were observed to emerge at night (*C. caretta*: n=24 nests; *C. mydas* n=12 nests) while a portion of *C. mydas* hatchlings emerged during the day from some *C. mydas* nests (n=6 nests) (figures 5 and 6). Of the 24 *C. caretta* nests, 54% completed hatching on night 1 (figure 1). *C. mydas* hatchlings were observed to emerge from their nests over a period of 1 to 5 nights (n=12 nests) with 23% of nests completed hatching by night 1 (figure 2). In both species, 80% of hatchlings had emerged by night 1 (figure 3 and 4). Peak

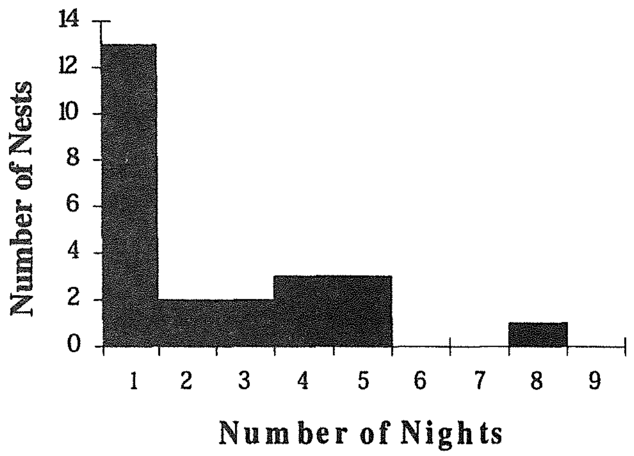

Figure 1: The number of nights over which C. mydas nests hatched.

emergence of *C. caretta* occurred between 02:00 and 03:29 when 47% of the hatchlings emerged. Emergence of *C. mydas* reached its highest (33% emerged) between 03:30 until 04:59. A Kruskal-Wallis test revealed that there was no significant difference in either *C. caretta* (H= 7.23) and *C. mydas* (H=6.27) emergence times among nights 1 to 4 ($p>0.05$).

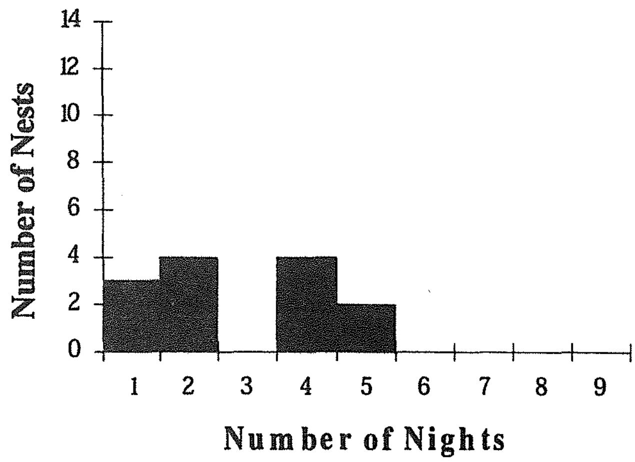

Figure 2: The number of nights over which C. caretta nests hatched.

EFFECTS OF SAND TEMPERATURE ON THE EMERGENCE PATTERNS OF *C. CARETTA* AND *C. MYDAS* HATCHLINGS.

As can be seen in figure 7, all *C. caretta* hatchlings emerged when a negative gradient existed at Dt10-15, this

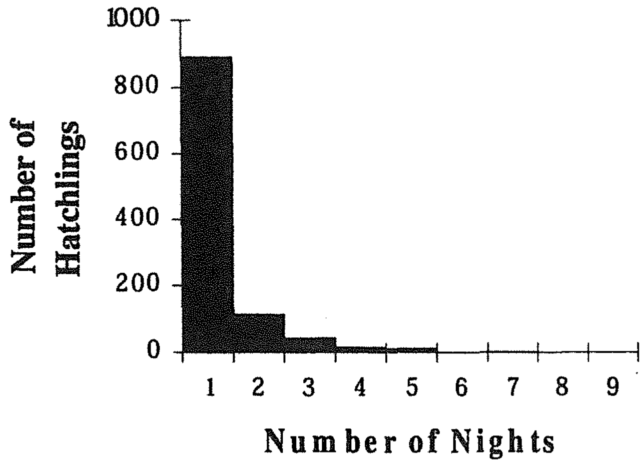

Figure 3: The total number of C. caretta hatchlings that emerged on each night.

also occurred at Dt15-20. The probability (absolute probability test) of this occurring by chance was $p<0.001$ in both cases. This suggests that the existence of a negative gradient at these depths may be the factor which initiates emergence. However, further down the sand column at depths greater than 20cm the probability of hatchlings emerging during a negative gradient present at these depths was not significant ($p > 0.05$). The emergence of *C. mydas* hatchlings appeared to be biased towards times when a negative gradient was present (figure 8), however a proportion emerged during times when the positive gradient existed.

VARIATION IN MORPHOLOGY AND VITALITY OF SIBLINGS ON DIFFERENT NIGHTS OF EMERGENCE.

Statistical tests were carried out on measurements obtained from *C. caretta* and *C. mydas* hatchlings to investigate whether there were any significant differences in width, length, weight and transit time among different nights of emergence (ANOVA, t-tests and paired t-tests). No significant difference in the morphology and vitality of *C. caretta* and

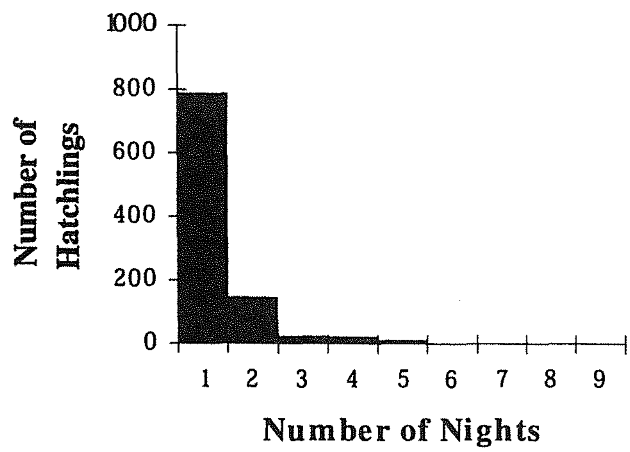

Figure 4: The total number of C. mydas hatchlings hatchlings that emerged on each night.

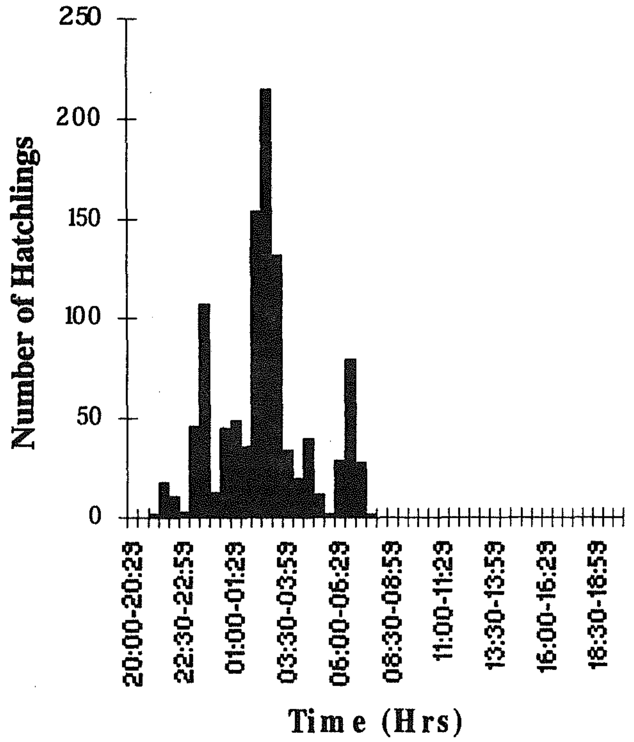

Figure 5: Emergence times of C. caretta.

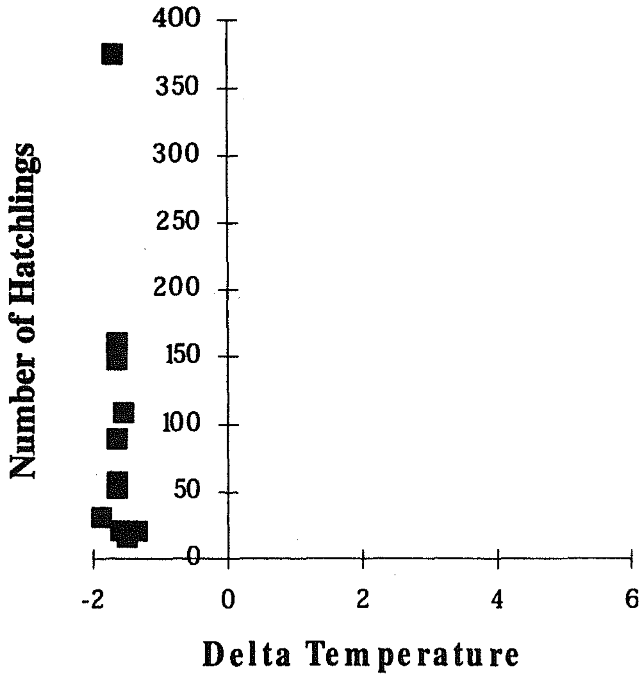

Figure 7: The number of emerging C. caretta hatchlings related to Δτ10-15.

C. mydas hatchlings that emerged from the nest on different nights was found.

DISCUSSION

Over 80% of both *C. caretta* and *C. mydas* hatchlings emerged on the first night that the nest hatched, which has interesting conservation implications. Results obtained by this study suggest that hatchling emergence by *C. caretta* is influenced by a negative temperature gradient through the sand column at depths less than 20cm. When subsurface sand becomes cooler than that beneath, emergence occurs. However, the relationship between the presence of a negative gradient and emergence for *C. mydas* was not demonstrated,

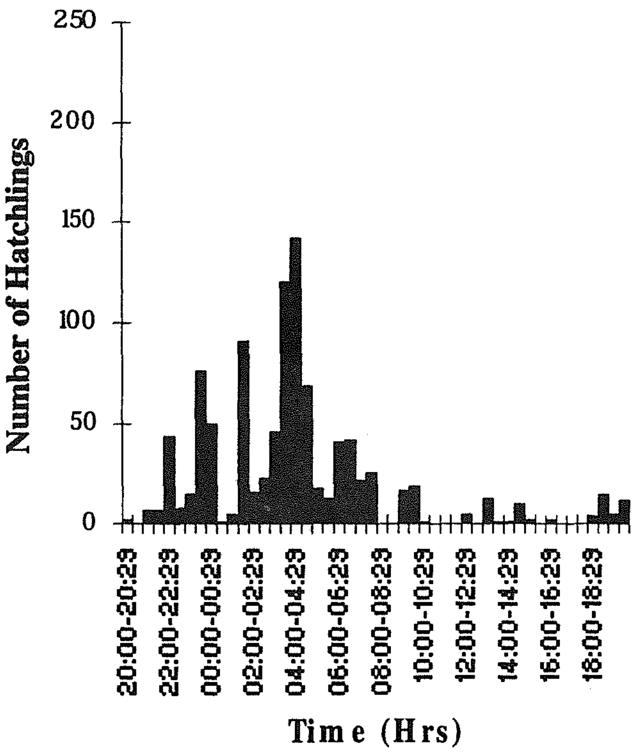

Figure 6: Emergence times of C. mydas.

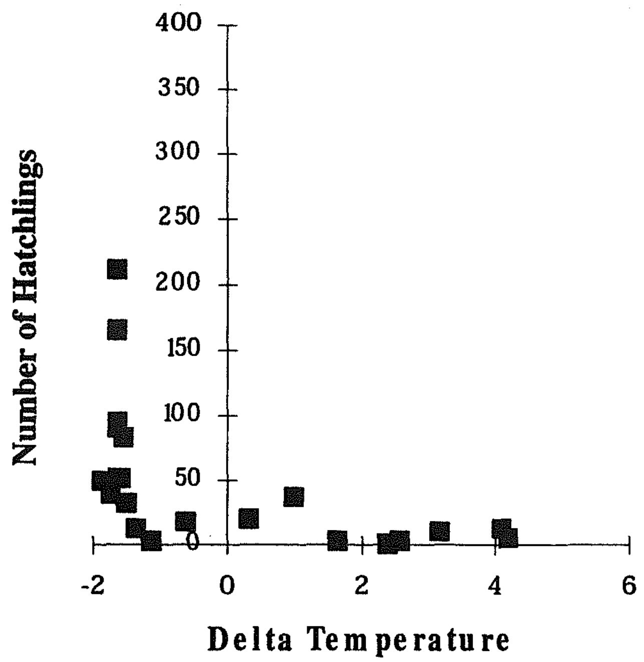

Figure 8: The number of emerging C. mydas hatchlings related to Δt10-15.

possibly due to a small sample size. No significant difference was observed in hatchling morphology or vitality on different nights of hatching.

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ENDOCRINAL INSIGHTS INTO THE MALE MATING SYSTEM OF THE GREEN TURTLE, *CHELONIA MYDAS*

Tim S. Jessop[1,3] and Colin J. Limpus[2]
[1]Department of Zoology, University of Queensland, Brisbane, Q4072, Australia. Tjessop@zoology.uq.edu.au
[2]Department of Environment, PO Box 155, Brisbane Q 4002, Australia
[3]Department of Anatomical Sciences, University of Queensland, Brisbane, Q4072, Australia

Steroid hormones have been empirically and theoretically linked with the expression of sexually-selected traits (behavioral, morphological and physical) in various male mating systems. Furthermore, hormones may also adaptively underlie the behavioral tactics and strategies of such mating systems. However the mechanistic role of hormones (if any), namely testosterone in modulating the potential strategies utilized by male green turtles during courtship is lacking. Utilizing hormonal and behavioral observations collected over two consecutive courtship seasons, we attempt to provide a possible framework by which phenotypic variation in testosterone may influence various mating strategies of individual male green turtles. Furthermore, we investigate the lability of testosterone (behavioral androgen responses) in individual male turtles in response to various breeding behaviors including inter-male aggression.

GROWTH AND BEHAVIOR DURING THE FIRST YEAR OF LIFE IN TWO SPECIES OF SEA TURTLES

Martha Mann[1 and 2], Roger Mellgrenl[2], Alejandro Arenas[2], and Adriana D'Amiano[2]
[1]Department of Psychology, The University of Texas at Arlington, Arlington, TX 76019, U.S.A. mann@uta.edu
[2]Acuario Xcaret, Carretera Chetumal-Pto. Juarez, km 282, Playa del Carmen, Quintana Roo, México

Relatively small numbers of hatchling turtles are kept at the aquarium at Xcaret for a year before being released into the sea. Larger numbers of hatchlings are given a "living tag" and released following a brief recovery period. The combination of the one year headstarting program and the living tag procedure has given us the opportunity to observe individual hatchlings across their first year of life. Multiple measures of physiology and behavior were made in two species of sea turtles. A summary of our findings for the first six months of the project was reported at the Seventeenth Annual Symposium on Sea Turtle Biology and Conservation (Mann, Mellgren and Arenas, 1998). Data compiled for the one year period are selectively reviewed below.

METHODS

A total of 36 green (*Chelonia mydas*) and 36 hawksbill (*Eretmochelys imbricata*) hatchlings were given living tags that identified each individual uniquely: Two of nine marginal scutes were marked allowing for identification by gross inspection of the carapace. The turtles were maintained on commercially prepared pelleted turtle chow supplemented with a gelatin consisting of pureed spinach, lettuce, cod liver and fish oil with yeast and vitamins A, D, E and B complex. At periodic intervals for the first year of development, body length and width and flipper lengths were recorded, the turtles were weighed and given a set of behavioral tests developed from our prior experiments (*e.g.*, Mellgren and Mann, 1996). Behavioral indices of physical responsiveness included: time spent struggling after being picked up by a human; latency to exhibit a righting reflex after being inverted; time spent struggling while inverted; latency to initiate feeding following the introduction of a novel food; and the latency to learn about the location and delivery of a novel food (see also Mellgren and Mann in this volume).

RESULTS

Comparative species data for the righting reflex and carapace and flipper measurements were reported previously (Mann *et al*, 1998). Behavioral tests conducted within the first month of life did not predict survivorship in either of the two species. However, it is important in future work to repeat these tests in older animals and to develop new tests that will address the biological preparedness of individual turtles over development, comparing animals during the so-called frenzy and post-frenzy intervals as well as during epipelagic and pelagic phases.

Body weight changes over 12 months for green (top panel) and over 7months for hawksbill (bottom panel) sea turtles are shown in Figure 1. Significant linear trends in weight gains were evident for both green and hawksbill turtles but growth rates between species differed significantly. Members of each species exhibited significant increases in weight at each measurement interval. By 7 months (215 and 220 days posthatch for the greens and hawksbills, respectively) green sea turtles weighed 33 times their initial body weight. By contrast, hawksbill turtles experienced only a 14 fold increase from their initial weight.

Figure 2 provides a comparison of weight gains in hawksbill turtles categorized as nonsurvivors or survivors. Nonsurvivors (n = 9) are those animals that died before 220 days posthatch (~ 7 months). Attrition among nonsurvivors was most apt to occur between 90 -142 days posthatch. Survivors (n = 19) are those that could be easily identified by their carapace marks at 220 days posthatch. The figure shows that there was no significant difference between the average body weights attained by the groups at 24 days posthatch. However, those categorized as nonsurvivors weighed significantly less than survivors at 67 and 90 days posthatch. By 67 days posthatch, nonsurvivors attained 78% of the average weight of the survivors. By 90 days posthatch, nonsurvivors' weights dropped to 68% of that of the survivors.

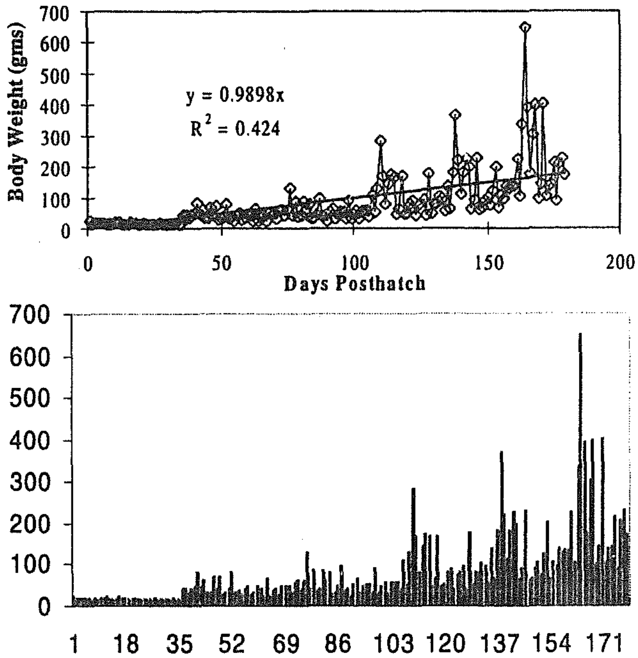

Figure 1. Weight Gains of Hawksbill Sea Turtles

DISCUSSION

Preliminary analyses suggest that behavioral markers such as the righting reflex (obtained at 3-4 week of life in this study) did not predict survivorship in green and hawksbill hatchlings. The development of other tests of biobehavioral maturation is warranted both for captive rearing situations and for relating phenotypic variation in behavior in wild populations to other estimates of age and growth rate such as skeletochronology assessments. Behavioral markers that could be used in future research include groom-

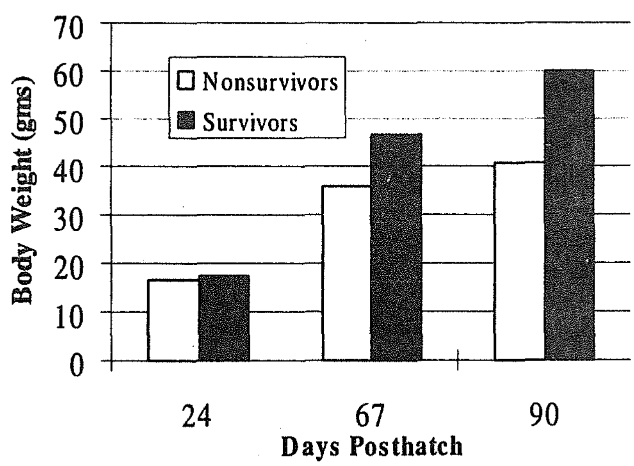

Figure 2. Weight Differences: Nonsurvivors vs Survivors

ing and play, responses that appear to change reliably with advances in chronological age (Mann and Mellgren, 1997 and unpublished observations). Burghardt (1988) predicted that if play behaviors were to occur among reptiles, well-fed sea turtles in warm oceans would be the likely species given the relative energy efficiency of their aquatic habitats and taking into account their changing energetics during early development.

Green sea turtles maintained in captivity for a year showed pronounced changes in growth and little mortality (*i.e.*, only 4 out of 36 green hatchlings failed to survive to one year). Hawksbill hatchlings that exhibited deficient weight gains at 67 and 90 days posthatch (*i.e.*, 9 out of 36) died within the next two months. Therefore, weight per se may be an important factor for survivorship of individuals of this species. We note, too, that intraspecific aggression was apt to occur in hawksbills beginning at 90 days posthatch, suggesting that this may be a behavioral variable critical to survival and perhaps of special importance when growth has been compromised. Future work will address the ontogeny of intraspecific aggression in this species with the aim of remediating rearing situations that cause injury to young turtles.

As noted by Chaloupka and Musick (1997), there have been few longitudinal studies of growth in captive reared turtles. However, such data are essential for understanding the constraints on growth when diet and environmental conditions are stable relative to those factors in the wild. Allometric analyses (*e.g.*, Reiss, 1989) may prove useful for understanding the behavior and ecology of these species. Such analyses already have been performed to understand some aspects diet selection and the foraging ecology of sea turtles and could be extended to the rehabilitation of turtles recovered from degraded foraging habitats (Bjorndal, 1997).

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DIVING, BASKING, AND FORAGING PATTERNS OF A SUB-ADULT GREEN TURTLE AT PUNALU'U, HAWAII

Marc R. Rice[1], George H. Balazs[2], Leon Hallacher[3], Walter Dudley[3], George Watson[1], Kimberly Krusell[3], and Brent Larson[3]

[1]Hawaii Preparatory Academy, 65-1692 Kohala Mt. Road, Kamuela, Hawaii 96743 U.S.A. mrice@hpa.edu

[2]National Marine Fisheries Service, Southwest Fisheries Science Center, Honolulu Laboratory, 2570 Dole Street, Honolulu, Hawaii 96822-2396 U.S.A.

[3]Marine Option Program, University of Hawaii at Hilo, 200 W. Kawili Street, Hilo, Hawaii 96720-4091 U.S.A.

INTRODUCTION

Punalu'u is a small sheltered bay on the southeast coast of the Ka'u district on the Island of Hawaii. The area is a county park and a popular tourist stop and has been a green turtle study site since 1976. Green turtles (*Chelonia mydas*) in Hawaii feed primarily on benthic algae in the rocky foraging pastures around the eight major Hawaiian Islands. The primary food source for green turtles at Punalu'u is an intertidal red alga, *Pterocladia capillacea* (Balazs *et al.*, 1994).

Green turtles are known to spend most of their time feeding or resting underwater. Foraging behavior of green turtles is well documented and in Hawaii is typically characterized by numerous short dives in shallow water (<3 m) with short surface intervals (<5 sec) (Balazs, 1980). Resting periods are characterized by longer dives (>20 min) in deeper water. The amount of time that turtles spend foraging versus resting is still largely unknown. Previous studies have observed foraging and resting behavior over relatively short periods of time (Ogden *et al.*, 1983; Brill *et al.*,1994; Balazs, 1995).In addition to feeding and resting behavior, turtles in Hawaii have been exhibiting a new behavior, terrestrial emergence (basking). Basking behavior, mainly involving adults, has been known for many years to occur in the Northwestern Hawaiian Islands (Whittow and Balazs, 1982), but was rarely observed in the main islands until recently (Balazs, 1995). The reasons for basking behavior in green turtles are unknown although several theories have been postulated (Garnett, 1984; Swimmer *et al.*, 1996). At Punalu'u, several sub-adult and juvenile turtles regularly crawl out onto the black sand beach and bask. This behavior is normally observed during the day, but lack of night-time observations makes it difficult to know the frequency of nocturnal basking. The purpose of our study was to determine the relative allocation of time given to each of the three major behaviors (diving, basking and foraging) over an extended period of time.

MATERIALS AND METHODS

Data were obtained from November 15, 1996 to July 22, 1997 from a sub-adult green turtle hand captured in shallow water using snorkeling equipment at Punalu'u, Hawaii. This turtle, hereafter known as Turtle 257, was first captured at Punalu'u in July, 1990. Turtle 257 had an apparent 7 year history of residency at Punalu'u. At the time the TDR and sonic tag were applied, the turtle measured 72.5 cm in straight carapace length and it weighed 52.5 kg.

A Wildlife Computers, Inc. MK5 time-depth recorder, and a Sonotronics, Inc. CHP-87-L sonic tag, were attached to the third lateral scute on the right side of the carapace. To set the MK5 and sonic tag in place, a two part silicon elastomer was first applied to the base of the tags which were then placed on the sanded and cleaned scute. The tags were safely and securely attached using pigmented polyester resin and fiberglass cloth. In addition, a small square of fiberglass cloth was placed high on the second lateral scute on the left side to facilitate identification during field observations.Two students from the University of Hawaii, Hilo conducted visual searches from shore and while snorkeling in the bay on 23 different days. The observations of the turtle's location, behavior and activity were noted along with the time and date. These data were later compared with the TDR data to associate certain behaviors with specific MK5 data profiles.The MK5 sampling protocol was set to record depth every minute. When the tag was out of the water, sampling was suspended and the time of emergence was recorded. Turtle 257 was electronically monitored for a total of 249 days, and data from 226 days were used in this study (days lost represent time when TDR memory was full). The data for the day after each capture/release were not used in this study as our work elsewhere indicates that capture/release changes normal behavior for approximately 24 hours. Data was downloaded in the field using the Wildlife Computers, Inc. interface hardware and a Macintosh Powerbook.

The data obtained showed a depth reading for the turtle every minute giving 1440 data points each day. If Turtle 257 left the water to bask, the total time basking was recorded. Each day's data were graphed and analyzed as to whether the depth and breath-hold profiles represented resting or foraging behavior. Diving profile characteristics were evaluated based on observations at Punalu'u and experience from other sites in Hawaii. Diving profiles were characterized as resting dives (dives to a relatively constant depth for more than 20 minutes), and foraging dives (generally short, shallow dives from 0 to 3 M). Terrestrial emergence (basking) behavior was noted as dry periods by the TDR and is represented as a negative depth (-4 meters) by the analysis software. Figure 1 shows a sample 24 hours of data with resting, foraging and basking periods indicated.

RESULTS

Resting Dives: Resting dives showed a depth range from 4 to 38.5 meters. The average depth of resting dives was 12.9 M. Dives deeper than 14 meters were uncommon and appeared to be exploratory dives. Resting dives had a mean duration of 59 minutes with a range of 20 to 117 minutes. On the average, there were 12 resting dives per day with a range of 2 to 25. Surface intervals during resting dives averaged 2.8 minutes (N=84). None of the data indicates that Turtle 257 made resting dives inside the bay, although we have occasionally observed a few animals resting on the bottom in the bay during night observations.

Terrestrial Basking:

Turtle 257 exhibited basking behavior on 64 days (82 incidences) for a total of 176 hours or 3.2% of the observed time. The average length of terrestrial basking was 130 min with a range of 7 to 945 min. Basking has normally been observed to occur during the day, but data from Turtle 257 showed that terrestrial basking does occur at night. While basking normally began during the middle of the day (median 1100 hours), there were 10 occasions when basking continued into the night for a total of 44.4 hours or 25% of the total basking time. Basking was never initiated after dark. The reason(s) turtles bask is still not understood. It is clear, however, that the behavior accounts for a significant portion of Turtle 257's behavior.

Foraging Behavior:

Dives made in shallow water for short periods of time were interpreted as foraging behavior. TDR dive profiles do not allow ready determination of dive time or surface intervals, but direct observations and data from other observers give dive times of 4 to 8 min. with a mean of 4.5 min. Foraging turtles normally take one breath between feeding bouts and are only on the surface for a matter of seconds. Numerous green turtles can commonly be found feeding in shallow water at Punalu'u during daylight hours when the tide is medium to high. *Pterocladia capillacea* is an intertidal algae and the tide must be medium to high for the turtles to access it. Often turtles were observed with their entire carapace exposed briefly as they fed in shallow water. Turtle 257 was observed feeding in very shallow water on several occasions. The foraging depth data does not allow us to determine actual feeding time and certainly includes other activities.

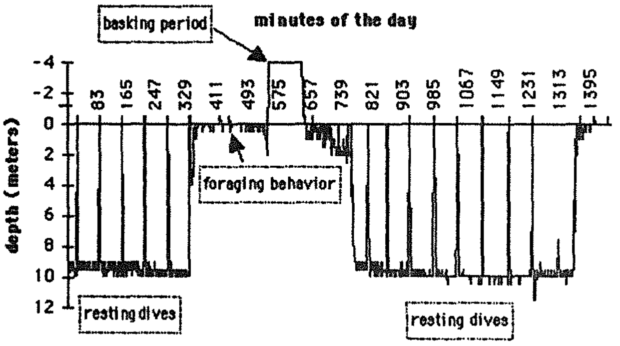

Figure 1. Sample 24 hour diving profile for Turtle 257 showing resting dives, foregin and basking behavior.

Data that fits the foraging profile show that most foraging occurs at between 0 and 2 M depth for an average of 8.9 hours/day. The range of foraging time was between 0 and 20 hours/day. The cause of this variation is unknown but could be related to weather, food availability, tides, or any of a number of factors. Before green turtles in Hawaii were fully protected in 1978, they fed nocturnally at Punalu'u. Since that time, they have begun to feed primarily during daylight hours. Seventy-two percent of foraging behavior in Turtle 257 occurred between the hours of 0600 and 1800. This is in line with observations of Punalu'u turtles in general and Turtle 257 in particular.

Although this study involved only one sub-adult green turtle, all indications are that this particular animal has exhibited a consistent behavior pattern over time. Turtle 257 has been well known by residents and scientists who regularly visit the area and has at least a 7 year residency history at Punalu'u. On the average, Turtle 257's daily behavior pattern was divided into approximately 12 hours of resting dives, 9 hours of foraging behavior, 1 hour of basking behavior and 2 hours of surface/travel time. The range of time devoted to various activities was very large. There were days when no foraging behavior was exhibited and the total time was allocated to resting dives. On other days, the foraging behavior was nearly continuous for up to 20 hours. Terrestrial basking occurred approximately every 3.5 days throughout the monitored period and averaged 130 minutes per emergence. The factors involved in promoting this variability remain to be determined. Tidal level, food availability, weather and other factors undoubtedly influence green turtle behavior.

The use of TDR's in the study of green turtle behavior has revealed significant information about their daily diving and basking patterns. Continuing work using TDR's at several locations in Hawaii will undoubtedly clarify many of the questions raised in this study.

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DIURNAL CYCLING OF CORTICOSTERONE IN A CAPTIVE POPULATION OF KEMP'S RIDLEY SEA TURTLES (*LEPIDOCHELYS KEMPII*)

Kathryn Stephenson, Patricia Vargas, David Wm. Owens
Department of Biology, Texas A&M University, College Station, TX. 77843, U.S.A. kstephenson@bio.tamu.edu

INTRODUCTION

Corticosterone (B) is produced by the adrenal cortex in response to hypothalamic secretion of corticotropin releasing hormone (CRH) and subsequent pituitary secretion of adrenocorticotropic hormone (ACTH). The role of B as a stress hormone in sea turtles and its effect on metabolism is consistent with that of other vertebrates. Corticosterone has been shown to have daily cycles in some organisms, although there is little evidence for a daily B cycle in reproductive sea turtles. Identifying daily cycles of B will help us to better understand the physiology of sea turtles and interpret B data collected for a variety of studies.

The primary objective of this study was to determine if B levels were relatively constant, or changed with time during a 24 hour period. The secondary objective was to see if any stress response was evident which may be correlated with captivity.

MATERIALS AND METHODS

Experiments were conducted from 16 July through 21 July, 1997 at the Cayman Turtle Farm on Grand Cayman Island, B.W.I. The inventory blood samples were collected during daylight hours on 7/16-18, and 7/21. The timed series was conducted from 2000 h. 7/18/97 - 2000 h. 7/20/97. Blood samples from three different animals were taken at 4 hour intervals during a 48 hour period. No animals were sampled twice. The population sampled was kept in a 6.7 m. round outdoor cement tank filled with 110 cm. of sea water. They were subject to the natural photoperiod which was approximately 14L:10D and were fed commercial Purina turtle chow three times per day (~0800, 1230, 1630). Blood was taken in lithium heparin vacutainers with 1.5" 21 gage needles inserted in the dorsal cervical sinus within 0.5-1.5 minutes of capture (Owens and Ruiz, 1980). The blood was kept on ice for 15 minutes to four hours, separated by centrifuge and stored at -4 C until later analysis. Plasma corticosterone levels were determined by tritium radioimmunoassay (Valverde, 1996) conducted at Texas A&M University. During sampling, sex was recorded (based on tail length), and individual tag numbers were used to look up farm records on each turtle. Statistical analysis of the data included multiple regression and Duncan's multiple range test using the SAS program (Figure 3).

RESULTS AND DISCUSSION

The analysis of the samples taken during the Kemps Ridley inventory produced unexpected results. Instead of corticosterone (B) levels which could be used as zero time readings and compared to the time series, we observed a mild stress response. The stress response concurred with B levels reported for Loggerheads, 500-6000pg/mL (Gregory *et al.*, 1996) and Olive Ridleys 500-7500 pg/mL (Valverde, 1996). Values of B from samples taken during the inventory ranged from 138-3957 pg/mL (Figure 1). Although it did not seem like a stressful procedure, the process of removing and replacing animals housed in the same tank did contribute to the elevation of B (Figure 4).

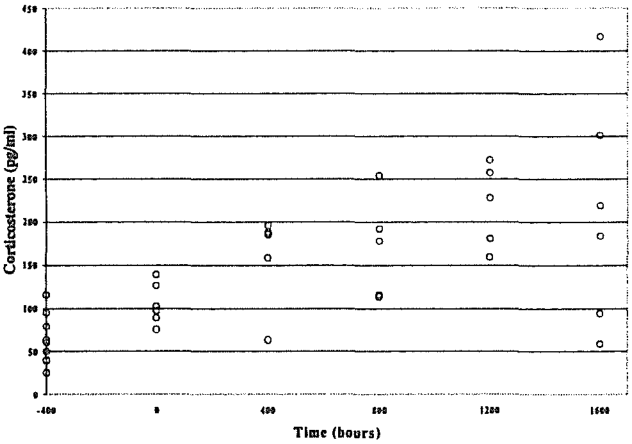

Figure 1. Time of day vs. Corticosterone (B) levels

Multiple regression on the plasma corticosterone levels from the time series experiment showed a significant change with time (p=.005). As a group, the four other variables tested (sex, age and the interactions of time*age and time*sex) did not contribute significantly to the B response (p>.2). The range of B values for the time series was 25-417 pg/mL (Figure 2). Although these are lower than many reported values indicating a stress response, it could be con-

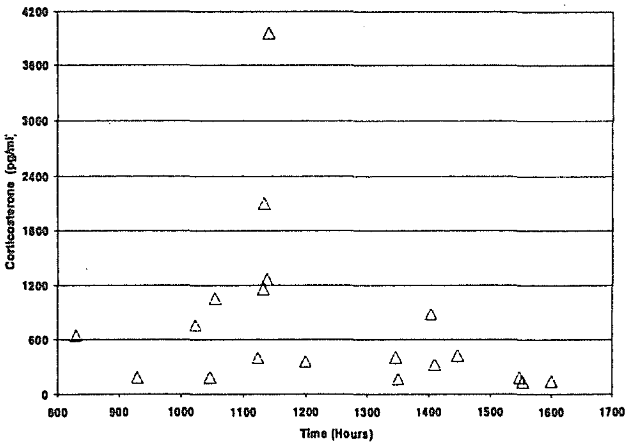

Figure 2. Corticosterone (b) levels during Kemp's Ridley inventory

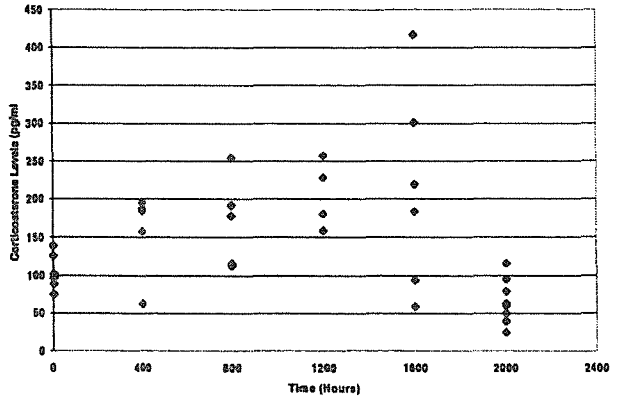

Figure 3. Corticosterone levels during timed series

fused for mild stress depending on the cut-off point chosen. This analysis accounts for only 59 % of the variability in B levels. There are several other sources of variability which need to be investigated more thoroughly. Feeding patterns and activity associated with daylight hours are two which may have the greatest impact (Figure 3). Correlation analyses for feeding times and sunrise/set were not performed for this poster.

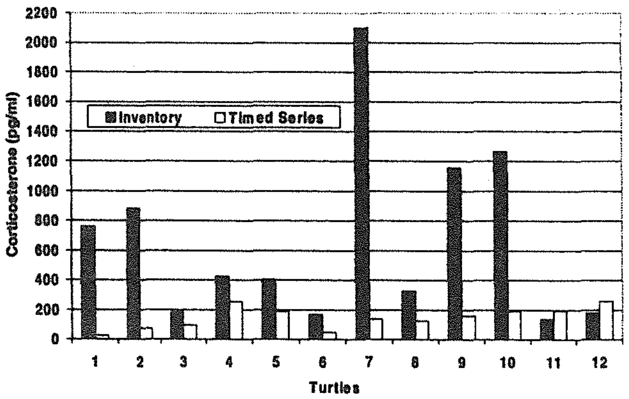

Figure 4. Comparison of Corticosterone (B) Levels During the Inventory vs. Timed Series

The implications which this study could have on experimental design are significant. A population of animals which cycle on a daily basis could inadvertently bias any corticosterone (B) levels recorded. Many experiments measure B as a stress indicator, whether or not the stress response is expected. We have shown an area of overlap between the daily peak in B, and a mild stress response observed during the inventory sampling (Figures 1 and 2). The two could be mistaken if there is no relative baseline for comparison.

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THE BIOLOGY OF BASKING IN THE GREEN TURTLE (*CHELONIA MYDAS*)

J. Yonat Swimmer[1] and George H. Balazs[2]

[1]School of Natural Resources and Environment, University of Michigan, Ann Arbor, Michigan 48109-1115 U.S.A. yswim@umich.edu

[2]National Marine Fisheries Service, Southwest Fisheries Science Center, Honolulu Laboratory, Honolulu, Hawaii 96822 2396 U.S.A.

The green turtle (*Chelonia mydas*) is the only species of marine turtle known to atmospheric bask, whereby large numbers of turtles remain hauled out on shore. Historic records indicate that basking was once a common phenomenon, yet coastal development may have reduced basking populations to only a few remote areas worldwide. Our study aims to determine physiological roles that this behavior serves. Data from both captive and wild populations of the Hawaiian green turtle indicate that basking is correlated with air and substrate temeperature, thereby indicating a role in thermoregulation. In captivity, only turtles afflicted with green turtle fibropapillomatosis (GTFP) were observed basking, suggesting a relationship between basking and disease.

Despite significantly increased body temperatures of basking turtles, metabolic rates of turtles post-basking were lower than metabolic rates of turtles post-swimming for the majority of turtles. These data suggest that basking serves as an energy-conserving mechanism. Furthermore, due to the prevalence of nesting females on basking beaches in all basking sites, this behavior likely serves a role in reproduction. The numerous physiological functions served by basking indicate the importance of this behavior in the biology of green turtles and the necessity in preserving their basking habitat.

LOGGERHEAD TURTLE RESPONSES TO AQUATIC PREDATION OFF SOUTHEAST NORTH CAROLINA, U.S.A.

Heather Miller Woodson
University of North Carolina at Wilmington, Department of Biological Sciences, Wilmington, North Carolina, U.S.A.
WoodsonH@UNCWIL.EDU

Due to the perilous status of marine turtles, a great deal of time and money has been spent worldwide to study the life history of these animals. While many facets of the life of the sea turtle have been studied extensively, still other aspects need to be researched more thoroughly. The loggerhead turtle (*Caretta carreta*) is the most common of the sea turtles on the southeastern United States and thus the easiest to study. It is on this species that I focus.

Oceanic predation is largely a mystery to researchers. Many terrestrial predators of eggs and hatchlings have been identified, including raccoons, ants, ghost crabs, foxes, coyotes, pigs, dogs, armadillos, and birds (Van Meter 1992). Incidental accounts of oceanic predation on sea turtle hatchlings are scattered through the literature (Randall 1967; Witham 1974; Frick 1976; Witzell 1981; Dodd 1988). Few studies have attempted to quantify oceanic predation or identify potential predators. Witherington and Salmon (1992) tracked 74 loggerhead hatchlings, of which five turtles were lost to unidentified oceanic predators. In a study by Gyuris (1994), 57 free swimming hatchling green turtles (*Chelonia mydas*) were followed by snorkelers. Of these, ten were lost from sight and 44 of the 47 remaining hatchlings were consumed by oceanic predators (93.6%), mostly groupers (serranids) and snappers (lutjanids). During the course of the same study, 1,740 tethered hatchlings were followed by snorklers, and predation rates averaged 31% during these trials (range 0-85%). None of the hatchlings took evasive action to avoid oceanic predation (Gyuris 1994). Clearly, due to the limited body of knowledge regarding oceanic predation on sea turtle hatchlings, more work needs to be done to help determine oceanic predators worldwide and further quantify predation rates.

USING HATCHLINGS OF THE LOGGERHEAD, I TESTED THE HYPOTHESES THAT:

(1) predation on the hatchling stage of the loggerhead sea turtle by fish is high off coastal North Carolina;

(2) fast moving predators, such as those in the families Scombridae, Carangidae, Coryphaenidae, Pomatomidae and Sciaenidae, are potential predators of hatchling loggerhead sea turtles in this area;

(3) hatchlings make evasive action to avoid predation; and

(4) models can be used to accurately quantify oceanic predation on live hatchlings.

A two-part field component of this study, which tests hypotheses 1 and 2 is still in progress. The following methodology addresses hypotheses 3 and 4 only.

MATERIALS AND METHODS

Collections:

A total of thirteen live hatchlings were collected at random as they emerged from the nest cavities of five randomly selected nests on Bald Head Island, N.C. Hatchlings were used in the study within 24 hours of emergence. Dead hatchlings from nest inventories were also collected for later use as models in this study.

Laboratory experiment:

Hatchlings were used in experimental prey perception tests. This is necessary to insure that models are being perceived by predators in the same way as live hatchlings. Using a 17,000 gallon tank located at the North Carolina Aquarium at Ft. Fisher, perception was tested by simultaneously offering fish both a live and a fresh dead (model) hatchling protected within plastic spheres, 30 cm in diameter. The top 7 cm of both spheres remained out of the water to allow the live hatchling to surface for air. Dead hatchlings were suspended by monofilament line through the top of the sphere to allow them to be jiggled slightly to simulate movement by wave action as is expected in the field trials. The spheres with live and dead hatchlings were placed one meter apart in the tank, and the position of the live and dead hatchlings within the tank was switched prior to each trial. fish in the tank were classified as predatory or non predatory species, and their responses to the hatchlings were analyzed according to the respective group. Four types of response to either one of the hatchlings were recorded by three independent observers: no response, positive orientation towards prey, approach within 25 cm and contact with the sphere. Trials were videotaped as well to verify the decisions of the observers. All trials lasted five minutes. Hatchling behavior in response to fish was also noted. New hatchlings, both live and dead, were used for each trial. Thirteen trials were completed between August and October 1997, with no more than three trials being conducted in a seven-day period.

RESULTS AND DISCUSSION

There were no significant differences in the number of positive orientations, approaches or contacts made by the two groups between the live and the dead turtle. This suggests that fish are visually perceiving the live and dead hatchlings in the same way and validates the use of dead hatchlings in the field trials.

None of the thirteen live hatchlings displayed any detectable anti-predator behavior, despite potential predators making contact with the plastic spheres. During every trial, hatchlings were observed swimming in the direction as these fish. This is consistent with the behavior reported by Gyuris (1994) in green turtle hatchlings.

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CLEANING SYMBIOSES BETWEEN HAWAIIAN REEF FISHES AND GREEN SEA TURTLES, *CHELONIA MYDAS*

Jill P. Zamzow
Hawaii Institute of Marine Biology and Zoology Dept., University of Hawaii, Honolulu, HI 96822, U.S.A.
zamzow@hawaii.edu

Fibropapillomatosis is a debilitating and frequently fatal disease of green sea turtles, *Chelonia mydas*, in the Hawaiian Islands. The disease has reached epidemic proportions in green turtle aggregations occurring in foraging habitats in Hawaii as well as in Florida and several other areas worldwide (Balazs and Pooley 1991). In Kaneohe Bay, Oahu, Hawaii, the prevalence of afflicted turtles has been severe for the past 10 years and continues in the present.

Cleaning symbioses between green turtles and various reef fishes that feed on organisms growing on the turtles' skin, scales, carapace and plastron have been reported in the literature for a number of years (Booth and Peters 1972, Balazs 1994). A cleaning symbiosis was recently reported in which the Hawaiian saddleback wrasse, *Thalassoma duperrey*, picks the turtle-specific skin barnacle *Platylepis hexastylos* from the skin of the green sea turtle, (Losey *et al* 1994). The objective of this work was to gain an increased understanding of these cleaning relationships and any correlation they may have with green turtle fibropapillomatosis. Reef fishes may serve as vectors for the disease as they move between turtles, or, by causing wounds while cleaning, leave the turtle open for infection. Conversely, the cleaning behavior may serve a beneficial purpose in controlling ectoparasites and/or ameliorating tumor tissue. Increased information on these cleaning interactions between fishes and turtles is needed to determine if a significant impact exists, positively or negatively, with regard to the fibropapillomatosis.

METHODS

This study was conducted over a five month period, from 30 April to 30 October, 1997. Four approaches were taken in order to gather information about the symbiosis, as follows:

1) Six twenty-four hour surveys of turtle cleaning and resting sites were performed in Kaneohe Bay, Oahu, Hawaii. Two camera systems were used: an underwater real-time remote video recording system, and an underwater time-lapse video recording system. The remote video system was continuously monitored from the surface during daylight hours, and video was recorded whenever a turtle was in view. A pan and tilt mechanism allowed 360-degree monitoring to the limits of visibility. The videotape was later analyzed in the laboratory utilizing behavioral event-recording software (BEAST).

2) Cleaning stations monitored during this study were mapped on a finer scale than can be found on nautical charts of the region. Reefs were mapped manually from an elevation of approximately 12 meters above sea level (utilizing the mast of a sailboat anchored approximately 5 meters from the reef edge).

3) Two cleaning sites outside of Kaneohe Bay (Hanauma Bay, Oahu, and Mauna Lani Hotel, Kona Coast, Island of Hawaii) were investigated via SCUBA and hand-held underwater videocamera. Videotape was analyzed as above.

4) A survey of dive tour operators around Oahu as well as University of Hawaii certified academic research divers was undertaken in order to ascertain the number, approximate locations and seasonality of cleaning sites around Oahu.

RESULTS

1) One hundred forty-four hours were spent in field observations of turtle resting and cleaning stations. A total of twenty hours (120,000 seconds) of real-time video and 85 s of time-lapse video footage were analyzed. The duration of cleaning interactions totalled 20,436 s and resting interactions totalled 7074 s (Table 1). Of the 29 individual turtles identified, 24 were from cleaning bouts, 3 from resting bouts, and 2 were involved in both types of interaction. At least 8 of these animals were tumored. Eighty-two turtle visits were analyzed. *Thalassoma duperrey*, the Hawaiian saddleback wrasse, was the main cleaner in Kaneohe Bay, with a total of 396 recorded bites. Canthigaster jactator was the only other carnivorous cleaner, with 2 recorded bites. *T. duperrey* concentrated their efforts on tumored turtles, yet did not selectively clean the tumors themselves. Herbivorous cleaners spent equal amounts of time on tumored vs. clean turtles (approximately 20% of total time observed).

Tumors were bitten by *T. duperrey* 11% of the time (spent on tumored turtles), and the one observed bite by *C. jactator* was on a tumor. Herbivorous fishes concentrated on the turtles' shell, and did not bite the turtles' tumors.

Eighteen resting interactions were observed, involving 5 turtles (Table 2). None of the resting turtles was visibly tumored.

Table 1: Observations of Turtle Cleaning Stations in Kaneohe Bay, Oahu, Hawaii

Turtle condition	Turtles observed (N)	*T. duperrey* bites (N)	Tumor bitten (N)	Herbivory duration (s)	Total time observed (s)
Tumored	8	147	16	1046	5076
Clean	16	249	N/A	3008	15360
Total	24	396	16	4054	20436

2) GPS technology was used to establish an accurate location of each cleaning site within Kaneohe Bay (Figure 1). In addition, the vicinities of both cleaner stations used in the study were mapped in detail to a radius of approximately 50m (Figures not included).

Table 2: Observations of Turtle Resting Sites in Kaneohe Bay, Oahu, Hawaii

Reef and Site	Turtle's Sex	Resting Bouts (N)	Duration (x ± s.d.) in seconds
42A	Male	1	420
42A	Male	8	329 ± 59
42A	Male	7	369 ± 75
42B	Undetermined	1	751
MA	Undetermined	1	694

3) Comparative cleaning sites yielded a total of 1801 s of videotape for analysis: 618 s from the Kona Coast, and 1183 s from Hanauma Bay. At the Kona site, herbivorous feeding only was observed on at least four individual turtles, none of them tumored. Cleaner species were *Acanthurus triostegus*, *Zebrasoma flavescens*, and other *Acanthurus spp.* Fibropapillomatosis is virtually nonexistent along the Kona coast (Balazs *et al* 1996). At Hanauma Bay, mainly herbivorous feeding was observed, by *Acanthurus spp.* However, carnivorous feeding was observed on one individual by *C.*

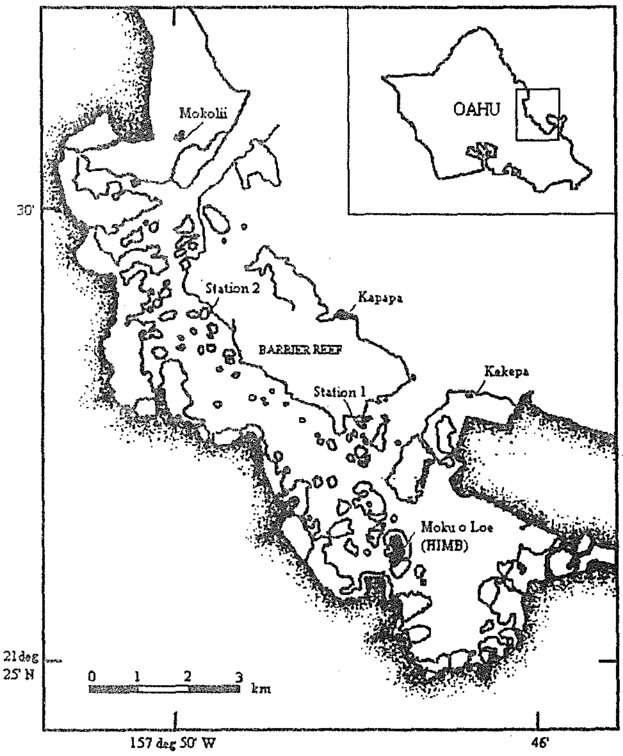

Figure 1. Green Turtle Cleaning stations in Kaneobe Bay Oahu, Hawai

jactator and *T. duperrey*. In contrast to Kaneohe Bay, these fishes focussed on the turtles tumors, apparently biting them painfully, as the turtle flinched and swatted at the fishes repeatedly before leaving the area.

4) Seven dive tour operators and 82 University of Hawaii academic research divers were polled in order to ascertain the location and seasonality (if any) of cleaning sites around Oahu. Five cleaning sites, in addition to the three known for Kaneohe Bay, were reported (Figure 1). These stations were primarily described as herbivorous cleaning stations, similar to Hanauma Bay.

CONCLUSIONS

The unusually low tumor rate (28%) observed in Kaneohe Bay was probably due to misidentification of very slightly tumored turtles as "clean". The low rate of tumor bites by *T. duperrey* in Kaneohe Bay indicates that the tumors are not targeted by the wrasses. Tumors harbor parasites (Balazs 1991) but the fish are ignoring this food source. This may be evidence that the fishes have learned that turtles swim away if tumors are targeted, and therefore more food can be gained by ignoring tumors entirely. Resting data showed an interesting correlation between sex and time of rest. This may be due to small sample size.

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CONSERVATION AND RESEARCH OF SEA TURTLES, USING COASTAL COMMUNITY ORGANIZATIONS AS THE CORNERSTONE OF SUPPORT - PUNTA BANCO AND THE INDIGENOUS GUAYMI COMMUNITY OF CONTE BURICA, COSTA RICA

Randall M. Arauz[1] and Isabel Naranjo[2]
[1]Sea Turtle Restoration Project, Earth Island Institute. rarauz@cariari.ucr.ac.cr
[2]Asociacion PRETOMA, Programa Restauracion Tortugas Marinas/Costa Rica

The coastal community of Punta Banco is located in the South Pacific region of Costa Rica, six kilometers south of Rio Claro de Pavones, in the Province of Puntarenas. In spite of never being reported as an important nesting site for sea turtles, this site supplies the local illegal egg market. During the 1995/96 nesting season poaching was apparently very close to 100% (personal communication from local representatives). The open and illegal harvest of turtle eggs is a major concern of community leaders. It must be mentioned that the site is of outstanding scenic and natural beauty, and is currently successfully exploited as an ecotourism destination. In July, 1995, the Tiskita Foundation, Punta Banco community members and the Sea Turtle Restoration Project of Earth Island Institute decided to implement a turtle conservation program in Punta Banco under a joint effort.

OBJECTIVES

- Evaluate sea turtle nesting activity in Punta Banco, Costa Rica.
- Evaluate and reduce the pressure induced by egg poachers.
- Increase hatching success and survival of hatchlings by relocating nests in a hatchery.
- Create and foster environmental concern among the citizens of Punta Banco, through active involvement in the project and activities to be carried out among the school children.
- Create a new service for ecotourists who visit the area (turtle watch).

METHODOLOGY

Locals (2 from each community) are hired and trained to be beach monitors. Sea turtles encountered are identified and measured. All nesting activity is recorded (false crawl, false nest, poached nest), and all clutches possible are counted and relocated into a hatchery.

RESULTS

As an initial effort, the Tiskita Foundation recorded 350 solitary olive ridley turtle tracks along a 5 kilometer stretch of beach from August to October of 1995. Intensive beach monitoring initiated during the 1996 nesting season, from July to December. During this first effort, 242 turtles crawled up the beaches of Punta Banco, to lay successfully in 153 of the crawls (62.22%), and to perform false crawls in 89 cases (36.77%). 129 (84.31%) of all nests recorded (153) were relocated into one of the three hatcheries, 126 of which (97.28%) were of olive ridley sea turtles, 2 of hawksbills (1.8%) and 1 of a Pacific green (0.9%). Poachers took 24 nests (18.6%). The average hatching success of the 129 nest located in three hatcheries was 73.55%, 78.74% and 75.6% respectively. In the end, 12969 eggs were protected and produced 8029 hatchlings during the 1996 season.

Table 1. Sea Turtle nesting activity and poaching of nests from August to December of 1997, in Punta Banco, Puntarenas, Costa Rica.

Species	#Nests	%	Number of nests poached	%	False crawls
olive ridley	133	97.1	32	24.2	46
Pacific green	4	2.9	1	25	2
Total	137		33	24.1	48

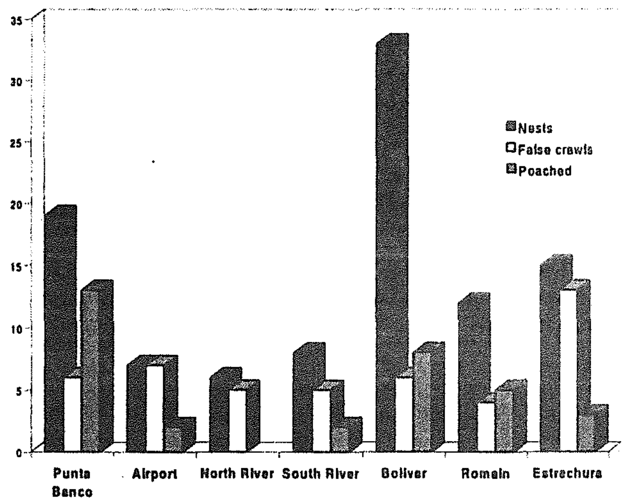

Figure 1. Number of nests, false crawls and poached nests per sector in Punta Banco, Costa Rica, Aug - Dec, 1997.

During the course of the 1996 study, the project was approached by the local indigenous Guaymi representative Rafael Bejarano, who expressed an interest to involve the coastal Guaymi community of Conte Burica, 7 kilometers south of Punta Banco, in the sea turtle protection program. As a result, tow Guaymi citizens were hired and trained during the 1997 season.

In 1997, 185 turtles crawled up the beaches of Punta Banco, to lay successfully in 137 of the crawls, and to perform false crawls in 48 cases (Table 1) 104 of the nests recorded were relocated into one of the four hatcheries. Poachers took 33 of the nests (24.1%). The average hatching success of the 101 olive ridley nests located in the four

Table 2. Description, neonate production and hatching success of 104 translocated sea turtle nests in four separate hatcheries, Punta Banco, Puntarenas, Costa Rica, from August 1997 to January, 1998

Species	# of nests	# eggs	X	SD	Min	Max	AVG days	SD	Min	Max	# of neonates	Hatching Success
Hatchery 1												
Olive ridley	23	2323	101	18.7	56	130	47	4.6	34	55	1075	43.71
Pacific green	1	73									0	0
Hatchery 2												
Olive ridley	37	3583	96	20.2	35	137	48	3.3	43	57	2184	61.83
Pacific green	1	100					53				89	62
Hatchery 3												
Olive ridley	29	2964	102	20.1	49	124	53	4.2	46	66	1078	33.5
Pacific green	1	94					35				93	98.9
Hatchery 4												
Olive ridley	12	1210	101	15.8	70	120	48	2.4	44	51	463	41.4
Total	104	10347									4982	

hatcheries was 43.7%, 61.83%, 33.5% and 41.4% respectively (olive ridley). Only 3 Pacific Green turtle nests were relocated into hatcheries, one of which was destroyed by the high tides (0% hatching success). The other two nests were in separate hatcheries, and presented hatching success rates of 62% and 98.9% respectively. In the end, 10347 eggs produced 4982 hatchlings (Table 2). 17%, 12%, 34% and 16% loss due to high tides was recorded for each hatchery respectively. Nesting activity along the 5 km stretch of beach during the 1997 season coincides with the general pattern of 1996 (Figure 1), however, a greater peak of nesting activity occurs in the zone Bolivar (24 turtles in 1996 and 42 turtles in 1997.

DISCUSSION

Fewer nests and eggs were protected, and fewer hatchlings produced in 1996 than in 1997. Several reasons have been identified to be the source of the reduced numbers for the 1997 season. Very high nest loss due to extremely high tides was recorded, which obviously impacted the hatching success. 1997 was a year in which four year cyclic extremely high tides occur along the Central American Pacific. The effect of these tides impacted all the hatcheries, but had a greater effect on hatchery number 3, which was the closest to the high tide line. Poaching also took a higher toll in 1997. Finally, dogs took a very high percentage of the two hatcheries that were located closest to the town. Dogs are considered a great problem, and since they are pets, a difficult one to solve. Poaching from a hatchery occurred for the first time ever in hatchery 3.

OTHER ACTIVITIES AND FUTURE GOALS

During 1998 the Project will be extended to include the new station in Caña Blanca, inside the Conte Burica Indigenous Territory. A Guaymi will be the project coordinator, and two local members of the coastal Guaymí community of Caña Blanca will be hired as beach monitors. In Punta Banco, the project will be coordinated by an international student, who will also periodically visit the project in Caña Blanca to assist and advise the Guaymí. In order to seek the future sustainability of these projects, we are fostering volunteer programs. Funds generated are used to hire locals as

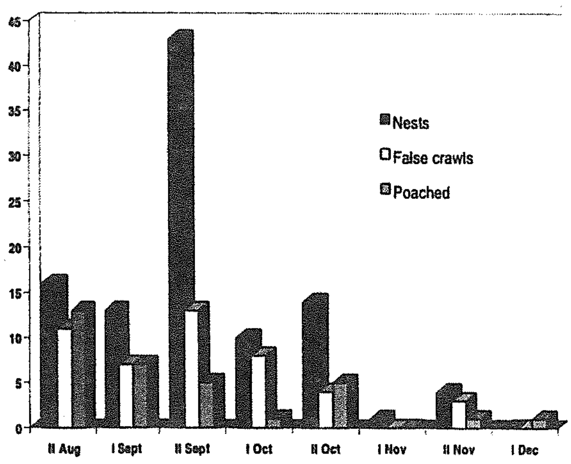

Figure 2. Number of nests, false crawls and poached nests recorded in two week intervals, Punta Banco, Costa Rica, 1997.

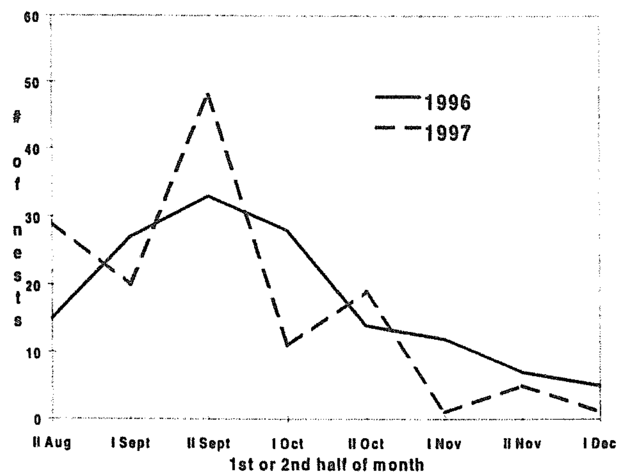

Figure 3. Nesting Activity in Punta Banco, Costa Rica, during 1996 and 1997.

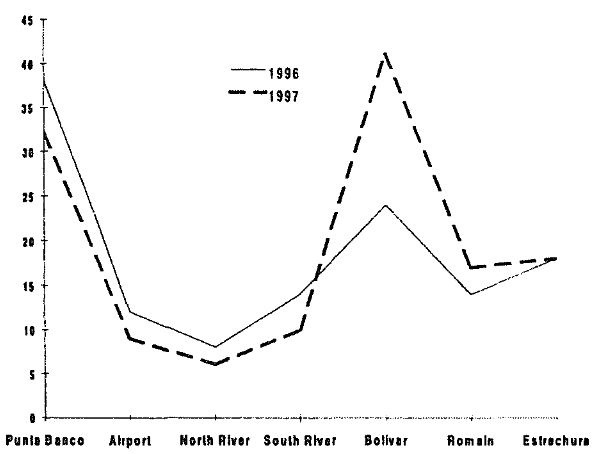

Figure 4. Number of nest recorded during two week intervals, Punta Banco, Costa Rica, 1996 and 1997

beach monitors. During 1997, 4 volunteers visited Punta Banco, and we expect this figure to grow during the future 1998 season. Furthermore, we are planning on developing an environmental education program in the schools, in co-operation with the World Society for the Protection of Animals (WSPA).

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PROGRAMA MODELO DE PARTICIPACIÓN INTERSECTORIAL PARA LA PROTECCIÓN DE LA TORTUGA MARINA EN PUERTO VALLARTA, JALISCO. MÉXICO

Oscar Vidal Barragan Cuencas and Juana Adelfa Delgado Quintana
Universidad de Guadalajara, Centro Universitario de la Costa Campus Puerto Vallarta, México

Dadas las adversas condiciones económicas por las que atraviesa nuestro país es necesario buscar vías alternas para sufragar los gastos producidos en un campamento tortuguero y no dejar esta responsabilidad solo en el sector oficial ó instituciones educativas. En este programa modelo se busca establecer una cooperación entre el sector oficial y el privado, promoviendo su participación en la conservación y el desarrollo sustentable.

Desde 1992 se integró en Puerto Vallarta, Jalisco un comité proconservación de la tortuga marina. En 1996 se integro con una nueva estructura y quedo conformado por representantes del sector oficial de los 3 niveles de gobierno, el sector privado, el sector social y el sector técnico-científico representado por la Universidad de Guadalajara. Las funciones de este comité son la planeación, coordinación y ejecución de las acciones del programa de protección a la tortuga, que tiene como objetivos participar en la conservación de la tortuga marina en el Pacífico mexicano, cubriendo aspectos disciplinares como el manejo, la vigilancia, la protección, la investigación, la educación y el desarrollo comunitario.

Este programa se basa en las estrategias y acciones que se establecen en el Programa Nacional de Tortuga Marina y particularmente en el programa universitario de la Universidad de Guadalajara.

INFORMATION EDUCATION CAMPAIGN OF MARINE TURTLE CONSERVATION IN THE PHILIPPINES

Renato D. Cruz
Pawikan Conservation Project, PAWB-DENR, Philippines 1101. pawb-plan@psdn.org.ph

The Pawikan (marine turtle) Conservation Project (PCP) of the Protected Areas and Wildlife Bureau (PAWB), Department of Environment and Natural Resources (DENR) was created in 1979 to protect and manage the remaining marine turtle populations in the Philippines. Aside from resource management and research, one of the major tasks of the PCP is to conduct information and education campaigns (IEC) throughout the country to increase the awareness of Filipinos and to solicit their participation in the conservation activities being implemented by the government. Since 1983, the Project has been utilizing, one way or the other, all possible and effective means of communications to promote marine turtle conservation.

Documentary film. The first 20-minute documentary film produced by the PCP focused on marine turtle biology, causes of the decline of marine turtle populations in the Philippines, creation of the Task Force Pawikan (original name of the PCP) and Council, and the activities being undertaken by the project. Besides being often shown in schools and colleges, copies of the film were also distributed to the regional offices of the DENR and some resorts. Another documentary film is currently being produced by the PCP, with a Filipino version to cater to the larger populace of people living in the countryside.

Radio Plug. The country, being archipelagic with inadequate or lacking communication facilities, makes the radio the most effective media tool that can be accessed. Thus, a 15-second radio plug that gave emphasis on the ban to collect or kill the endangered sea turtles was produced and translated in five common Filipino dialects. This was aired free of charge in the different regions of the country.

Posters. The PCP has so far produced four poster designs for distribution nationwide. The latest design depicts a turtle and dugong imposed on a collage of dinosaurs, with a caption saying, "Are we to let our children inherit only stories?"

Primers/brochures. Print materials containing a brief description of the biology and ecology of marine turtles, as well as the pertinent laws concerning their conservation have also been produced for distribution. Mimeographed versions in both English and Filipino are distributed during habitat surveys and IEC, and more specialized primers are given during seminars, lectures and training-workshops. The PCP also distributes these print materials to individuals who request for them.

Billboards. Billboard signs have been erected in strategic locations, such as piers and gates of a complex that houses more than 100 native souvenir shops. In spite of the ban, local businessmen still engage in the trade of marine turtle by-products. In fact, surveillance and confiscation conducted by the PCP and the enforcement arm of the DENR has yielded not less than U.S. $ 8,000.00 worth of by-products in 1996 and 1997 alone. DENR personnel deployed at the international airport have confiscated a number of stuffed turtles and guitars made of turtle carapaces from departing foreign tourists. The PCP intends to put up billboards in all international gateways of the Philippines, notably Manila, Cebu and Davao.

T-shirts/baseball caps. The project has conceptualized t-shirts with seven different turtle designs, and a baseball cap with an embroidery patch designed with a turtle and dugong. Along with a Certificate of Appreciation, either of these products are given to individuals, especially fishermen, who have reported turtles with metal tags or surrendered the turtles to the DENR for tagging and/or for release. In 1994, a manufacturer of popular t-shirts with conservation designs forged an agreement with the PAWB to donate 10% of the sales of its marine turtle-designed t-shirts to the PCP. This undertaking significantly helped in promoting marine turtle conservation awareness in the people, especially since the t-shirts are widely distributed in major cities in the country. In addition, many of the PCP's activities were financially supported through the donation.

Stamp Canceller. In 1989, in commemoration of the 10th year of the PCP, a stamp canceller with marine turtle design was produced in collaboration with the Philippine Postal Corporation; the project lasted a year.

Postcards. Pre-paid postcards depicting the five species of turtles found in Philippine waters are distributed to the DENR Regional Offices, concerned individuals, non-government organizations, local governments and community schools. Through the data gathered from the postcards and Field Action Officers' reports, the PCP has plotted the distribution of turtles in the entire country.

Training-Workshop for DENR Personnel. The Project has been fully utilizing the assistance of the DENR's 15 regional offices and branches, 69 Provincial Environment and Natural Resources Offices (PENRO) and 159 Community Environment and Natural Resources Offices (CENRO). These offices are in the forefront in implementing DENR's mandates at the grass roots level. In 1989, DENR Special Order No. 884 was promulgated, designating all Regional Technical Directors for Environment and Natural Resources as PCP Field Action Officers (FAO). One of the specific duties and responsibilities of the FAO is to assist the PCP in conducting a Conservation Education Program in their respective regions. The Project conducted Orientation-Training Workshops for DENR field personnel to equip them with the necessary knowledge to conduct IEC and implement other PCP activities. The topics of the training workshop include:

Biology and Ecology of Marine Turtles, Tagging and Hatchery Procedures, Existing Marine Turtle Rules and Regulations, Concepts of Marine Wildlife Conservation and Management, and Identification of Functions and Commitment of the Participants for Marine Turtle Conservation. From 1989-1997, more than 300 DENR personnel were trained by the PCP.

Seminars/lectures. As a cost-effective strategy, IEC is integrated with the habitat surveys conducted by the research unit of the PCP. The method used is interpersonal-group approach consisting of a simple lecture with a slide presentation or a film show. In areas with no sources of electricity, flip charts are used as visual aid. About 50-300 people, mostly children and fishermen, attend each of these lectures. From 1992-1996, the PCP conducted IEC in 253 local communities in 26 provinces. The PCP also gives lectures in schools upon invitation.

Dalaw-Turo (Visit and Teach). This is an outreach program of the DENR that employs a non-traditional educational participatory communication design of teaching biodiversity and sustainable development. The most interesting feature of this program is the integration of lectures, drama and games as a technique in imparting conservation of natural resources among its audience. The marine turtle has become a part of this program. From 1992-1996, more than 15 thousand students, 168 teachers and 200 DENR personnel from 12 regions have participated in the Dalaw-Turo.

Media Coverage. From 1991 onwards, media coverage was intensified, which have elicited considerable public support. The Department of Tourism sponsored a group of journalists from different newspaper and magazine publications to visit the Turtle Islands, some 1000 km south of Manila, the country's capital. The Turtle Islands was featured in two leading television programs.

Exhibits. Many non-governmental organizations (NGOs) had collaborative undertakings with the PCP. In 1994 and 1997, these NGOs coordinated with the project to set up month-long exhibits on marine turtles and other endangered species in popular shopping malls. Due to their strategic location, these projects elicited a number of patrons who contributed financial support to the project.

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COMUNIDAD, TORTUGAS MARINAS Y LA RESERVA DE ESCOBILLA, OAXACA, MEXICO

Carmen Elizalde and Florencio Nataren
Ecologia, Desarrollo y Medio Ambiente, A.C. (Ecodema) A.P. 29 C.P. 79900 Pochutla, Oaxaca

INTRODUCCION

Ecologia, Desarrollo y Medio Ambiente, A.C. es una organización no gubernamental con la misión de promover y ejecutar programas y proyectos encaminados a la conservación de los recursos naturales y al desarrollo de las comunidades.

Bajo este contexto nuestro mayor quehacer lo realizamos en la costa del estado de Oaxaca, donde se localizan poblaciones de tortugas marinas de importancia mundial, y donde se tiene la playa de Escobilla, Zona de Reserva y de mayor anidación para *Lepidochelys olivacea* en México.

Entre las comunidades humanas donde ECODEMA desarrolla sus trabajos y que están relacionadas histórica y ambientalmente con las tortugas marinas, se encuentran las asentadas en la cuenca hidrológica de Cozoaltepec en el municipio de Tonameca, río que desemboca a la playa de Escobilla. De tal manera que las actividades productivas y cotidianas que realizan los pobladores de estas comunidades influyen directamente en los ambientes de las tortugas marinas y en su conservación.

Considerando esta situación y comprometidos con el concepto de la sustentabilidad, nos hemos dado a la tarea de brindar y generar opciones en la busqueda del desarrollo integral de las comunidades a través de procesos productivos alternativos, de educación ambiental y capacitación en ecotecnologías. Algunos de los avances y resultados que tenemos en las comunidades son:

cursos a maestros y talleres infantiles de educacion ambiental con diversas estrategias y tecnicas educativas diseñadas para cada grupo.

Se ha capacitado a personal docente en el ambito de la educacion ambiental, y se han impartido multiples talleres Infantiles, donde los niños han aprendido sobre aprovechamiento y conservacion de recursos naturales, han realizado acciones de reforestacion composteo, reciclado de papel, liberacion de crias de tortuga al mar etc.

Capacitacion sobre tecnologias alternativas en 10 comunidades de la cuenca baja cozoaltepec y relacionadas con el area de reserva la escobilla.

Capacitacion y formacion de mas de 16 promotores de las 10 comunidades en curso intensivo sobre:

BIODIGESTORES

Xochical como sistema alternativo para tratar y reciclar desechos humanos que eviten la contaminación de la cuenca Cozoaltepec.

AGRICULTURA ORGANICA

Promoviendo obras de conservación de suelos, control integral de plagas, producción y aplicación de abonos orgánicos vegetales y animales.

NUTRICION ALTERNATIVA

Por medio de alimentos no convencionales, económicos, fáciles de preparar y delicioso.

ECOTURISMO EN LA RESERVA DE ESCOBILLA

Es un proyecto productivo alternativo para mejoranfiento de un pequeño grupo de pescadores y amas de casa, pero al mismo tiempo con la vision de que la comunidad de escobilla se vaya apropiando de esta alternativa para aprovechar sin destruir a las tortugas marinas, las iguanas y sus ambientes.

Parece ser que los tramites para obtencion del permiso para el desarrollo de las actividades ecoturisticas se esta burocratizando, pues a dias de un año de iniciar su gestion, no se tiene una resolucion, lo que ha impedido contar con el financiamiento de la embajada de holanda que se tiene apalabrado, para impulsar este proyecto.

El animo del grupo ha decaido al no contar con el permiso de la sexlarnap y por la destruccion de gran parte de la infraestructura que se habia generado antes de ocurrir los huracanes de 1997. A pesar de esto, los integrantes convencidos de su objetivo y en la medida de sus posibilidades y las de ECODEMA continúan trabajando elproyecto.

En barra del potrero Cozoaltepec frente a la playa escobillase impulsa el procesamiento natural de cultivos y plantas de la region en conservas, deshidratado de frutas y medicamentos, como una opcion economica y de autoempleo local para pobladores de la reserva tortuguera.

Se construye un centro de capacitacion y educacion alternativa para el desarrollo comunitario.

Desde 1994 se esta promoviendo e impulsando la apropiacion de biodigestores xochicalli para tratar y reciclar desechos humanos, habiendo ya 15 de estos sistemas en hogares de la comunidad, asimismo el empleo de estufas rurales ahorradoras de leña.

Actualmente se han comenzado con pobladores voluntarios acciones para la reforestacion y recuperacion de areas naturales y zona poniente de la reserva escobilla afectadas por los huracanes de 1997.

PREHISPANIC MARINE TURTLES IN PERU: WHERE WERE THEY?

J. Frazier[1] and Duccio Bonavia[2]

[1] Centro de Investigación y de Estudios Avanzados del I.P.N. Unidad Mérida, Carretera Antigua a Progreso km 6, A.P. 73 "Cordemex", Mérida C.P. 97310, Yucatán, México. frazier@kin.cieamer.conacyt.mx

[2] Laboratorio de Prehistoria, Departamento de Biolgía, Universidad Peruana Cayetano, Heredia, Lima, Perú

INTRODUCTION

The climate of coastal Peru is ideal for the long-term preservation of organic remains; and there is a large and ever-growing number of archaeological studies in this region. Nearly 11,000 years of coastal habitation, and 3,000 to 4,000 years of permanent human occupation on the Peruvian coast have left a wealth of archaeological evidence. Exploitation of marine resources has been persistent and conspicuous from about 5,000 years ago to the present. There are enormous midden mounds at many coastal sites, showing the degree to which marine resources were harvested. The diversity of marine organisms found in these sites is remarkable, including: algae, sea urchins, tunicates, scores of fishes - large and small, sea birds, seals and whales.

Detailed analyses of historic documents show a wealth of information on fishing and other marine activities along the Peruvian coast; yet, information on marine turtles is rare (Rostworowski, 1981). One document that stands out is Father Bernabé Cobo's chronicle of the New World, between 1613 and 1653. He reported the capture of 80 to 100 turtles in a single haul of a beach seine in the Pisco area, and stated that turtle meat and oil were much appreciated (Cobo, 1964). During recent years, thousands of marine turtles have been caught off southern Peru, especially around San Andrés, where their meat has been sold as a special dish (Vargas *et al.*,1994).

Marine turtles are potentially ideal for archaeological studies, for their bones are numerous, robust and relatively easily identified. Thus, remains of these animals would be expected to be common at many coastal archaeological sites in Peru.

At the same time, numerous prehispanic Peruvian cultures are famous for their representations of a wide diversity of animals. There are great quantities of prehispanic ceramics and textiles, many of which have astonishingly realistic depictions of both terrestrial and marine animals, as well as hunting and fishing scenes. Artifacts from Moche and Paracas cultures are especially notable for their representations of animals.

Table I. Summary of information on marine turtle remains at prehispanic archaeological sites in Peru and northern Chile (BP = years before present).

Site	Estimated Age	Number of Turtle Remains	Source
Peru			
Quebrada de Siches	7980 – 5605 BP	1	Richardson 1978
Pariñas	2300 – 1600 BP	10	Wing 1977
Huaca Prieta	4257 – 3550 BP	4	Bird et al. 1985
Los Gavilanes	4869 – 3908 BP	3 – 6	Bonavia 1982
Sto. Domingo, Paracas	6000 – 4000 BP	> 30	Engel 1981
Chile			
Playa Miller	Ceramic	"few"	Bird 1943
Los Verdes	1070 - 930 BP	Cranium	Morales *in litt.* 1993
Playa Vicente Mena	1000 – 1400 BP	Carapace	Morales *in litt.* 1993-94

PREHISPANIC REMAINS OF MARINE TURTLES IN PERU

Remains of marine turtles have been documented at five prehispanic sites along the coast of Peru (Table I), spread out from the extreme north to southern Peru. Although an impressive diversity of marine animals has been reported from scores of coastal sites, no other reports of prehispanic marine turtle remains are known from Peru. There are three sites in northern Chile were marine turtle remains are documented (Table I); these are all ceramic sites, and in two cases the turtle remains are exceptionally intact.

PREHISPANIC CULTURAL DEPICTIONS OF MARINE TURTLES IN PERU

Marine turtles were portrayed in Moche ceramics (from 200 BC to 700 AD), some of which are remarkably realistic. Although Moche ceramics are numerous and famous for their naturalism, compared to other animals, marine turtles motifs are very infrequent; Lavallée (1970) studied more than 1,600 Moche pieces, and stated categorically that turtles were rare. Including all Peruvian cultures, we can find only about 20 ceramic pieces depicting turtles. A high proportion of these have unreliable data, and their cultural affinities are unknown. The case with textiles is similar, and despite a wide variety of animals portrayed in them, turtles are just not found (Peters 1991).

WHY IS THERE SO LITTLE EVIDENCE OF MARINE TURTLES FROM PRE-COLOMBIAN PERU?

There are several possible explanations as to why there is so little evidence of marine turtles from prehispanic Peru. Each of these is discussed in turn:

Turtles did not occur in Peru until recently?

Remains of marine turtles are known from Peru some 5,000 to 8,000 years ago; and there are remains in northern Chile, at least from ceramic times. There is no reason to assume that marine turtles have not been a regular part of the Peruvian fauna for the past few millennia.

Turtles occurred, but far out to sea, where people did not normally encounter them?

At least since Colonial times, these animals have been found - occasionally in large numbers - in coastal environments, sometimes in relatively shallow water. Furthermore, rock paintings from Quebrado el Médano, Chile, show scenes of harpooning whales, large fishes and turtles; and it is known that prehispanic peoples from this region were capable of lengthy and extended sea voyages.

Turtles were encountered along the coast, but people did not have the technology to catch them?

Preceramic peoples had nets, and possibly even small vessels; furthermore, faunal remains show that large fishes were caught - evidently in beach seines. Faunal remains and rock paintings show that large, powerful marine vertebrates (whales, sharks and turtles) were harvested.

Marine turtles, although present, and catcheable, were avoided because of taboos?

Turtles are important elements in creation myths and legends of many American cultures, but at the same time, marine turtles are exploited and relished as food by most coastal peoples.

Marine turtles were harvested by prehispanic peoples in Peru, but processed in such a way that the remains have not been detected by archaeologists?

Turtle shells and other bones may have been discarded on beaches, rather than being brought to habitation sites: the same reasoning is used to explain the paucity of sea lion bones in prehispanic sites. Also, scavenging by camp dogs would have destroyed many turtle bones. Nonetheless, given the large number of bones in a single turtle, and the fact that the appendages (neck, limbs and tail) - all of which have distinctive bones - might best be processed in habitated areas, it is still remarkable that so few bones have been reported.

Archaeologists have, for some reason, not detected or reported marine turtle bones from Peruvian sites?

Given the diversity of faunal remains that have been reported, some of which are much more delicate and difficult to identify than marine turtles, it is difficult to understand why there would be a bias against reporting marine turtle remains.

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1996 AND 1997 COURSES ON SEA TURTLE BIOLOGY AND CONSERVATION IN VENEZUELA

Hedelvy J. Guada[1], Ana Trujillo[2], Laura Sarti[3], Héctor Horta[4], Vicente Vera[5], Tito Barros[6], Lenin Parra[6], Alexander Acuña[6], and Diego Amorocho[7]

[1]WIDECAST/USB. Apdo. 50.789. Caracas 1050-A. Venezuela. 95-79050@USB.VE

[2]PROVITA. Apdo. 47.552. Caracas 1041-A. Venezuela

[3]UNAM/INPESCA. Pitágoras 1320, 5to. piso. Santa Cruz Atoyac. México D.F. CP 03310. México

[4]Departamento de Recursos Naturales y Ambientales. P.P. Box 009066600. Pta. de Tierra Station. San Juan. Puerto Rico 00906-6600

[5]PROFAUNA. Edif. Camejo. Mezzanina. El Silencio. Caracas 1010. Venezuela

[6]Universidad del Zulia. Museo de Biología. Apdo. 526. Maracaibo 4010. Edo. Zulia. Venezuela

[7]Fundación FES. Cali. Calle 64 Nte # 5B-146. L26. Cali. Colombia

INTRODUCTION

We have taught seven courses on sea turtle biology and conservation since 1992. The goal of the courses have been to provide the scientific information and basic capacitation in the biology and conservation techniques of the sea turtles. This strategy will promote the realization of research and sound conservation efforts, needed in Venezuela because of the five species of marine turtles occuring in the country (green turtle, hawksbill turtle, loggerhead turtle, olive ridley and leatherback turtle) are endangered by human activities (killing of females, poaching of eggs, lost of nesting and foraging habitats, entangling in fisheries nets, etc.).

METHODS

During 1996 and 1997 we have organized and taught 3 aditional short "Courses on Sea Turtle Biology and Conservation". The V and VI Courses were done in the Escuela de Ciencias Aplicadas del Mar of the Universidad de Oriente, Isla de Margarita (July 9-13, 1996 and August 4-8, 1997, respectively). The auspicers have been the Universidad de Oriente, WIDECAST, PROVITA, PROFAUNA, INPARQUES, Conservation International, Departamento de Recursos Naturales y Ambientales (Puerto Rico), Columbus Zoo, SARPA, Pro-Margarita and FENAPESCA. The VII Course was organized in La Universidad del Zulia (LUZ), Maracaibo (October 13-17, 1997). The auspicers of this course were LUZ, WIDECAST, Fundacion FES, Columbus Zoo and SARPA.

The courses have had theoretical, practical (field and identification) and video sessions. The theoretical sessions include: taxonomy and geographical distribution, biology and ecology, monitoring techniques, conservation strategies, among others. In the identification sessions the participants work with live sea turtles and preserved materials. The field sessions included field surveys during the day. Through the video sessions we present some advanced research techniques and international sea turtle conservation programs. A set of selected bibliography was provided to the participants.

RESULTS

We had a total of 47 participants, including students of Biology, Marine Biology, Veterinary Medicine, Oceanology and personnel from several governmental and non-governmental organizations. Three foreigner instructors came to Venezuela to proportionate a regional view on the Caribbean sea turtle conservation issues. The invited instructors were: Laura Sarti, from the National Autonomous University of Mexico (UNAM) and National Institute of Fisheries (INPESCA); Hector Horta, from the Department of Nature Resources (Puerto Rico) and Diego Amorocho from FES Foundation and WIDECAST Country Coordinator in Colombia.

EVALUATION

The courses have resulted very exciting, because a lot of the undergraduates have begun to be interested in to know more about sea turtles and, to cooperate with environmental education activities or with research projects. As example, a group of five students of the Simon Bolivar University (Caracas) is organizing several lectures for kids with the sea turtle kit provided through the Columbus Zoo. An undergraduate working in Peninsula de Paria has improved his work protecting nests in a leatherback nesting beach. One student of the Zulia University, who participated in the course of 1993 and what organized the Sea Turtle Course in October of 1997 will begin the first undergraduare thesis about sea turtles in the country. Near five of the participants of the 1997 Zulia course will be helping him in the field. This thesis will complement a study conducted by Diego Amorocho in the Colombian Guajira.

Several participants of the courses are attending to the "18th. Annual Symposium on Sea Turtle Biology and Conservation" (Mazatlán, Mexico). Once finished the courses, participants continue connected through the "Tortuga News", a quarterly two-pages bulletin what offer information on the sea turtle conservation efforts in Venezuela and the world.

ESTABLECIMIENTO DE UN RANCHO TORTUGUERO EN LA REGIÓN DE CABO SAN LUCAS, B.C.S., MEXICO

Melania C. López Castro

Departamento de Biología Marina. Área Interdisciplinaria de Ciencias del Mar. Universidad Autónoma de Baja California Sur. Carretera al sur Km. 5.5 A.P. 19-B. La Paz, B.C.S. C.P. 23080., México. mol@lapaz.cromwell.com.mx

Overfishing of sea turtles in the past left all species as endangered or threatened. Even though a decree in 1986 declared all nesting beaches as sanctuaries protected by law, there's still egg poaching in nesting beaches. Efforts are being done to avoid this crime, but the resources are not enough and the protection programs haven't been completely successful. Due to these situation I propose the establishment of a turtle farm with the involvement of the hotels, conservation groups and people of Cabo San Lucas regarding that turtle farms like Rancho Nuevo, Tamaulipas have demonstrated to be among the most effective methods for the re-establishment of turtle populations. The main objective of this turtle ranch is to obtain basic information for the assessment of population size and contribute in the re-establishment of the sea turtle Lepidochelys olivacea through the protection of eggs and new hatchlings. If we consider that this region is highly turistic, it's an excellent opportunity to educate people about the importance of sea turtles as natural resources. Other studies can be done to the better understanding of the biology of sea turtles.

THE PUPPET THEATRE AS A TOOL FOR ENVIRONMENTAL EDUCATION

Raul Miranda Velasco
Secretaria de Ecologia, Gobierno del Estado de Yucatán; Calle 64 No. 437 X 53 y 47-A, Mérida Yucatán México, Tel. (99)24 47 98 y 28 13 35, Fax s4 67 69

Since 1990, the Department of Ecology began the program of protection and vigilance for the marine turtle at the State Reserve of 'El Palmar'; a year later this was possible also at the State Reserve of 'Dzilam'. The mentioned Program is based on patrolling walks on the beach shores of both Reserves to avoid the capture of turtles in nests and change the position of the nests into a safer place for the correct monitoring and protection. Never the less was missing a complementary action to enforce these tasks, so in 1996 the Program 'Puppets Theatre as Tool of Environmental Education' begins, based in the experience of 6 continuos years protecting and observing the hunting in high indexes. There for was considerate of primal importance to foment to the population (among the children specially) the conciseness of not consuming the turtle products. This job as well as the protection, is justified because at the 'Palmar' Reserve the number of turtles is very low compared to the others, and that is why the urgency of the actions. In Sisal the fishermen are predators of turtle and turtle eggs, taking advantge of the 36 Kms. of beach that can not be patrolled permanently, plus the near distance between Sisal and Mérida, where they commercialize the obtained products. Related to The Protection Program, in the 1997 season, 95 nests were taken to the farmyard, with 14,518 eggs and 9,173 new born turtles were set free, all of them of the 'Carey' species, with a 63.18% of the total suriviving.

THE BARBADOS SEA TURTLE PROJECT: IMPLEMENTING THE WIDECAST RECOVERY ACTION PLAN FOR BARBADOS

Anthony Poponi[1], Lotus A. Vermeer[1], Julia A. Horrocks[2], and Patrick McConney[3]
[1]Bellairs Research Institute, St. James, Barbados, West Indies. bellairs@sunbeach.net
[2]Department of Biological and Chemical Sciences, University of the West Indies, Barbados
[3]Fisheries Division, Ministry of Agriculture and Rural Development, Barbados

INTRODUCTION

Barbados is the most easterly island in the Lesser Antilles. The island has an area of 430km2, with 44km of beach utilized for nesting by two species of sea turtle: the hawksbill (*Eretmochelys imbricata*), the predominant species nesting in Barbados, and the less common leatherback (*Dermochelys coriacea*). Green turtles (*Chelonia mydas*) and the occasional loggerhead (*Caretta carreta*) forage but do not nest in Barbados.

Existing regulatory mechanisms to protect sea turtles in Barbados are inadequate. Current legislation prohibits the harvest of turtle eggs, the capture of turtles on the beach or within 90m of the shore, and the selling or possession of any turtle of weight under 14kg. Enforcement of legislation protecting turtles is difficult which is in part due to the diffuse and extensive beach areas utilized by nesting turtles in Barbados, and existing penalties for harvesting turtles (*e.g.* a fine of approximately $50US) are an insufficient deterrent. All species of turtle are currently harvested in Barbados. Turtles are caught at sea in entangling nets set offshore, and are also speared opportunistically. However, most turtles are harvested illegally whilst nesting. A complete moratorium on sea turtle harvest and the harvest of eggs has been drafted as part of a newly revised Fisheries Act, but has yet to be enacted.

Sea turtle conservation activities of the Barbados Sea Turtle Project (BSTP) have been ongoing since 1987, and actions identified by the WIDECAST Sea Turtle Recovery Action Plan (STRAP) for Barbados have been conducted over the past 6 years. To date, STRAP activities have largely been implemented and sponsored by Bellairs Research Institute (BRI), with support from the local Fisheries Division. In 1997, the Columbus Zoo (Ohio) provided funding to extend monitoring to the east coast of the island.

The major STRAP activities conducted are (1) monitoring of nesting activity, (2) tagging of post-nesting females and of foraging sub-adults and juveniles, (3) monitoring of hatching events, (4) responding to strandings and care of sick/debilitated sea turtles, (5) compilation of a sea turtle database, (6) increasing environmental awareness, and (7) promotion of the non-consumptive use of sea turtles. Details of each of these activities currently being conducted and future initiatives, where relevant, are discussed.

METHODS

The Barbados Sea Turtle Project relies heavily upon the cooperation of the general public, particularly hotel staff and guests, and other persons living and working near beaches, to monitor nesting and hatching activity during the turtle season (April to December). The Project provides a year long, 24-hour "turtle hotline" which the public can use to call in information on sea turtles at any time. In the event of a nesting activity, members of the Project response team travel to the beach to tag and measure the turtle, to mark the nest location or move the nest if necessary, and ensure that the turtle re-enters the sea safely. In the event of hatching activity, Project personnel help any disoriented hatchlings to find the sea, and excavate nests to ensure that all hatchlings have managed to escape from the nest and to examine nest contents.

RESULTS AND DISCUSSION

Monitoring of Nesting Activity

Between 1987 and 1996, the BSTP relied almost exclusively on public reports of nesting activities. BSTP staff respond to reports to confirm a nesting activity, to document the location of the nest, and to translocate the nest if threatened by predation (including predation by man), beach erosion, storms or compaction. Public awareness has increased substantially over the past few years, and there has been a marked increase in the number of nesting activities documented. In 1997, the BSTP continued to respond to public reports, but also conducted nightly surveillances between May and November on two index beaches on the south and east coast of the island, and frequently monitored a third high nesting density beach on the west coast. Through these efforts, 46 new nesting females were tagged. Despite increased BSTP efforts, it is interesting to note that more than half (167 of 301) of all documented nesting activities in 1997 were reported by the public.

Future initiatives will involve the implementation of a saturation tagging program on the primary index beach on the south coast of the island (see Woody *et al.*, presentation).

Tagging of Post-Nesting Females and of Foraging Sub-Adults/Juveniles

BSTP personnel provide immediate response to public reports of nesting turtles. Females are tagged, measured, and photographed whilst nesting, and their safe return to the sea following nesting is closely monitored. Titanium tags are used which bear a number and the following inscription "Bellairs Research Institute, Barbados, Reward".

Preliminary surveys of nearshore marine habitats used or potentially used by sea turtles along the west coast of Barbados were initiated in 1991. Surveys were conducted to increase the number of non-nesting turtles tagged annually, in order to define important feeding and refuge areas, quantify species diversity, monitor population trends, and to identify adverse impacts on important foraging and refuge habitats. In 1997, more extensive surveys were conducted islandwide by BSTP personnel and through assistance from local dive enthusiasts, dive shop operators and commercial charter boats. Surveys were conducted over a 5-month period (August-December) which yielded 180 turtle sightings at more than 60 different locations.

Future activities will involve collaboration in a regional project to track and monitor post-nesting females using satellite telemetry in order to investigate habitat utilization, nest-site tenacity, inter-nesting movements, and post-nesting migration behavior. It is hoped that such an activity will also help to further deter poaching attempts of nesting females in Barbados.

Future initiatives with respect to juvenile turtles will involve the implementation of a program to tag, track and monitor juvenile green and hawksbill turtles in order to investigate their offshore behavior, movements, residency, and habitat utilization in the waters around Barbados. Behavior of turtles at sea, particularly juveniles, is poorly understood; inter-reef movement and residency of this important life stage is largely unknown. Tagging of juveniles will be undertaken by trained BSTP biologists at commercial dive sites. Blood samples from tagged juveniles may also be collected for future genetic studies. Involvement of dive operators and dive enthusiasts in monitoring on a continuous basis will foster community participation in the conservation of these critically endangered species. A poster will be produced to describe the Project and inform Barbadians on how to recognize the turtles under study.

Increased knowledge of the local and international movements of turtles will provide the basis for determination of the extent to which Barbados shares its sea turtle stocks with neighbouring countries, and hence the extent to which cooperative measures are required to ensure the success of local efforts to further the survival of sea turtles in Barbados.

MONITORING OF HATCHING EVENTS

All nests are closely monitored by BSTP personnel. Following hatchling emergence, nests are excavated and nest contents examined to assess hatch success and possible causes of embryo and hatchling mortality. Persons working or living close to nests laid on brightly illuminated beaches are asked to dim lights and keep a look out for disoriented hatchlings. Where disorientation is inevitable, thereby leading to high mortality, the nest is translocated to a dark portion of the same beach. If this is not feasible, nests are moved to BRI for hatching and hatchlings are then returned to the same beach for release. Disoriented hatchlings found during the day following hatching are collected and released the same night from the natal beach. Unplanned events such as these provide the BSTP with an unique opportunity to stage hatchling releases for local residents and visitors, with emphasis placed on involving school children and youth community groups.

RESPONSE TO STRANDINGS AND THE CARE OF SICK/DEBILITATED TURTLES

Strandings of dead or injured sea turtles are reported to the BSTP or the Fisheries Division. BSTP personnel collect the turtle and bring it to BRI. Dead turtles are identified to species, measured and necropsied for possible cause of death.

Stomach contents and tissue samples are preserved. Injured turtles are typically those that have partially drowned in nets, but human-induced injuries have also included embedded fish hooks, spear and bullet wounds, and injuries caused by dynamite blasts and boat propellers. BSTP personnel and 2 veterinary surgeons treat sick and injured turtles. BRI maintains several seawater tanks for rehabilitation.

Sea Turtle Database

Data collected through monitoring efforts of sea turtle nesting activity (*e.g.* numbers and locations of nests, numbers of poached nests and turtles, numbers of disoriented hatchlings, post-hatchling emerge data from excavated nests) and data obtained from sea turtle strandings are compiled and maintained at BRI. Fisheries Division and other interested governmental and non-governmental agencies are provided with compiled data upon request.

INCREASING ENVIRONMENTAL AWARENESS

BSTP personnel are actively involved in conducting extensive public education programs on sea turtles and promoting increased awareness about conservation efforts in Barbados. The frequent beach site visits by Project personnel has resulted in an increased spread of information regarding the status and conservation of sea turtles in Barbados. Prior to the beginning of each turtle season, notices and articles are put out by the Project in local newspapers, requesting assistance from the public in monitoring and conserving turtles. Flyers and pamphlets are sent out to all beachfront hotels and restaurants and coastal property management agencies. Direct consultations are made with hotel managers, hotel staff, coastal property managers, beach cleaners, beach vendors, and enforcement officers in the interest of enlisting their support for turtle protection. Information on maintenance of turtle nesting habitats is disseminated to coastal construction companies, architects and landscape architects in attempts to mitigate potential adverse impacts of coastal developments. Project personnel give talks on sea turtle biology and conservation to schools, governmental and non-governmental agencies, and organise formal presentations at a variety of public fora. Environmental programs implemented by governmental and non-governmental organisations in collaboration with the BSTP have furthered the active participation of the general public in monitoring turtle activities and maintaining turtle habitats.

Non-consumptive Use of Sea Turtles

In 1997, a coastal fishing community created a popular tourist attraction by capturing, raising and releasing 6 green turtles. These animals are hand-fed daily and can be predictably seen by dive boats, glass-bottom boats, snorkellers and sea bathers. Although neither WIDECAST nor the BSTP encourage the rearing of sea turtles, these animals have proved to have considerable educational value in that local people can see the attraction that tourists have for live turtles. Problems with this type of non-consumptive use may occur if appropriate guidelines are not put in place that will deter too many other persons creating similar attractions.

ACKNOWLEDGMENTS

The authors would like to thank Kimberly Woody, Steven Herzlieb, Vicky Copeman for their dedication throughout the nesting season. Our appreciation goes out to William Bertalan, the Barbados general public, dive operators, hotel staff, and Bellairs Research Institute for their continued support in our efforts. The authors would like to thank the Chelonia Institute and the Symposium Travel Fund for providing a travel grant.

PHOTO-IDENTIFICATION OF HAWAIIAN GREEN SEA TURTLES

Austin Richardson[1], Lawrence H. Herbst[2], Peter A. Bennett[3], and Ursula Keuper Bennett[3]
[1]Grade 6, Sir John A MacDonald Middle School, Brampton, Ontario, Canada
[2]Albert Einstein College of Medicine, 1300 Morris Park Avenue, Bronx, New York 10461, U.S.A.
[3]Turtle Trax http://www.turtles.org (Canada) howzit@turtles.org

Our study demonstrated that use of facial markings is a reliable way to identify individual green sea turtles. Dr. Herbst and I had to compare 25 turtles appearing on videotape with 93 images representing 30 animals. We correctly matched 21 animals to their photos and weren't fooled by the remaining four whose photos were intentionally withheld from us.

The basic use for facial photo records is for underwater fieldwork where turtles either don't have tags or you will disturb them if you have to read the tags. Reading faces lets you stay farther away and observe them more naturally. - possibly for their entire lives.

HATCHLING DISORIENTATIONS ON ST. GEORGE ISLAND, FL: PAST, PRESENT, AND FUTURE..

Tammy M. Summers, Teresa J. Calleson, George O. Bailey, and H. Lee Edmiston
Apalachicola National Estuarine Research Reserve (ANERR), Florida Department of Environmental Protection, 350 Carroll St., Eastpoint, Florida 32328. calleson@digitalexp.com

INTRODUCTION

Under natural conditions, hatchlings find the sea by crawling toward the brighter, lower oceanic horizon and away from the darker, elevated silhouettes of vegetation and dunes that usually border the landward edge of the beach (Lutz and Musick, 1997). Artificial light sources in proximity to nesting beaches produce highly directed light fields that misdirect hatchlings (Witherington, 1995). Disoriented hatchlings are usually guided away from the water and are attracted to artificial light usually leading to death by dehydration, exposure, predation, or vehicular mortality.

There are several strategies for minimizing the effects of artificial lighting on sea turtles. These include 1) education--informing the public and making them aware of the problems and possible solutions, 2) legislation--implementing light management laws, 3) prevention and enforcement--issuing warnings before nesting season to resolve problems before they happen (Witherington and Martin, 1996).

Impacts of artificial lighting on sea turtles has not always been a significant problem on St. George Island beaches. Between 1990 and 1996, a total of 19 sea turtle hatchling disorientation incidents were recorded. Approximately half of these incidents occurred in front of commercial areas with numerous lights such as motels, condominiums, and public beach accesses. However, St. George Island in northwest Florida (Figure 1) experienced almost a ten-fold increase in hatchling disorientations from 1996 to 1997, and with the threats imposed by increasing development and a local economy whose base is switching from seafood to tourism, area biologists must turn to the above mentioned strategies for sea turtle protection.

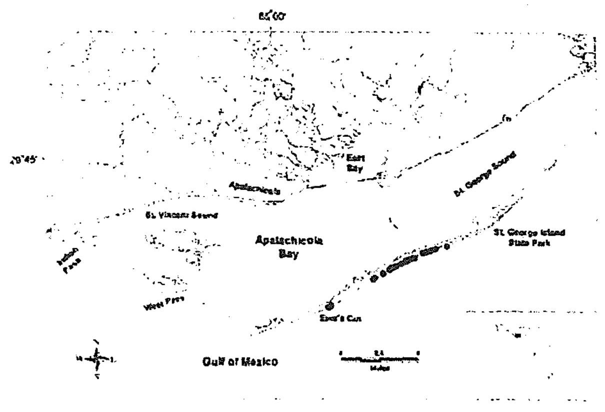

Figure 1. Location Of 1997 hatchling disorientation events documented on St. George Island in Franklin Country, Florida.

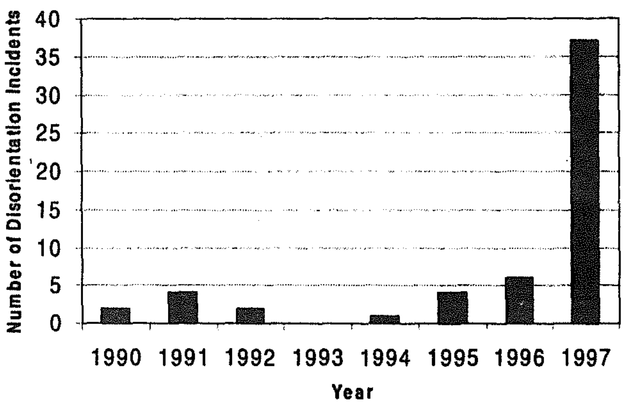

Figure 2. Sea turtle disorientation incidents by year on St. Gorge island, Fl.

PRESENT

During the 1997 nesting season, it became evident that St. George Island did indeed have a light pollution problem with Reserve staff documenting a total of 37 hatchling disorientation events (Figure 2). These incidents were attributed to multiple light sources including commercial areas, street lights, and beachfront rental home porch/carport lights. Approximately 29 of these disorientations were attributed to rental home porch/carport lights leading us to believe that the major source of our problem was not commercial areas (as was the case in previous years) but seasonal renters/vacationers. ANERR staff began taking steps to educate the public of the lighting problems on St. George Island. Sea turtle informational brochures ("Attention Beach Users") provided by the Center for Marine Conservation were distributed to local real estate offices and were then posted in rental houses along the beach. Several reporters representing local papers and newsletters wrote articles concerning the sea turtles and the lighting problem on the island. In addition, a local radio station, WOYS radio, sponsored several public radio announcements devoted to protecting sea turtle hatchlings by reducing light pollution. Preliminary discussions had also begun with local officials on the subject of a light ordinance for St. George Island.

FUTURE

Future plans include several ideas for public education and community involvement. A light switch cover has currently been produced (Figure 3) and will be placed by real estate and Reserve personnel in each beach facing house and condo prior to the 1998 sea turtle season. A light switch cover

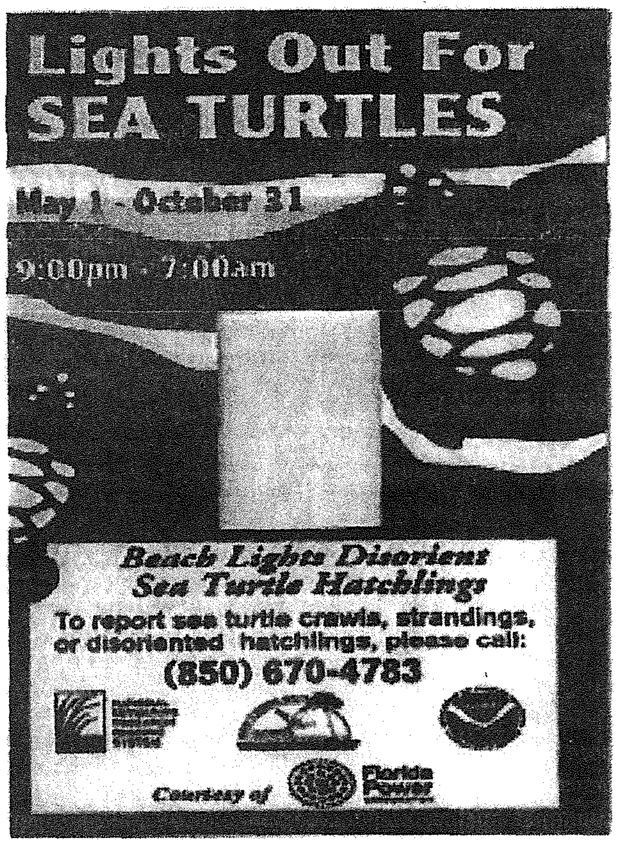

Figure 3. Light switch cover design.

poster unveiling its design, along with sea turtle information brochures were presented at the ANERR education booth during the 34th Annual Florida Seafood Festival held in nearby Apalachicola. A community-funded billboard warning of the effects of lights on hatchlings is in the works for placement on the causeway leading to St. George Island. The St. George Island Civic Club, in cooperation with ANERR staff, are also currently soliciting support for light ordinance legislation. With community support, a lighting ordinance will be in place by the 1998 nesting season. These preventative measures, combined with the continued placement of educational brochures in rental houses and the use of the local media, will target the island's primary beach users. The ultimate goal is to educate every resident and visitor of St. George Island of the plight of sea turtle adults and hatchlings and to accomplish this by working closely with the local community.

St. George Island is unique in that most of the population during the summer is made up of weekly or monthly renters from other areas. To date, it has been difficult if not impossible to educate each new group of tourists concerning the dangers of porch/carport lights to sea turtle hatchlings. St. George Island is also unique in that the street lights are privately owned. Therefore, ANERR staff had to obtain the property owners' permission to have the local power company, Florida Power, turn off these street lights for the duration of the hatching season. In addition, the amount of development and tourism is rapidly increasing on St. George Island and, as a result, the artificial light pollution problems that accompany these environmental pressures. However, with increased public awareness, community involvement, and the adoption of light ordinance legislation, the number of disoriented hatchlings can be significantly reduced to preserve otherwise suitable nesting habitat for both endangered and threatened sea turtle species for years to come.

ACKNOWLEDGEMENTS

The authors would like to extend their appreciation to Wayne Vonada for his help recovering disoriented hatchlings, recording problem lights on St. George Island, and his humor. A special thanks to Cindy Clark (Bay Media Services) for designing the light switch cover and to Florida Power for their cooperation in turning off street lights and for purchasing the light switch covers for the 1998 season. Sincere thanks to Barbara Sanders and the St. George Island Civic Club for their help in making a light ordinance an attainable goal. Thanks to Martha Maglothin for the use of her camera. Special thanks to the residents and vacationers of St. George Island for turning your lights off!

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SHORT-RANGE REPRODUCTIVE MIGRATIONS OF HAWKSBILL TURTLES IN THE HAWAIIAN ISLANDS AS DETERMINED BY SATELLITE TELEMETRY

Denise M. Ellis[1], George H. Balazs[2], William G. Gilmartin[3], Shawn K. K. Murakawa[1], and Lawrence K. Katahira[4]
[1]Joint Institute for Marine and Atmospheric Research, 2570 Dole Street, Honolulu, Hawaii 96822-2396 U.S.A. Denise.Ellis@noaa.gov
[2]National Marine Fisheries Service, Southwest Fisheries Science Center, Honolulu Laboratory, 2570 Dole Street, Honolulu, Hawaii 96822-2396 U.S.A.
[3]Hawaii Wildlife Fund, P.O. Box 70, Volcano, Hawaii 96785 U.S.A.
[4]Hawaii Volcanoes National Park, P.O. Box 52, Hawaii National Park 96718 U.S.A.

Five hawksbill turtles, *Eretmochelys imbricata*, nesting in the Hawaiian Islands during 1995-97 were tracked by satellite using the Argos system. The purpose of this study was to locate resident foraging pastures utilized by the turtles, and to determine the routes taken to reach these sites. The hawksbill is a rare and endangered species in the Hawaiian Islands where it has recently been the focus of increased research and recovery efforts. Nesting is confined to only a few beaches on the islands of Oahu, Molokai, Maui and Hawaii in the southeastern segment of the archipelago. Sightings by ocean users of immature or adult hawksbills are uncommon in marine habitats of the Hawaiian Islands. In contrast, green turtles, *Chelonia mydas*, are numerous and routinely encountered by divers and tour operators promoting the underwater viewing of sea turtles.

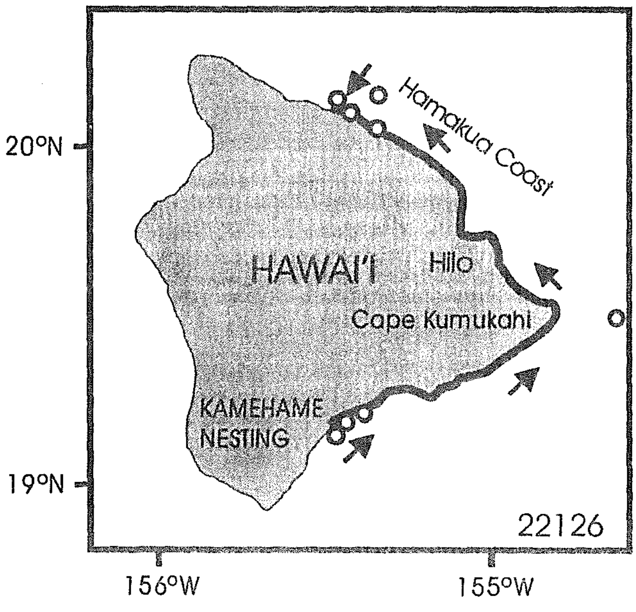


Figure 1. 1995 post-nesting migration of Hawksbill 22126 from Kamehame beach 180 km in a counter-clockwise direction to Honoka' a on the Hamakua coast.

A knowledge of the marine habitats used by Hawaiian hawksbills, especially adult females, is essential for effective protection and management. The flipper tagging of 38 nesting hawksbills since 1991 has only yielded resightings on or near the beaches where the turtles were originally tagged. The Hawaiian Archipelago extends for 2450 km across the North Pacific (19°N, 155°W to 28°N, 178°W) and is among the most isolated of all island groups. Prior to the satellite tracking reported herein, distant migrations by hawksbills to destinations both within the archipelago, and to international areas beyond, were considered as possibilities.

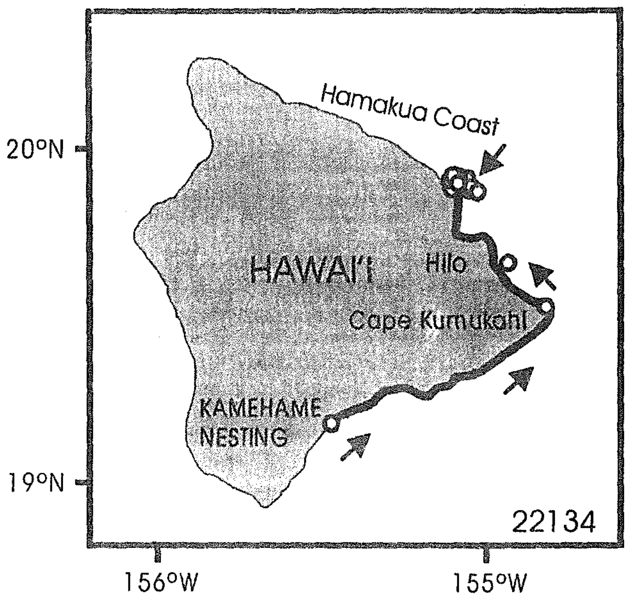


Figure 2. 1995 post-nesting migration of Hawksbill 22134 from Kamehame Beach 135 km in a counter-clockwise direction to Honomu on the Hamakua coast.

ST3/ST14 one-watt UHF satellite-linked transmitters made by Telonics (Mesa, Arizona U.S.A.) were safely and securely attached with polyester resin and fiberglass cloth to the carapaces of four hawksbills nesting at Kamehame on the island of Hawaii (two in 8/95, two in 8/96) and one nesting at Kealia, Maui in 9/97. The three turtles tracked in 1996-97 were also equipped with Telonics MOD-225 VHF transmitters to allow auxiliary monitoring using a portable receiver and antenna at nearby coastal sites.

Three of the turtles tracked from Kamehame and the one tracked from Kealia migrated to the nearshore waters of the Hamakua Coast, a windswept shoreline of cliffs on the island of Hawaii that is inhospitable for recreational use (Figures 1-4). The routes taken were mainly coastal involving estimated distances of only 135-255 km traveled in 7-10 days.

The fourth turtle tracked from Kamehame migrated to Kahului Bay on the windward side of Maui, a distance of 315 km (Figure 5). The route of this migration was again mainly along the coastline taking an estimated 18 days.

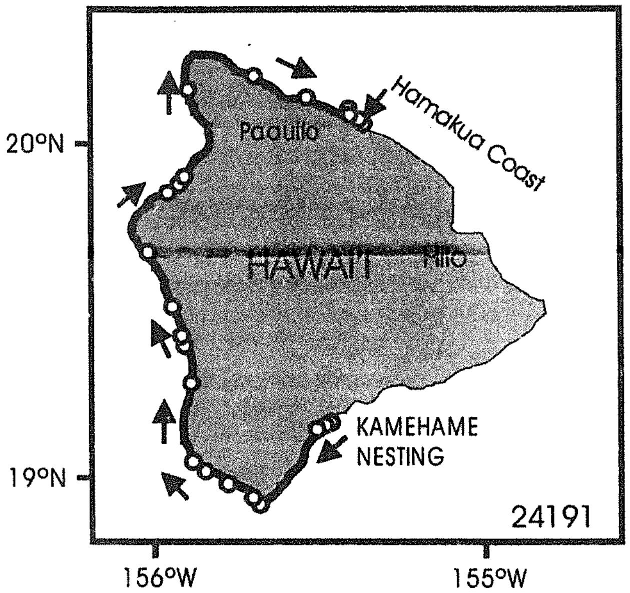


Figure 3. 1996 post-nesting migration of Hawksbill 24191 from Kamehame Beach 255 km in a clockwise direction to Paauilo on the Hamakua Coast.

Upon completion of the post-nesting movements to a coastal area, satellite transmissions continued to confirm each turtle's presence for periods of 71-204 days prior to transmitter signal deterioration. VHF coastal monitoring of the turtle that traveled to Kahului Bay (Figure 5) confirmed its presence there for at least 184 days. Sufficient data were therefore obtained to reasonably presume that foraging areas had been reached where extended residency occurs, possibly until the turtle embarks upon its next reproductive migration.

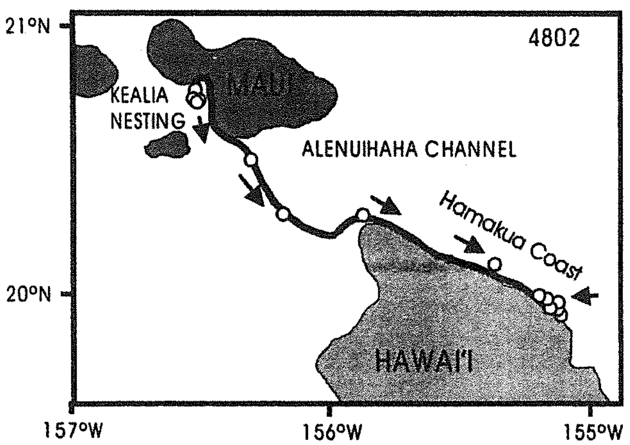


Figure 4. 1997 post-nesting migration of Hawksbill 4802 from Kealia Beach, Maui 240 km to Kuku Point on the Hamakua Coast of the Island of Hawai'i.

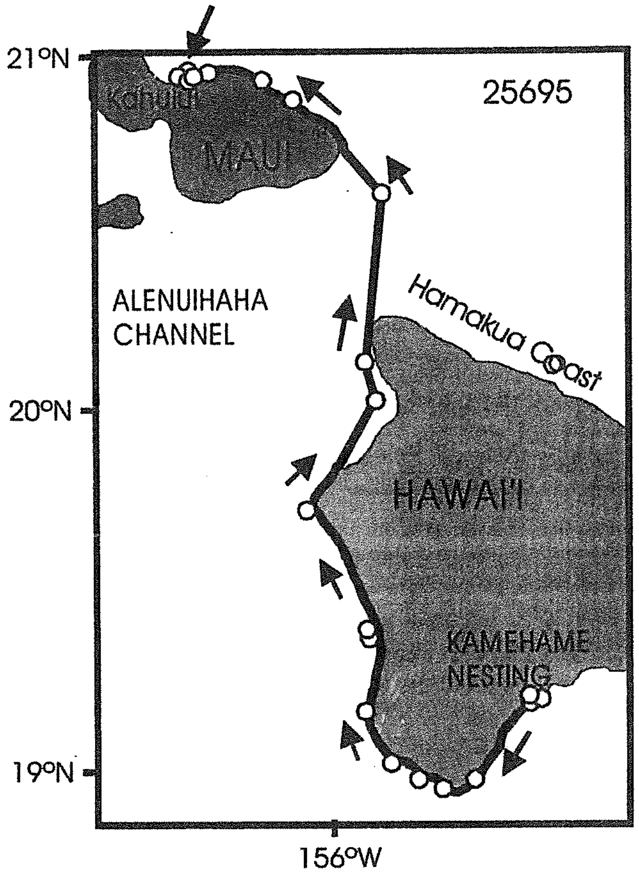


Figure 5. 1996 post-nesting migration of Hawksbill 25695 from Kamehame Beach 315 km Kahului Bay on the Island of Maui.

Results presented in this paper constitute the most successful satellite tracking of hawksbills reported to date. Future research in the Hawaiian Islands will be directed at underwater habitat assessments and censusing of hawksbills in the areas identified by satellite tracking.

USE OF EPOXY IN TELEMETER ATTACHMENT

Sarah V. Mitchell
NOAA, Gray's Reef National Marine Sanctuary, 10 Ocean Science Circle, Savannah, GA 31410, U.S.A.
smitchell@ocean.nos.noaa.gov

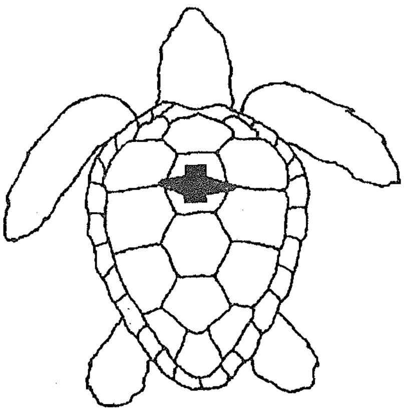
SITE BACKGROUND AND OVERVIEW OF STUDY

Gray's Reef National Marine Sanctuary is one of the largest nearshore live-bottom reefs of the southeastern United States. As such it is an important habitat for sea turtles including the threatened loggerhead sea turtle (*Caretta caretta*). The ledges and overhangs of the reef provide the loggerhead sea turtle with protected resting spots, a bountiful resource of food, and close proximity to nesting sites on barrier island beaches. The National Oceanic and Atmospheric Administration (NOAA) manages Gray's Reef and the other national marine sanctuaries to protect their natural resources. For each sanctuary, a management plan is developed to encourage compatible public uses, and to promote scientific understanding and public awareness of the marine environment. Gray's Reef National Marine Sanctuary is located 32 kilometers (17.5 nautical miles) off Sapelo Island, Georgia and encompasses 58 square kilometers (17 sq. nautical miles) of live-bottom habitat.'s Reef is a submerged hard bottom (limestone) area that, as compared to surrounding areas, contains extensive but discontinuous rock outcropping of moderate (3 meters) height with sandy, flat-bottomed troughs between. The series of rock ledges and sand expanses has produced a complex habitat of caves, burrows, troughs, and overhangs that provide a solid base for the abundant sessile invertebrates to attach and grow. This rocky platform with its carpet of attached organisms is known locally as a "live bottom habitat". This topography supports an unusual assemblage of temperate and tropical marine flora and fauna. Algae and invertebrates grow on the exposed rock surfaces: dominant invertebrates include sponges, barnacles, sea fans, hard coral, sea stars, crabs, lobsters, snails, and shrimp.

Satellite telemeter tracking of male loggerheads captured at GRNMS, off the coast of Georgia, U.S.A., necessitated a method of attachment that reduced the time of transmitter attachment and the risks to the animal. The length of time for the adhesive to cure, potential thermal reaction in the adhesive mixture and reliability of transmitter attachment to the carapace were examined.of several methods of telemeter attachment led to the finding of a two-part epoxy as a viable alternative to fiberglass. Use of epoxy significantly reduces the length of time of telemeter application compared to fiberglass. The attachment procedure typically requires less than 20 minutes when using epoxy as the adhesive. Fiberglass attachment of telemeters usually obligates several hours (the time will vary and is dependent on environmental conditions such as temperature and humidity, as well as the ratio of catalyst added to the adhesive).

OBJECTIVES

Objectives of this project are to monitor: Migratory pathways during the inter-nesting period, diving behavior, offshore reef utilization, inshore spatial use (identification of preferred water areas), seasonal and daily habits,foraging patterns, of loggerhead sea turtles in the South Atlantic Bight.observations by sanctuary staff have documented the presence of various size and age groups of loggerhead sea turtles within the sanctuary and along the South Atlantic Bight, little is known about the turtle's daily and seasonal behavior or their use of the ocean habitats, especially off the coast of Georgia. Many studies have focused on nesting behavior and post nesting movement of adult females, while little work has been conducted on adult male and juvenile behavioral patterns and spatial use of coastal waters.Sea Turtle Satellite Tagging Project utilizes backpack satellite tags to monitor adult and juvenile loggerhead sea turtle behavior and movement in the South Atlantic Bight. Specifically, parameters including turtle's position, time, and depth are electronically collected and transmitted via satellite to researchers at GRNMS. The data will allow scientists to:



1) help explain movement and dive patterns of loggerhead sea turtles,

2) develop a biological model to increase the predictability of these patterns, and

3) obtain information concerning loggerhead behavior and activity off the coast of Georgia.project methods include turtle capture, weight measurement, blood analysis, satellite tag attachment, and release of turtle. To capture a turtle, a loggerhead is directed by divers into a hand held net, carried to the surface, and lifted onto a boat. Turtles are returned to the capture site following a blood sample and the attachment of a satellite transmitter and identification tag.this study satellite transmitters are attached to the turtle using a new method that emloys a 2-part adhesive.

Transmitters are placed on the highest part of the animal's carapace, the second vertebral scale. As the turtle and transmitter are exposed to air, the data collected while underwater is transmitted via satellite. The transmitted information provides specific information concerning turtle position, time intervals between surfacing, migration behaviors, day/night swimming patterns, and inshore/offshore preferred water ranges through near real-time data readout of the loggerhead sea turtle's behavior patterns.this study, nesting female loggerhead sea turtles were captured on Wassaw and Blackbeard Island beaches. Both islands are part of the U.S. Department of the Interior National Wildlife Refuge System. NOAA vessels are utilized to capture adult male sea turtles at GRNMS. To capture a loggerhead offshore, a turtle is directed by divers into a hand held net, carried to the surface, and lifted onto a boat (boat lift and net were designed by S. V. Mitchell, GRNMS). The turtle is returned to the capture site after the transmitter has been attached and the adhesive has set.time satellite data from the three loggerhead turtles, "Isabelle", "Annie", and "Ariel", tagged by GRNMS staff can be seen on the Whale NET server: http://whale.wheelock.edu/whalenet-stuff/loggerhead_cover.html.

OF EPOXY IN TELEMETER ATTACHMENT

Fast Epoxy (The Rawlplug Co. Inc.) is a 2-part structural epoxy available in a specially designed compartment cartridge. The epoxy is odorless, produces minimal thermic reaction, and is a high strength epoxy which has a proven track record. The Foil-Fast cartridge can be dispensed from manually operated injection tools. Each tool has a dual piston design which applies even, consistent pressure to the cartridge to insure proper mixing, eliminating the possibility of measuring errors. The two components: Base Resin and Hardener, are mixed in a 1 to 1 ratio using the manual tool system and mixing nozzle. To insure complete and proper mixing of the epoxy components, the Foil-Fast Systems use a static mixing nozzle. This reduces the possibility of mixing errors which are common with hand mixed materials. The nozzles have been designed with a unique series of stationary components called mixing elements. The elements are motionless and remain in a fixed or static position as the epoxy components are pumped through the nozzle. As the components are pumped through the nozzle, they are progressively divided and recombined by the stationary mixing elements to insure precise automatic mixing of the components. Weld is used as a physical barrier to hold the Foil-Fast in place, as a means to level the space between the carapace and transmitter, and as a secondary adhesive. This two part epoxy is designed to be mixed by hand and is easily malleable. Mix the contents of one entire tube of Sonic-Weld for the application of each transmitter. An additional benefit of mixing the full tube is the elimination of measuring errors. Sonic-Weld must be applied before hardening begins, usually within two minutes.working with these two epoxies, the researchers have found Foil-Fast and Sonic-Weld to be non-irritating to human skin, although either may cause a reaction to sensitive skin, and may be harmful if swallowed.

RESULTS

Two-part epoxy method of attachment for satellite transmitters has proven successful in this study. Transmitters attached with this method have remain attached, transmitting satellite tracking information from the turtles for seven months.

RESEARCH AT GRNMS

Gray's Reef National Marine Sanctuary recognizes the importance of long term monitoring to understand and recognize the health and status of the significant resources found in the sanctuary. Long term monitoring of the resources also serves the management concerns of other state and federal agencies as Gray's Reef is one of the largest natural live-bottom reefs in the South Atlantic Bight and serves as a good indicator of overall live bottom health in this region.:carapace for transmitter attachment. If the bottom surface of the transmitter is smooth it is preferable to score opposing diagonal lines into the bottom surface of the transmitter with a semi-sharp object such as a screw driver or metal putty knife.up and prepare supplies:chalk gun loaded with 2-part Foil Fast epoxy, and secure nozzle in place on gun.mix 2 oz of Sonic-Weld by hand.the Sonic Weld into 1 cm coils the following lengths (these figures are formulated for transmitters that measure 7 X 14.5 cm on the bottom surface):coils that are each 18 cm in lengthcoils that are each 7 cm in lengtha 1 cm diameter by 18 cm in length coil of thoroughly mixed Sonic Weld around the edge of the bottom of the transmitter such that it covers 1/3 of a long side, the entire short side and 1/3 of the following long side, as shown in the drawing below. This coil will form a lip on the transmitter when it is mounted on the turtle. Repeat with the other 1 cm diameter by 18 cm long coil of Sonic-Weld to the opposite end of the bottom of the transmitter (again 1/3 long side - entire short side- 1/3 long side). Attach one coil 7 cm in length (1 cm in diameter) to each of the 4 coil ends that you have just placed on the transmitter. Leave these ends hanging free at this point. Completely cover the entire bottom of the transmitter with a generous amount of Foil Fast. Place the transmitter in the correct position on the turtle and press the transmitter firmly against the carapace. Excess Foil Fast will discharge as the transmitter is placed on the turtle from the 2 openings on the long sides in areas where there is an absence of Sonic-Weld. If Foil Fast does not flow outside from the bottom of the transmitter, remove the unit and apply additional Foil Fast to transmitter and reapply onto carapace. Press the lip coils of Sonic Weld securely in place against the carapace. Press the 4 loose pieces of Sonic Weld into the carapace forming a triangle on each side on the transmitter as shown in the drawing (The transmitter forms one of the sides of the triangle, the other two sides are formed by the 7 cm long coils.)in the triangle formed by the Sonic-Weld on each side of the transmitter with Foil Fast. epoxies will set in approximately 7 to 8 minutes.

USE OF A MINIATURE DATA STORAGE TAG ON A JUVENILE HAWKSBILL TURTLE (*ERETMOCHELYS IMBRICATA*) AT BUCK ISLAND REEF NM, U.S. VIRGIN ISLANDS

Mitchell M. Sisak[1], Zandy Hillis-Starr[2], Brendalee Phillips[3], Roy A. Pemberton Jr.[4], and John W. Crow[5]
[1]Lotek Marine Technologies Inc., 114 Cabot Street, St. John's, NF A1C 1Z8. mitch.sisak@lotek.com
[2]National Park Service, Buck Island NM, St. Croix, VI
[3]U. S. Geological Survey, Biological Resource Division, Buck Island NM, St. Croix, VI
[4]The College of William and Mary, Virginia Institute of Marine Science, Glouster Pt., VA
[5]Computer Support Services, St. Croix, VI

ABSTRACT

Data is presented for a juvenile hawksbill turtle (*Eretmochelys imbricata*) instrumented with a miniature data storage tag (LTD_100) equipped with transducers for depth, temperature and photoperiod. The three week deployment marks the first use of the miniature data logger on marine turtles. The small size of the instrument (16 mm x 52 mm, 16g) permits use of a time depth recorder on smaller individuals than was previously possible, gaining insight into the activities of individuals in these size classes. The five year battery life and 1 Mbytes of on-board memory permit long-term deployment yielding data with extensive spatial and temporal resolution.

Dive time and duration are presented. The restricted geographic area over which the test animal ranged during the attachment period precluded the use of photoperiod to determine geographic position, but the utility of the technique is discussed. The attachment method employed permits the attachment and removal of the datalogger with minimal stress to the individual.

INTRODUCTION

The hawksbill turtle (*Eretmochelys imbricata*), a marine turtle with a circumtropical distribution, was identified as endangered in 1970 and is listed under the Endangered Species Act of 1973. It's status has not changed. While one of the most commonly observed species in Caribbean and tropical Australia, these individuals are almost entirely made up of subadults, and few nesting colonies exist (NMFS, 1995). Hawksbill turtles occupy the pelagic environment as posthatchlings and reenter coastal waters when they reach approximately 20-25 cm carapace length (Lutz and Musick, 1997). Coral reefs are widely recognized as the resident foraging habitat of juveniles, subadults and adults, and the hawksbill sea turtle recovery program has identified the conservation of these areas as critical for the protection of the species (NMFS, 1993).

In 1988 the National Park Service began conducting research on the nesting biology of the hawksbill sea turtle at Buck Island Reef NM (BUIS) (Photo 1). The program was expanded in 1994 to include the study of juvenile hawksbill turtles resident and foraging in the coral reef habitat surrounding BUIS (Philips, 1996). In December 1997, as part of the study under the NPS/VIMS Cooperative Agreement, an automated biotelemetry system was established on Buck Island to provide location data on instrumented juvenile hawksbill turtles in the area around the Monument (Figure 1). This information, together with in-water observations, will be employed to identify zones of activity toward a better understanding of the developmental habitat, habitat utilization and foraging ecology of juvenile hawksbill turtles around Buck Island.

While telemetry data is invaluable in monitoring the general activity of animals in the wild, the attachment of data storage tags provides the possibility of providing physical data of unrivaled spatial and temporal resolution. In the past, data storage tags were quite large in size and the memory capacity was limited. Recent advances in micro-electronics have addressed these issues, resulting in a new generation of data storage tags which are small and long lived. The reduced size of the tag permits the use of data storage tags on the smaller size classes of marine turtles, particularly smaller subadults and juveniles.

In conjunction with the ongoing biotelemetry studies being undertaken at BUIS which are based on radio and acoustic telemetry techniques, a newly developed data storage tag was deployed to permit the monitoring of diving behaviour in juvenile hawksbill turtles. The small size of the unit and its large data capacity and autonomy permit the collection of detailed information on small juvenile turtles. The temporal resolution of the data was previously only available in larger instruments unsuitable for use on the smaller size classes. With an air weight of 16 g the tag is usable on a 320 g turtle if the 5% rule is followed. The size class distribution for all the juvenile hawksbills tagged to date at BUIS ranges from 1.5 to 49.5 kg., and as such, the data storage tag is applicable in all cases.

MATERIAL AND METHODS

Turtle number QQD-622, a juvenile male hawksbill turtle was captured on December 16, 1997, off the East end of Buck Island using a hand capture technique (Figure 1). This individual was first captured on June 6, 1995, as part of the NPS/BUIS long term foraging study. He has been recaptured 18 times since and at the last capture measured 54.2 cm CCL and weighed 14.0 kg. The 40-50 cm size class represents 35.1 % of the population of juvenile hawksbill turtles tagged at BUIS to date.

A miniature data storage tag (Model LTD_100, Lotek Marine Technologies Inc.) was deployed on QQD-622 for a period of 23 days (December 16, 1997 through January 8, 1998). The deployed unit had a depth range of 100 m and an accuracy of ± 0.2 m. Weighing 16g in air (1 g in water), the data storage tag was cylindrical in shape, measuring 18 mm x 57 mm. The sensor suite consisted of temperature, light and pressure and total memory capacity for the unit was 1 Mbyte. The sampling interval was programmed to 30 seconds for pressure and 1 minute for light and temperature. Memory utilization with this sampling regime resulted in a life of 3 months for the unit before the memory was filled. Memory employed is of a FLASH type, guaranteeing data retention for 20 years in the event of battery exhaustion prior to recovery. The light sensor enables changes in ambient light to be recorded. This information, employed with the precise time information recorded at the moment of sample acquisition, enables the use of algorithms which permit geolocation to be determined to an accuracy of approximately 40 km (Klimey and Mangan, 1994).

The unit was attached to the left postmarginal scutes (#9 and #10) using 2 mounting holes (0.6 mm) drilled dorsoventrally through each scute through the non-living tissue. The holes were drilled approximately 10 mm and 30 mm inboard of the outer margin of each scute. The data storage tag was secured within a carrier (PVC tube) which was in turn attached between the mounting holes using epoxy as a bedding material (Photo 2). Additionally, nylon cable ties and stainless steel locking wire were passed around the unit and through the mounting holes. Fiberglass resin and Bondo were filleted between the tag carrier and the carapace to improve adhesion. The design of the mount was such that the contained data storage tag could be recovered without the need to remove the carrier, facilitating the execution of long-term studies.

Part of a long-term telemetry study, the animal was also instrumented with a coded acoustic transmitter, cylindrical in shape, measuring 16 mm x 51 mm, weighing 31 g in air (16.6 g in water) which was mounted on the right post marginal scute in a similar fashion. A specially adapted coded radio frequency transmitter measuring 80 mm x 56 mm, weighing 109 g in air, and incorporating an abrasion resistant vertical antenna was mounted high on the apex of the carapace on the #2 vertebral scute (Photos 3 and 4). An automatic data logging station installed on the summit of Buck Island continuously monitors the activity of radio transmitter equipped turtles upon surfacing in the area surrounding the island, while the acoustic transmitter permits the manual re-location of instrumented submerged animals. Well within the established norms, the total attached instrument mass did not exceed 1 % of the mass of QQD-622. Photo 5 illustrates the animal swimming following its release. The normal in water posture suggests minimal instrument induced effects. Four subsequent sightings by the researchers of QQD-622 in the same general areas of BUIS, along with continuous radio tag monitoring suggests no obvious change in demonstrated behaviour.

DATA RECOVERY

The animal was re-captured in the general vicinity of initial capture on January 8, 1998, utilizing the hand capture technique. The data storage tag was recovered and the carrier removed. Raw data was downloaded using the supplied tag reader and TAGTALK software into a comma separated text file (i.e. csv). Each record consisted of date, time and pressure. The tag held 59,740 pressure records. Light and temperature data were also stored in the tag. Light and temperature data were examined, but not analyzed as the subject remained within the area of BUIS during the course of the deployment. As such, geolocation information was not required, and the isothermal environment encountered within the reef area demonstrated minimal variation with time.

The pressure records in the data were transformed into meters of sea water, and the data were entered into a custom software program (DIVELOG developed by Computer Support Services of St. Croix, Virgin Islands), and parsed into dive events. DIVELOG permits the user to set a depth at which a surface event is recognized by the program, and setting the surface detection threshold at 0.43 meters captured most surface events which had been previously identified by manually scanning the raw data. Over the 23 day deployment period, DIVELOG identified 693 dive events.

Data files generated using the depth information were output listing dive event number as well as its duration, average depth, maximum depth and surface interval. Dives were grouped into day and night dives to permit analysis for any diel differences either in dive duration or depth. Day dives were classified as any which took place between the hours of 06h00 and 18h00, while night dives were dives which took place between 18h00 and 06h00.

RESULTS AND DISCUSSION

While the small sample size and relatively long sampling interval combine to prohibit fine-scale analysis of the dive data, preliminary analysis has revealed several interesting findings. Table 1 summarizes the collected dive data for QQD-622.

DIVE BEHAVIOUR

Figures 2 and 3 illustrate dive profiles generated from raw data downloaded from the storage tag over a 2.5 day period immediately after the animal was released and over a 3 day period 10 days following his release .

The subject was released at approximately 14h51 on December 16, 1997. Visual observations made at the time of release confirm that QQD-622 made his way gradually out toward deeper water, as is supported by the dive profile (Figure 2). Subsequent dive profiles suggesting transitional activity are seen on December 26, 1997, particularly evident between 06h00 and 08h00 and again on December 27, 1997 between 06h53 and 09h00 (Figure 3). This transition from resting to higher activity occurs as the night dive pattern is replaced by a day pattern. The data is supported by long term field observations of turtles resident in the BUIS

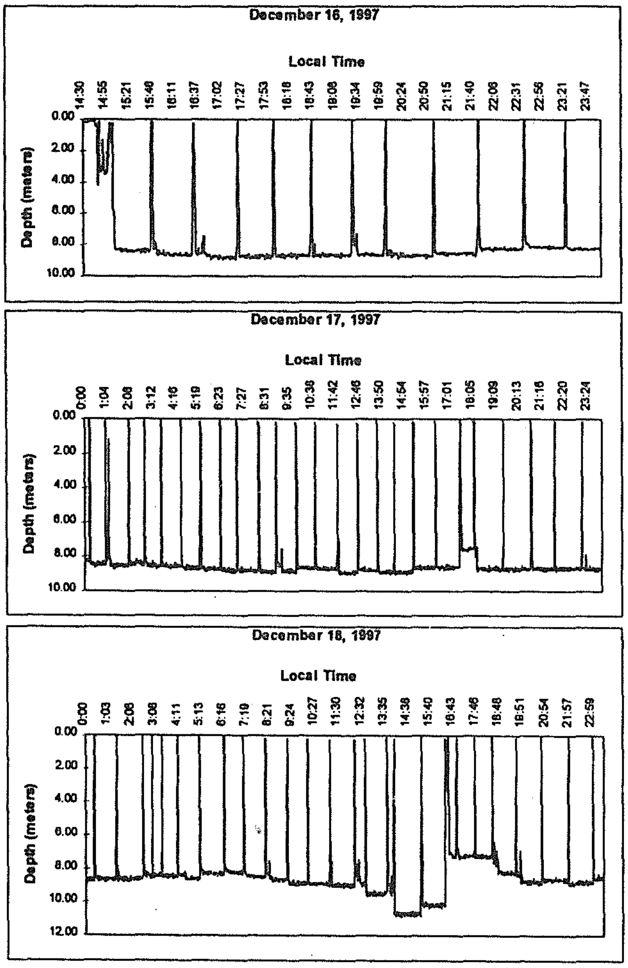


Figure 2: Diving Behaviour of Turtle QQD-622 December 16-18, 1997

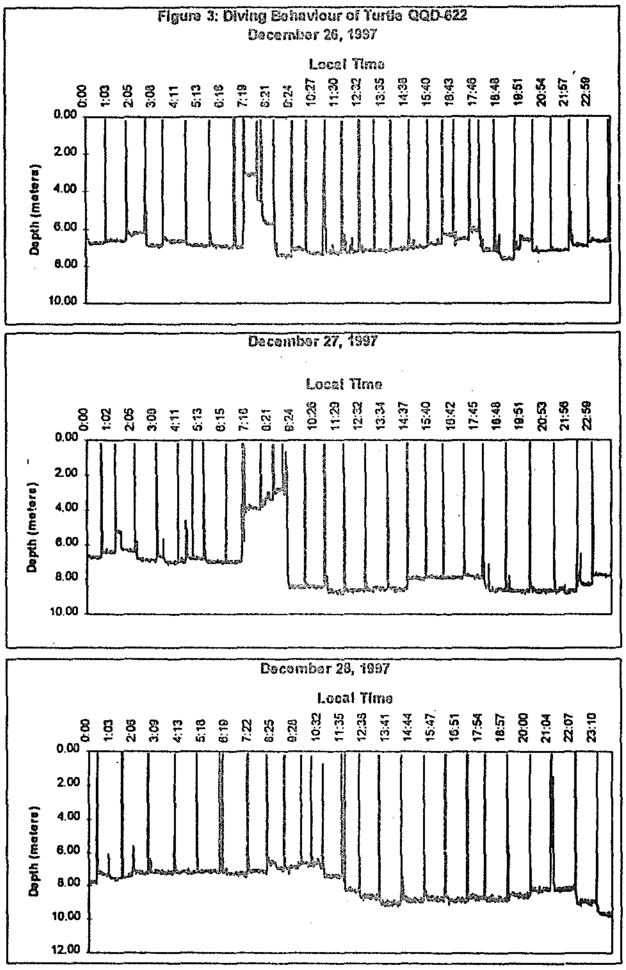


Figure 2: Diving Behaviour of Turtle QQD-622 December 26-28, 1997

area.

Of the total 693 dives recorded over the 23 day period, 446 were day dives, with the remaining 247 dives being made at night. Figures 4 and 5 present frequency distributions for dive duration and average depth, for day and night dives. Depth of dives undertaken during the day tended to be more variable than dives at night, the latter tending to be more regular as to depth and duration.

Referring to Table 1, the mean dive duration for day dives was shorter than for night dives. Average depths of dive showed no diel differences. The deepest dives recorded took place during day dives and registered 14.1 meters. The deepest night dive was to a depth of 12 m.

Direct observation of the BUIS population of resident hawksbill turtles suggests that they typically utilize a restricted geographic range and that their activity during daylight hours is split between the relatively shallow (depth = 4 m) back reef area and the deeper (depth = 8 m) forereef area.. Though the tag data is lacking with respect to geographic position, the apparently bimodal distribution depicted by the day time

Table 1: Summary of data collected by the data storage tag for QQD-622 for Day and Night Dives.

Period	n	Dive Duration (minutes) mean ± SE min - max	Dive Depth (meters) mean ± SE min - max	Maximum Depth Recorded (meters)
Day	446	39.9 ± 1.2 1.1 - 134.8	5.6 ± 0.1 0.5 - 13.7	14.1
Night	247	61.0 ± 1.1 2.8- 126.5	6.9 ± 0.1 3.0 - 11.8	12.0

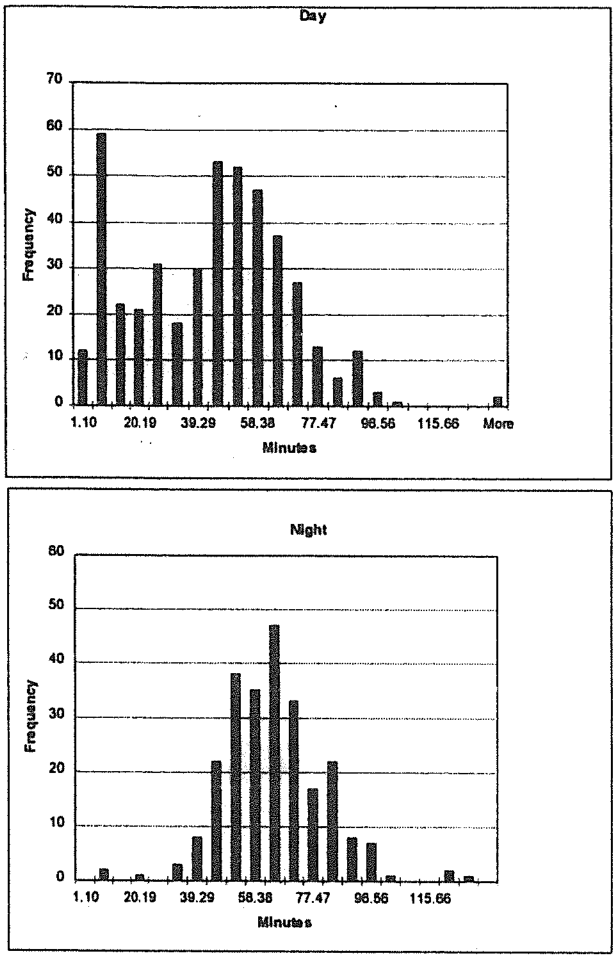


Figure 4: Frequency Distribution of Dive Duration

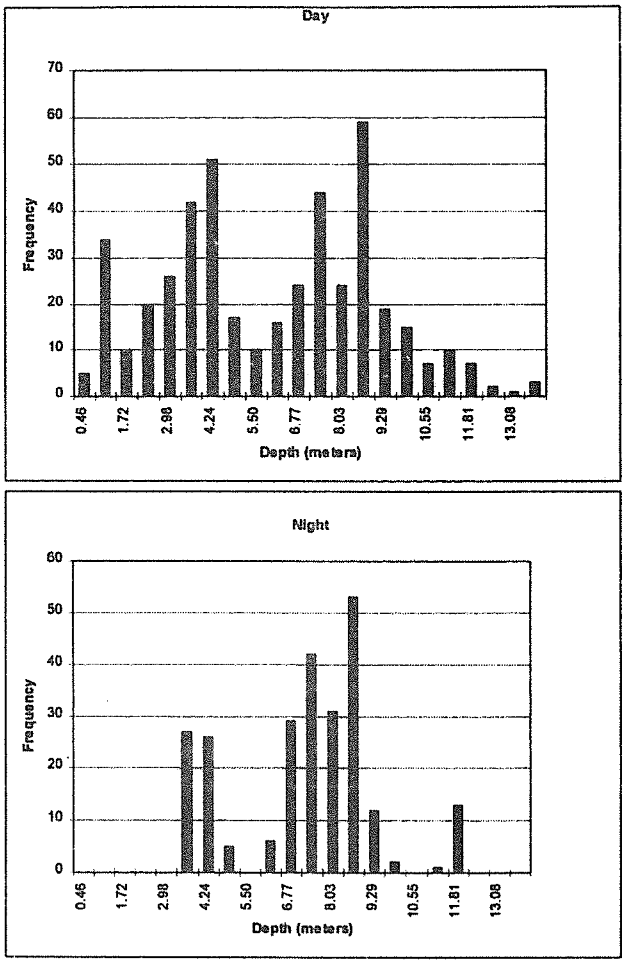


Figure 5: Frequency Distribution of Average Dive depth

frequency distribution of average dive depth (Figure 5) supports these observations. Further, though visual observations are not feasible through the night, tag data for this period suggests that this time is spent in deeper water, with activity showing less variation with respect to time. Although the radio telemetry data base is still undergoing construction, once developed, the correlation of the data storage tag depth data with concurrently recorded relative position estimates will permit the testing of this hypothesis.

Future projects include the re-deployment of the LTD_100 (or possibly an LTD_20) programmed so as to enable only the depth sensor. This configuration will enable the tag to sample pressure at 5 second intervals and yield a tag life of one month. Increased spatial resolution will permit more accurate recording of dive duration and particularly surface interval, which was difficult to assess with any precision given the 30 second sampling interval employed in the initial deployment.

The first deployment of this new generation of data storage tag on a marine turtle has revealed the instrument to be well-suited to the application. The combination of small size, large memory capacity and extended battery life result in a package ideal not only for coastal studies, but also for size classes and species which demonstrate large-scale oceanic migration. With options which include increased memory size and 20 m, 1000m, and 3000 m depth capability, the tag is an extremely versatile tool. Though presently in beta version, the Divelog program promises to enable researchers to more easily handle the huge quantities of data amassed by the tag, which can then be easily imported into analytical packages for further manipulation.

The availability of robust, dependable electronics packages and powerful software holds great promise for the field of sea turtle research.

ACKNOWLEDGMENTS

The authors would like to thank all of those involved in this study for their much appreciated contributions, particularly NPS Volunteers Rick Starr and David "Corky" Houghton. We would also like to thank CellularOne, St. Croix, Virgin Islands for helping to support this research.

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INCIDENTAL CAPTURE OF TURTLES WITH PELAGIC LONGLINE

Federico Achaval, Yamandú H. Marín, and Luis C. Barea
Facultad de Ciencias. Sección Zoología Vertebrados. Tristán Narvaja 1674, 11200 Montevideo Uruguay. achaval@genetica.edu.uy

Data concerning incidental catch of several Turtle species by longliners in SouthWest Atlantic are presented. Data were collected on board by two longliners, which operated between 1994 and 1996. Their target species were Swordfish (*Xiphias gladius*), Tuna (*Thunnus obesus*) and other related species. Each vessel used a different rigging of the fishing gear called Spanish system" and "Florida system", with differences in the materials, bait, presence of chemical light sticks, and presence of wire in the ga ngions. Collected information includes set and haul geographic position, surface water temperature, number of hooks and catch composition separated by species and number of individuals. The main used bait was Squid (*Illex argentinus*), combined with Mackerel (*Scomber japonicus*). Species of captured turtle were *Caretta caretta* and *Dermochelys coriacea*, in a general frequency of 1,8 ind./1000 hooks. 1,9 % of captured turtles resulted died, while 98,1% were released alive but with the hook still in the mouth.

TRENDS IN SEA TURTLE STRANDINGS, U.S. VIRGIN ISLANDS: 1982 TO 1997

Ralf H. Boulon, Jr.
Division of Fish and Wildlife, 6291 Estate Nazareth 101, St. Thomas, U.S. Virgin Islands 00802-1104, U.S.A. ab309@virgin.usvi.net

The U.S. Virgin Islands have three species of sea turtles that frequent our waters, green (*Chelonia mydas*), hawksbill (*Eretmochelys imbricata*) and leatherback (*Dermochelys coriacea*). Virgin Island waters support relatively large populations of juvenile green and hawksbill turtles which have increased significantly since protection was afforded them under the U.S. Endangered Species Act of 1973. Hawksbill turtles are the most common nester on the many small pocket beaches of the Virgin Islands. Green turtles also nest but in fewer numbers and mostly on St. Croix. Leatherbacks migrate from the north Atlantic to nest on a few beaches in the Virgin Islands with individual internesting intervals of two or more years. The largest nesting aggregation of leatherbacks in the United States occurs on Sandy Point, St. Croix. Only one or two nests per year are reported from St. Thomas or St. John.

Since 1982, the Division of Fish and Wildlife has maintained records of all reported strandings of turtles in the Virgin Islands. Strandings are generally reported by citizens and followed up on by Division personnel. A stranding is defined as any turtle which is found dead for any reason or is recovered from a compromised situation and released back to the wild. Only three strandings have resulted in turtles being released. No stranding records were maintained for hatchlings.

Strandings were categorized into five categories. Boat strikes were generally obvious by the presence of a crushed carapace or deep cuts from a propeller. Fishing gear includes entanglement in nets or fishing line or spear. Turtles found on shore with evidence of having been butchered are considered to be poached. "Other" causes of stranding include identifiable reasons for the stranding that were not frequent enough to be in their own category. Unknown reasons are those for which no external cause of mortality was evident and for which, if a necropsy was performed, no internal cause of mortality was determined.

RESULTS

Turtle stranding records for the U.S. Virgin Islands have documented at least 122 turtle strandings from 1982 through 1997. We know of a few other reports but sufficient information was not available to record them. During this period, annual reported strandings have ranged from one to 25 turtles with a trend showing a gradual increase in reported strandings (Figure 1). Strandings have included 79 green, 38 hawksbill and five leatherback turtles (Figure 2). Of the reported strandings, 56 (46%) were from St. Croix, 46 (38%) from St. Thomas and 20 (16%) from St. John (Figure 3). Green turtles were the most commonly stranded species on both St. Thomas and St. Croix, while St. John had equal numbers of greens and hawksbills reported (Figure 3). St. Croix had the greatest number of hawksbills reported and also had all of the leatherback strandings (Figure 3).

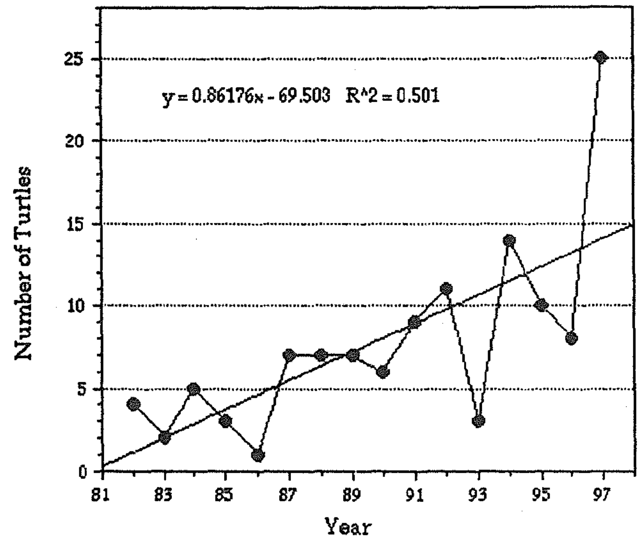

Figure 1. Number of turtle strandings per year: 1982 to 1997, U.S. Virgin Islands (n= 122).

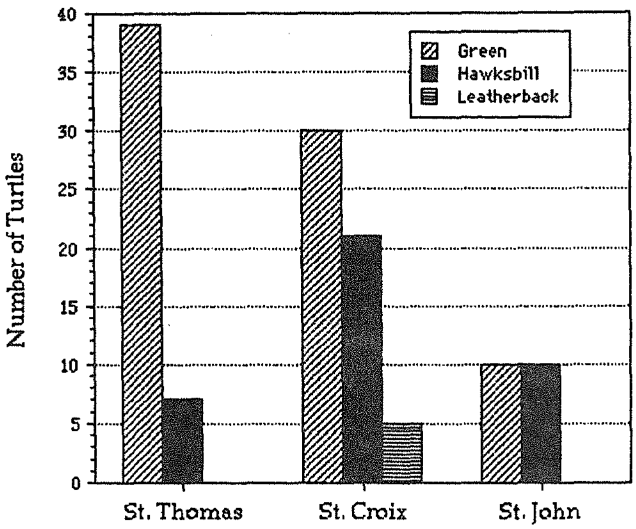

Figure 3. Annual strandings by island and species: 1982 to 1997, U.S. Virgin Islands.

Boat strikes account for the greatest number of the strandings (34.43%) followed by undetermined causes (29.51%), poaching (13.11%), "other" (12.3%) and fishing gear entanglement (10.66%) (Figure 4). Most green strandings are due to boat strikes while hawksbill strandings are mostly from undetermined causes and leatherbacks are from poaching (Figure 5). The primary cause of strandings in St. Thomas and St. John is from boat strikes while for St. Croix it is unknown with poaching being the second greatest cause (Figure 6). During the period from 1982 to 1997, numbers of reported boat strikes per year has increased (Figure 7). The data was looked at for seasonality of strandings by species. There were no indications of any seasonality with the exception of leatherbacks which were all adult and stranded during the nesting season.

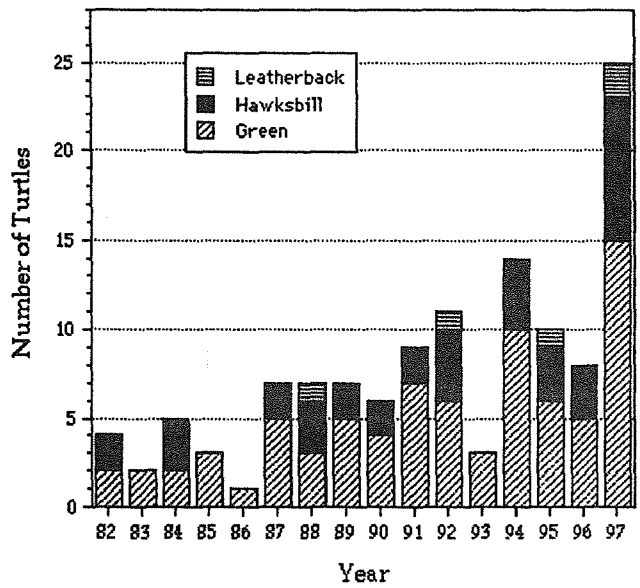

Figure 2. Annual strandings by species; 1982 to 1997, U.S. Virgin Islands.

DISCUSSION

The numbers of stranded turtles reported here certainly do not include all of the strandings for the Virgin Islands during this period. As we rely on reporting by individuals, many stranded turtles may be observed without being reported. Many others may never be observed. However, the reported strandings are probably very reflective of the species composition, distribution and relative causes of stranding for sea turtles in the Virgin Islands.

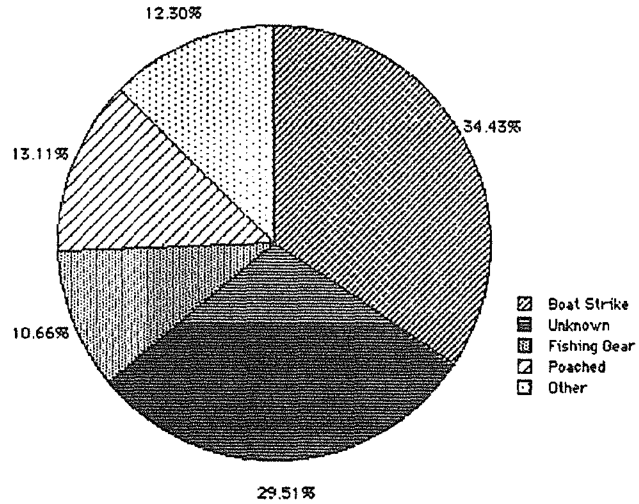

Figure 4. Causes of turtle strandings: 1982 to 1997, U.S. Virgin Islands.

The increase in reported strandings from 1982 to 1997 may be due to a number of factors. Our turtle populations have certainly increased since 1973 when the ESA was enacted. This would numerically allow for a greater number of strandings. Increasing human populations with its resultant increase in environmentally damaging activities also produces more strandings as contact with these activities has become

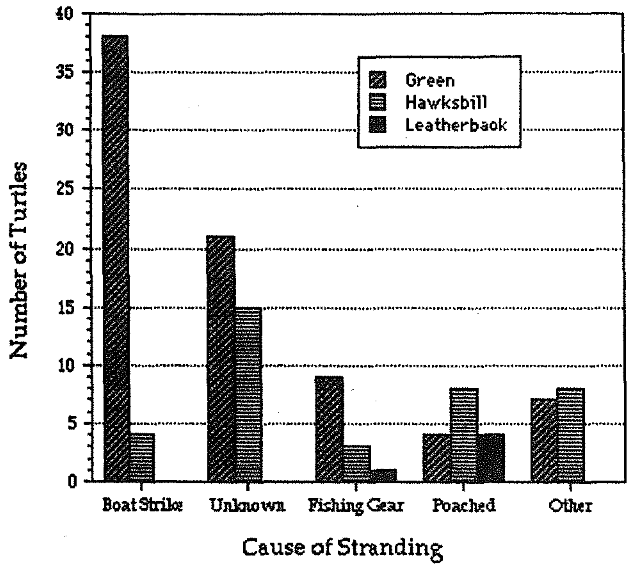

Figure 5. Species specific causes of strandings: 1982 to 1997, U.S. Virgin Islands.

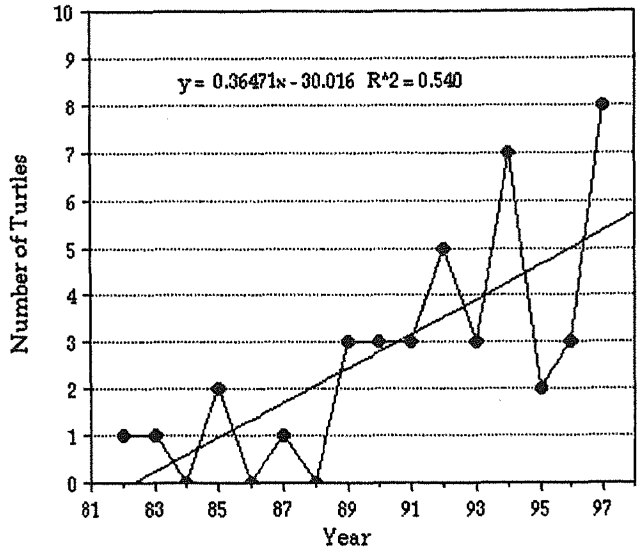

Figure 7. Number of boat strikes per year: 1982 to 1997, U.S. Virgin Islands.

more unavoidable. An example of this is the increase in boat strikes reported. Increasing numbers of turtles and high speed power boats has resulted in increased numbers of unfortunate encounters. Additionally, general public awareness of problems with our natural environment has increased, resulting in more people likely to report a stranded turtle.

Causes of stranding tend to follow certain logical suppositions. More greens strand due to boat strikes because they are more likely to be found in shallow bays where boats are more commonly operated. More boat strikes occur on St. Thomas because there are more boats there. More hawksbills are poached because they are the most common nesting turtle in the VI. More turtles have died due to encounters with fishing gear in St. Thomas because there is more fishing activity there. Leatherbacks all stranded on St. Croix where nearly all of the nesting takes place.

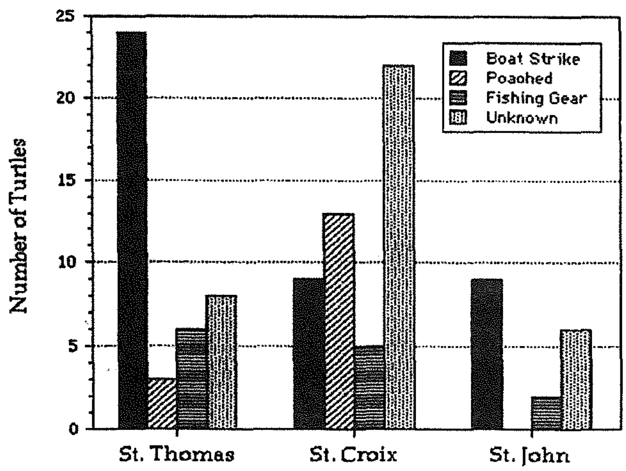

Figure 6. Causes of strandings by island: 1982 to 1997, U.S. Virgin Islands.

Fifteen of the strandings reported here were placed in the category of "other" causes. Some of these were the result of shark attack, some were necropsied and found to have had internal problems that resulted in death, some died as a result of entanglement in cables and in one case a lawn chair. One turtle fell into an open construction pit which led to changes in permitting requirements for coastal construction in the V.I. Of great concern are the four green turtles found in 1997 with papillomas. One was operated on and released after removal of the tumors, recovery of vision in one eye and restoration of healthy feeding behavior. One turtle was euthanized due to its extreme condition. The other two had small papillomas that were not related to the cause of stranding. As only a few turtles have been observed before in the Virgin Islands with tumors, it is strongly hoped that this increase in 1997 is not indicative of a general increase in this disease in Virgin Island green turtle populations.

ACKNOWLEDGEMENTS

Many people have contributed to this stranding database over the years. On St. Croix I would like to thank Toby Tobias, Zandy-Marie Hillis-Starr, Amy Mackay, Brendalee Phillips, Mike Evans and DPNR Enforcement. On St. Thomas, I would like to thank DPNR Enforcement and Dr. Andy Williamson for necropsies. On St. John I would like to thank Tom Kelley, Elmo Rabsatt and Vonnie Small-Zullo as well as other NPS personnel. I also owe thanks to the many citizens who took their time to report stranded turtles and provide me with the information on them.

GREEN TURTLE (*CHELONIA MYDAS*) CAPTURE BY ARTESANAL FISHERMEN IN LA BLANQUILLA ISLAND, VENEZUELA

A. Fallabrino, A. Rodríguez, A. Trujillo, and J. Marcano
PROVITA, Apdo. Postal 47.552, Caracas 1041-A, Venezuela. provita2@telcel.net.ve

La Blanquilla Island, in the Caribbean Sea (11° 50' N, 64°35' W), has an area of 52 km^2. There are no permanent residents on the island, but there is a permanently occupied Naval Base. Between April and September every year, fishermen establish seasonal camps on the Island, staying mainly at La Muerte and Caño Martín beaches.

We have made expeditions to La Blanquilla yearly since 1995, and have frequently found large quantities of sea turtle bones and shells near fishermen's camps. They often consume green turtle (*Chelonia mydas*) meat while they are camping on the Island, and we have reports that this meat is also sold on Margarita Island, from where most of the fishermen originate. Turtle shells are used on La Blanquilla as receptacles, both for salting fish and for cooking food, and it is common to observe burnt shells for this reason.

Most fishermen know that the capture and consumption of sea turtles is forbidden by Venezuelan law, but when we have asked them about this, most of them reply that captures are incidental. They report that most turtles are caught on longlines, hooked mainly in their limbs and neck.

In spite of the presence of the Venezuelan Navy Base on La Blanquilla, as well as periodic inspections of fishermen's boats and camps, the problem of capture and trade of sea turtles persists. We recommend the application of more effective and stricter patrolling and law enforcement, to be carried out by personnel from the Navy Base, as well as educational and sensitization programs for the fishermen.

ACKNOWLEDGMENTS

We thank AEREOTUY and Armada de Venezuela for their cooperation to work in La Blanquilla. We received financial support from The David and Lucile Packard Foundation, CONICIT and TACA Group for travel to the Symposium. For all of this aid we are very appreciative.

THE TURTLE EXCLUDER DEVICE AS A TOOL TO OPTIMIZE THE SELECTIVITY OF SHRIMP NETS AND THE MEXICAN NORMS CREATED FOR ITS OBLIGATORY APPLICATION

P. Eduardo González J., Dionisio Zúñiga L., Alejandro González C, Aurelio Ramírez V., and Eulalio Rodríguez A.
Centro Regional de Investigaciones Pesqueras Tampico-Tamps, (Instituto Nacional de la Pesca)México. Apdo. Postal 197 México. criptam@tamnet.com.mx

The ecological implications of the extraction of shrimp and the incidental capture of benthonic communities with trawl nets have originated diverse developmental and technological innovations. At a worldwide level, in the sixties, institutions from France, Iceland, Norway, Belgium, the Netherlands and the United States, trying to increase the selectivity in the capture by trawling system, included in the nets mesh panels in different sections of the body so that in relation to their behavior when faced with being captured, the species could be collected in different containment bags or expelled out of the net. In this sense, institutions from Mexico have carried out research studies on fishing selectivity with Turtle Excluder Devices (TEDs), incorporated with the clear objective of optimizing the shrimp capture as well as preventing incidental capture of these chelonians. In this study, we describe the juridic-normative development that our country has achieved with the application of selective devices in the shrimp nets, and whose norms have established the obligatory use of these devices in the shrimp nets in the Gulf of Mexico as well as the Mexican Caribbean and Pacific, allowing with its results, going from using soft TEDs, to using hard TEDs.

THE PHENOMENON OF COLD-STUNNED SEA TURTLES ALONG THE NORTHEAST ATLANTIC COAST

Phillip E. Allman
University of Maryland at Baltimore County, Department of Biological Sciences, Baltimore, Maryland, U.S.A. PAllman@aol.com

INTRODUCTION

Sea turtle migrations to the North Atlantic have been well documented and seem to be an annual event for four species, including the fragile *L. kempii* (Lazell 1980; Morreale *et al.*, 1992; Evans *et al.*, 1997). The turtles migrate into the shallow coastal areas during the late summer for foraging purposes (Lutcavage and Musick 1985). As winter approaches, water temperatures drop below those tolerated by sea turtles (Witherington and Ehrhart 1989). In captivity, sea turtles have been reported to suffer from cold-stunning, or extreme hypothermia, at temperatures below 9° C (Schwartz 1978). Each year in the Northeastern United States, cold-stunned sea turtles are found on the shoreline. If rescue and rehabilitation measures are taken immediately, the turtles can be treated with success. This paper reports stranding data from 1993-1997 in the Northeast United States.

RESULTS

Stranding reports for 1993-1997 were obtained from the Virginia Science Museum (Virginia), National Aquarium in Baltimore (NAIB) (Maryland), Marine Mammal Stranding Center (New Jersey), Riverhead Foundation (New York) and Mystic Aquarium (Connecticut). Over the last five years, 118 sea turtles, consisting of three species (*C. caretta, C. mydas and L. kempii*) were reported cold-stunned in this area. Six of these turtles were found onshore in Virginia, Maryland and Delaware, and 112 were found in New York and New Jersey.

The stranding events to occurred primarily in late fall and early winter (96.6%). Collectively, twenty turtles were reported in November and 94 were reported in December. The earliest report of a cold-stunned sea turtle in this area occurred on October 10 in Delaware. Only two turtles were reported in January (n = 1) and February (n = 1).

All nine of the stranded *C. mydas* were found in New York and New Jersey. A total of 62 L. kempii and 47 *C. caretta* were reported during this time (Table 1). The mean yearly number of stranding reports over the past 5 years was 23.6 turtles with a range of 3 to 79. The straight carapace lengths from L. kempii ranged from 22.7 cm to 40.3 cm (n = 62, mean = 29.7 cm) with one unknown length. Fifty five percent (n = 34) of these animals were below 30 cm. The straight carapace lengths of *C. caretta* ranged from 33.1 cm to 61.1 cm (n = 47, mean = 50.3 cm).

DISCUSSION

The wide range of turtles reported each year may be due to fluctuations in the number of sea turtles in this area or variations in effort between the years among the different stranding centers. The number of stranding reports each year shows that it is critical for standing programs to rescue and rehabilitate the animals back to health. The time distribution of the stranding events show December to be the most active month. By January, water temperatures may fall below the critical tolerance limit for sea turtles, causing death. All *C. caretta* individuals were of juvenile or sub-adult size, based on categories by Lutcavage and Musick (1985). The L. kempii size distribution fell within the range for sub-adults (ccl = 20-60 cm), described by Ogren (1989).

Because populations of sea turtles have become depleted, it is important that each individual turtle receive the best treatment possible. The first step in the treatment process is an initial health assessment. This involves a physical and visual examination which will indicate the severity of the animal's condition. This examination may include eye-touching, nose-touching and observing head lift (Riverhead Foundation). The appearance of a sunken neck may indicate dehydration which can result from the turtle's inability to osmoregulate after becoming cold-stunned. This inability is evident from the elevated concentrations of ions including phosphorous, magnesium, sodium, chlorine, potassium, and calcium. Blood samples are taken to identify any secondary bacterial infections and electrolyte levels that result from cold-shock.

Table 1. Number of cold-stunned turtles reported from New York to Virginia between 1993 and 1997.

Species	1993	1994	1995	1996	1997	Total
C. caretta	0	1	42	2	2	47
C. mydas	0	2	4	2	1	9
L. kempii	3	8	33	6	12	62
Total	3	11	79	10	15	118

Initially, the turtle is placed in low salinity water with a temperature approximately 4-6° C above the ocean temperature from which it came. This low saline water allows the ion concentrations to drop as osmoregulation begins to stabilize. Heat lamps placed above the holding tank may serve useful in heat absorption. When treating a cold-stunned turtle it is important that constant care and frequent observations are made. Initially, the animal may refuse to eat, but as body temperature increases feeding should slowly increase as well.

ACKNOWLEDGMENTS

A special thanks to Dr. Brent Whitaker (NAIB), David Schofield (NAIB), Wendy Walton (VMSM), Rob Digiovanni (Riverhead Foundation), Rob Nawojchik (Mystic Aquarium) and Bob Scholkopf (Marine Mammal Stranding Center) for the data. I thank the Chelonia Institute and The David and Lucile Packard Foundation for their financial support. I am grateful to Beth Richardson at the University of Maryland at Baltimore County for all the help.

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PRESENCE OF *PSEUDOMONA AERUGINOSA* IN A BLEPHAROCONJUNCTIVITIS OUTBREAK IN CAPTIVE HAWKSBILL TURTLES (*ERETMOCHELYS IMBRICATA*)

Adriana D'Amiano[1], Alejandro Arenas[1], and Roberto Sánchez[2]

[1]Acuario Xcaret, Carretera Chetumal-Puerto Juárez km 282, Playa del Carmen, Quintana Roo, México acuario@cancun.rce.com.mx

[2]Via Delphi, Carretera Chetumal-Puerto Juárez km 282, Playa del Carmen, Quintana Roo, México

During the month of june 1997 at the Eco-Archeological park Xcaret, 50 Hawksbill turtles from a total of 115 organism were observed with signs of reddish conjuctive, increased size eyelids and purulent discharge. Bacteriological cultures were made and Pseudomona aeruginosa was detected. Ceftazidime IM was used in a dose of 20 mg/kg every 72 hours in a period of four weeks, making a total of 8 doses and topic oxitetracycline was used O.I.D. in a period of one month. Improvement of lesions were observed two weeks after initial treatment. The problem was solved one week later.

TEMPORAL CAPTIVITY OF TURTLES IN REPRODUCTION PERIOD IN MARINE CORRALS IN ISLA MUJERES QUINTANA ROO, MEXICO

Fernando Fernandez-Marthen, Rolando Figueroa-Paz, Favio Figueroa-Paz, Gonzalo Chale-Velazquez, Carlos Aguilar-Cardozo, Juan de Dios Martinez-Aguilar, Marco Tito Coba-Ríos, Gabriel Felipe Escobedo, and Buenaventura Delgado-Gomez.

Estacion de Investigaciones Pesqueras de Isla Mujeres Q. Roo. Apartado postal 45; Cp 77400; Isla Mujeres Q. Roo.

Centro Regional de Investigacion Pesquera de Puerto Morelos Q. Roo. Apartado postal 580; cp 77501; Cancun, Q. Roo. Instituto Nacional de La Pesca.

An implemented method in the Mexican Caribbean is described in order to protect to diverse species of marine turtles in times of reproduction. The advantages of the same are discussed, considering the probable impact in the handling of the organisms reproducers to the captured being and transferred the net corrals with artificial beaches in Isla Mujeres. It was found the green turtle (*Chelonia mydas*) adapted easier to the captivity, in comparison with the overhead turtle (locally called cahuama) (*Caretta caretta*). Diverse information on aspects of reproduction, survival and mortality of the eggs and neonat in several seasons is given in this poster.

DIETARY REGULATION OF PLASMA CALCIUM AND PHOSPHORUS VALUES IN VIRGINIA MARINE SCIENCE MUSEUM SEA TURTLES

Kimberly E. Goldman, Robert H. George, and W. Mark Swingle
Virginia Marine Science Museum, 717 General Booth Blvd., Virginia Beach VA 23451, U.S.A. vmsm@norfolk.infi.net

INTRODUCTION

Although research exists on diet and nutrition of wild sea turtles, very little information is available on nutrition of sea turtles in captivity. Of primary concern for exhibit sea turtles are plasma calcium (Ca) and phosphorus (P) values. Abnormally low Ca and high P levels may, over time, cause metabolic bone disease with resulting decalcification of bone (Boyer 1996). Plasma Ca and P levels, in sea turtles, are usually expressed as a ratio. Studies have shown wild, loggerhead sea turtles *(Caretta caretta)* to have Ca:P ratios of 1:1 (George 1996) or less than 1:1 in juveniles (Bellmund 1988). There are no data reported for exhibit sea turtle Ca:P ratios; however, we have assumed that healthy turtles should have Ca:P ratios similar to those measured in wild turtles. In order to monitor their general health, the Virginia Marine Science Museum (VMSM) husbandry and veterinary staff regularly take blood samples from our sea turtles. In analyzing the plasma profiles from the exhibit loggerheads, we found that the Ca:P ratios, and plasma Ca and P levels, differed from those reported for wild sea turtles. One way to affect plasma Ca and P levels is through diet. At present, there are no dietary guidelines, specifically, for exhibit sea turtles. By reevaluating and modifying the VMSM sea turtle diets we were able to alter the plasma Ca and P levels. This study was conducted to evaluate VMSM exhibit sea turtle diets, to correct the abnormal plasma Ca and P levels, and to improve the loggerhead's Ca:P ratios.

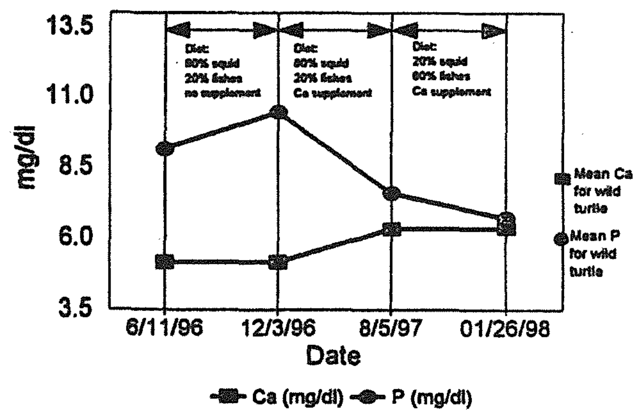

Figure 1. Mean Calcium and Phospherus levels for exhibit sea turtles (n=7).

METHODS AND MATERIALS

Initial blood samples were taken in June 1996. Turtles were removed from the aquarium and blood was drawn from the dorsal cervical sinus. Blood was collected in Lithium heparin tubes, the plasma was removed and refrigerated until analyzed. Analyses were performed within 24 hours employing a Hitachi 737 autoanalyzer. Full plasma profiles of each loggerhead were reviewed. Subsequent blood samples were taken at six to eight month intervals after the initial sampling. Mean plasma Ca and P levels were determined for the loggerhead sea turtles (n=7) (Figure 1). Ca to P ratios were determined before and after dietary changes for each sea turtle (Figure 2). Utilizing a study of wild loggerheads from Chesapeake Bay, mean plasma Ca and P values were used to calculate a "normal" Ca:P ratio for wild loggerheads (George 1996) (Table 1). Nutritional information on squid and other seafood items included in VMSM sea turtle diets was researched. We noted the Ca and P levels of these food items (Table 2). Dietary modifications were made after obtaining this nutritional information in attempt to correct the plasma profiles of the exhibit turtles.

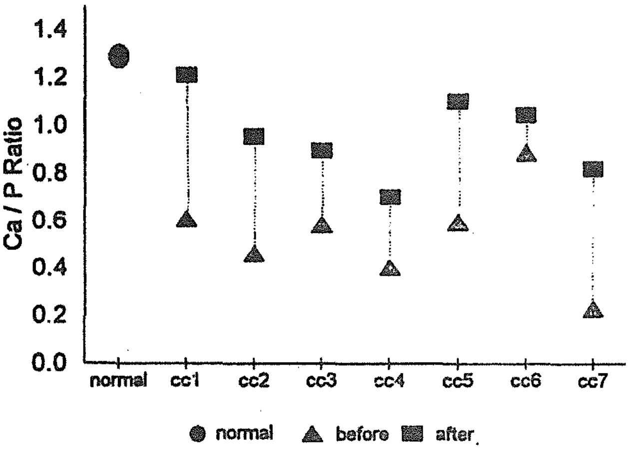

Figure 2. Calcuim and Phosphorus Ratios of Exihibit Turtles before and after diet change.

Table1. Plasma Calcium and Phosphorus Values in Healthy, Wild Loggerhead Sea Turtles (Caretta caretta).

	Range	Mean
Calcium (mg/dl)	6.4-9.0	7.7
Phosphorus (mg/dl)	4.6-7.2	5.9

Adapted from George, R.H. 1996. Health Problems and Diseases of Sea Turtles, in The Biology of Sea Turtles, Lutz, P.L., Musick; J.A., Eds., CRC Press, New York. 363-384.

RESULTS

The plasma Ca and P levels for VMSM loggerhead sea turtles were determined to be abnormal following blood samples taken in June and December 1996. Mean Ca levels were low and mean P levels were high as compared to the mean values of healthy, wild loggerheads (Figure 1). The June 1996 Ca:P ratios for all the loggerheads were lower

Table2. Calcium and Phosphorus Levels of Sea Turtle Diet.

Seafood Item	Calcium (mg/100g)	Phosphorus (mg/100g)
Squid (unspecified)	27	193
Shrimp (*aztecus* sp.)	89	258
Smelt (*Osmeridae* family)	567	534
Herring (*harengus* sp.)	20	280
Mackerel (*scrombus* sp.)	8	307

Adapted from Sidwell, V. D. 1981. Chemical and Nutritional Composition of Finfishes, Whales, Crustaceans, Mollusks, and their Products, U.S. Department of Commerce, NOAA Technical Memorandum NMFS F/SEC-11. 432pp.

(*i.e.* <1:1) than the wild turtle Ca:P ratio of 1.3:1(Figure 2). The sea turtles' diets consisted of 80% squid, 20% teleosts, and vitamin supplementation at the time of these samplings. Calcium supplements (calcium gluconate tablets) were added to the turtles' diets and resulted in Ca levels rising towards the normal mean Ca level for wild turtles (Figure 1, Table 1). Nutritional examination of the sea turtle dietary components showed squid to have exceptionally low Ca levels and high P levels (Table 2). Additionally, P levels in various teleosts were all relatively high in P (Table 2). Based upon this information, VMSM sea turtle diets were modified to 20% squid and 80% teleosts. Regular supplements of crabs and mussels were also added to the diets. After dietary adjustments were made, blood samples taken in August 1997 and January 1998 showed plasma Ca and P levels were stabilized near the normal means and Ca:P ratios continued to climb toward a normal, mean ratio of wild loggerheads (Figure 1, Figure 2).

DISCUSSION

Exhibit sea turtles' diets often include seafood items which differ greatly from the items found in natural diets of wild sea turtles. Sea turtles are not discriminating in what foods they will eat, and therefore, it is often easiest to feed those items which are already on hand for other aquatic animals in a facilities' collection. Routine plasma profiles provide a relatively simple method for monitoring these aspects of the nutritional health of captive sea turtles. Plasma Ca and P levels can be abnormal in exhibit sea turtles whose diets are not correctly balanced for these important elements. Utilizing methods of dietary adjustment with VMSM loggerheads, we could modify their diets with positive changes in Ca and P levels. By decreasing the amount of squid, increasing foods high in Ca such as crabs and mussels, and adding Ca supplements in the tablet form, we were able to improve all turtle's plasma profiles. This was evident in plasma profiles following the dietary modifications. This study indicates that the revised VMSM sea turtle diet maintains the animals in good physical condition. It also indicates that this diet results in plasma profiles which closely mimic wild turtle plasma profiles. Regular blood sampling is crucial to the health of exhibit turtles and is beneficial in developing proper nutritional protocols.

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A DESCRIPTION OF THE PROCESS TO MAINTENANCE AND ADAPTATION OF SEA TURTLES AT THE NATIONAL MEXICAN TURTLE CENTER

Martha Harfush Meléndez, Elpidio Marcelino López Reyes, and Porfirio Hernández Saldaña
Instituto Nacional de la Pesca. Centro Mexicano de la Tortuga. P. O. Box 16, Puerto Angel 70902, Oaxaca, México
cmtharfu@angel.umar.mx

INTRODUCTION

The change of habitat that the sea turtles have when they are placed in a lodging with different conditions which finds at their natural environment it is a fact which requires a process for adaptation. The answer every species exhibits in the face of their transfer in a new home is different, motive which it is necessary improve investigations which allow to know the particular features of the adaptation to the captivity process, since the same instant in which an individual is extracted from their natural environment.

The ways which a turtle is joined to the population of captive organisms at the CMT are two: the subtraction of their natural environment in an age at which is logical suppose it is already perfectly adapted to this, and their recruitment before reach the sea, to being collected since the beginning of their incubation inside an egg. In both cases, nevertheless the "ways access" to the captive life form are different, a common factor exists whose importance is certain: everyone the individuals possess genetic information makes them be distinguished by behavior characteristics of its species a group of attributes it commonly called instinct. The instinct involves nutritious characteristics, answer to stimuli, conduct dive and a lot other aspects whose knowledge is indispensable tool in the management of organisms in captivity.

In addition, two elements are fundamental to the maintenance of captive organisms, on one hand, the provision of appropriate, sufficient and opportune feeding, and in other hand, the design of medical preventive and curative treatments, based on the continuous monitoring to the water conditions, cleaning of aquariums and tanks, assessment of haematic parameters and continuous observation to the conduct of the individuals, which on the whole they act to reduces the risks of manifestation of illnesses.

In this work are shown the main features of the labor of CMT that carries out to the knowledge the maintenance and adaptation of sea turtles at a life style different: the captivity.

FACILITIES

The facilities of the CMT, which were built for adapting and maintaining turtles in captivity, include 18 aquarium exhibition pool windows, 13 of which are filled with sea water, 3 with fresh water and there are also 3 more terrarium type exhibition windows, besides 96 fiberglass tanks, 8 concrete small pools and 2 large concrete tanks for storage of more than 15,000 liters; all of these within a covered area.

The Center also has 2 sections of cactus botanical garden intended for the exhibition of all Mexican type of xerophilous and next to it the tortoises can be seen.

In view of the conditions mentioned above, the Center complies with the necessary requirements for the study of all sea turtles species found in Mexico, as well as other turtle breeds from fresh water and terrapins.

Sea water supply flows from a pumping system that has a capacity for a million liters a day and which flow by gravity to all sea water ponds, aquarium and pools but the stream passes first through a mechanical filter and ultraviolet rays treatment.

Thanks to the system described above it is possible to have a constant water supply that also allows to have approximately 30% of daily change of all the water contained within the complex, unrelated of all other water replacements made during cleaning works.

MAINTENANCE AND CLEANING WORKS

All ponds are daily washed using stream water pressure and brushing the walls of the pond. For the concrete and fiberglass tanks cleaning work is done once or twice a day; once a week for the aquarium exhibition windows and for the ponds of concrete, every two weeks.

Frequently it is required make labors of maintenance, so inside the aquariums as well as in the facilities hydraulics and electric, due to the quick deterioration on the equipment which is in direct contact with the salt water. When it is necessary, cleans deeply or if needed is replaced.

NUTRITION

The turtles are fed minimum once a day; however baby turtles are fed four times in the same period. Sea turtles diet is mainly composed by fish (specially tuna fish and sail fish), mollusks and crustaceans, depending on what produce is available in the regional market; fresh water and tortoises are fed by fruits, vegetables and legumes. Food supplements such as vitamins and calcium are periodically supplied as needed. The feeding routine is strictly coordinated with that of cleaning works hence immediately after the feeding time we continue with the cleaning of the large pools using water pressure and doing a total replace of water in the fiberglass and concrete small tanks.

HEALTH CONTROL

When any sign of disease or any unusual behavior indicating some broken health is detected, the individual is put aside from other turtles for observation and treatment. Most common illness or disease here are skin infection, lung illness and enteric occlusion. The veterinarian treatments are following go from prescription of special medicine to surgery. On the later we would refer the recent surgery made to a green turtle *Chelonia mydas* presenting enteric problem which was successfully removed.

RESEARCH

Most important research projects made at the Center have been:

Nutrition.

Tattooing tags in some individual as an identification technology which works conveniently in some kind of turtles.

Population in tanks. Optimum number of individuals.

Sexual reversion study.

INFORMATION RELEASE

Basic objectives and goals for which the Center was created and in which the captivity maintenance play an important role, is the exhibition of live turtles as a mechanism of conscience for people. Consequently CMT is yearly visited by approximately 70,000 persons from all over the world and Mexico.

ACKNOWLEDGMENTS

To the staff of the Centro Mexicano de la Tortuga. At the same time to Mrs. Betty Harfush for her help in translation.

OLIVE RIDLEY SEA TURTLE STRANDED IN PUERTO RICO. A GOOD EXAMPLE OF OUR NEW REHABILITATION PROGRAM

Héctor C. Horta[1], Debra Moore[2], Robert Matos[1], Rosaly Ramos[1], Marelisa Rivera[3], José Rivera[4], Stephanie Stielow[5], Sandra Tripp[5], and Ernest R. Williams[5]

[1]Puerto Rico Department of Natural and Environmental Resources, Sea Turtle Rehabilitation Program
[2]Caribbean Center for Marine Studies, U.S.A.
[3]U.S. Fish and Wildlife Service, Caribbean Field Office, U.S.A.
[4]National Marine Fishery Service, Miami laboratory in Puerto Rico, U.S.A.
[5]University of Puerto Rico, Department of Marine Science, U.S.A.

On August 30, 1997, an olive ridley sea turtle was found on the northwest coast of Puerto Rico, 2 miles offshore between Aguadilla and Rincón. The animal was entrapped in a floating net and was unable to free itself from its confines. Two sports fishermen rescued the animal and transported it to the local police who then contacted the Department of Natural and Environmental Resources Rangers. The animal was then transported to the University of Puerto Rico, Department of Marine Sciences, Sea Turtle Rehabilitation Facility for emergency veterinary assessment, care, and rehabilitation under the direction of Dr. Debra Moore, from the Caribbean Center for Marine Studies, Program's Chief Veterinarian, under permit # DNRA: 97-EPE-28.

The only other reported case of an olive ridley sea turtle in Puerto Rico occurred in 1969 and is thus considered "very rare" (Caldwell and Erdman, 1969). The species is well known in northeast South America (Pritchard, 1966, 1967; Carr, 1967), and has been occasionally reported in the Greater Antilles (Aguayo, 1953; Carr, 1957). It is more commonly found throughout the Eastern Pacific.

Physical examination revealed the animal to be a 20.4-kg female olive ridley sea turtle, *Lepidochelys olivacea*, (Pritchard, P. *et al* 1983). The standard carapace length was 58.5 cm, and total carapace length was 60.0 cm. The animal was dehydrated and extremely emaciated with a distinct protuberance of the occipital bone. The eyes were severely depressed into the orbital bone and there was a general malaise in behavior. The animals carapace was indented and scarred from the net or rope entrapment, and superficial lacerations were found on the caudal flippers and plastron.

The animal was unable to dive and radiographs revealed air throughout the coelomic cavity. A substantial amount of air was removed from coelomic cavity using a vacationer and 60cc syringe.

The remaining air was absorbed internally and the animal was later able to dive and submerge normally. Blood was collected for a complete blood count (CBC) and biochemistry. The hemogram specifically the red blood cells revealed a blood parasite identified as *Hemoproteus spp*. This parasite is apparently often nonpathogenic and is often seen in sea turtles. The animal had a leukopenia.

Biochemistry data showed a hyperglycemia, elevated BUN, and LDH, hypercalcemia, hyperphosphatemia, hypercholesterolemia, hyperkalemia and low ALT. Increased serum LDH activity occurs with degenerative or necrotizing muscle injury. This supports the diminished heath status and emaciated muscles of the animal. The hyperphosphatemia, hyperglycemia, hypercalcemia, hypercholesterolemia, and hyperkalemia, were most probably elevated due to the intracoelomic administration of lactated ringers with a 5% dextrose drip and a recent fish/squid gruel tube feeding.

The lacerations were treated with bethadine solution 2 or 3 times daily and healed with no further consequence. Dr. Sam Dover, veterinarian at Sea World of Florida, was consulted and both veterinarians agreed that a lactated ringer solution with 5% dextrose solution should be administered because of the severe dehydration status of the animal. The animal was subsequently fed a fish/squid gruel, then force fed with fish and squid pieces. On the ninth day the animal began eating squid willingly. The animal showed no interest in pieces of sardines placed in the pool. Her diet steadily increased and she was maintained on 3-5 lbs. of squid daily.

On day 47 the animal began to dive and stay submerged on the floor of the pool. She steadily improved and maintained her dietary consumption of squid. Her weight increased to 29.5 kg and blood was taken for reassessment. All values where improved and most were within normal range.

On day 187, February 6, 1998, the animal was released approximately 40 miles South of the Island of St. Croix USVI, by a USCG Helicopter, assigned to Air Station Borinquen, Aguadilla P.R., after a full recovery and general health assessment. Her weight had increased to 40 kg. Tag numbers DRN 473/474, were placed on the frontal flippers at the time of release.

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ABNORMAL DEVELOPMENT IN SEA TURTLE EMBRYOS

Yakup Kaska[1], Roger Downie[2], and Robert W. Furness[2]
[1]Pamukkale Üniversitesi, Fen Edebiyat Fakültesi, Biyoloji Bölümü, Denizli, Turkey. 9406804k@udcf.gla.ac.uk
[2]Institute of Biomedical and Life Sciences, University of Glasgow, Glasgow G12 8QQ, U.K..

INTRODUCTION

Few studies are available on embryonic development of sea turtles and the best embryonic descriptions are for *Chelydra s. serpentina* (Yntema, 1968) and *Chrysemys picta belli* (Mahmoud *et al.*, 1973). Crastz (1982) described 31 stages for *Lepidochelys olivacea*, and Miller (1985) described the embryonic development of six marine turtle species. Embryonic staging alone contributes little to the understanding of a species or to its survival, but in the context of other studies on managerial problems and the effects of human intervention, basic embryological information can remove some of the guess work from decision making.

All marine turtle eggs normally have pliable, parchment-like shells and are typically spherical although not turgid at oviposition (Bustard, 1972; Ewert, 1979). Odd-shaped and yolkless eggs are occasionally reported (Bustard, 1972; Miller, 1985). When laid, the eggshell is creamy-white. During the first one to two days, the heavy yolk settles downward, and the eggshell at the top starts "chalking" as the mucus dries and the egg absorbs water (Blanck and Sawyer, 1981; Miller, 1985).

Although some abnormalities have been mentioned (Ewert, 1979; Blanck and Sawyer, 1981; Miller, 1985), there was not detailed work showing the frequency of abnormalities in sea turtle embryos and hatchlings. Therefore we aimed to calculate the frequency of abnormalities in the embryos of sea turtles in the Eastern Mediterranean.

MATERIALS AND METHODS

We used eggs from partly predated nests, of which the date of laying was known, to describe the stages of development in field conditions and identified the stages of dead-in-shell embryos i.e. those found to have died at some time after laying. The post-ovipositional development of loggerhead and green turtle embryos were described from a total 1882 (75 eggs sampled, 270 partly predated eggs and 1537 dead in shell embryos) loggerhead turtle and 1169 (35 eggs sampled, 105 partly predated eggs and 1029 dead in shell) green turtle embryos, collected in three consecutive seasons (1994 to 1996) on the beaches of Northern Cyprus and Turkey. The percentage of abnormalities was calculated as a proportion of the total number of eggs observed.

RESULTS

The most common form of abnormality was supernumerary and /or subnumerary scutes (8 % of all embryos) on the carapace among normally pigmented embryos as well as among the albino forms. Albino forms were 1% of the total embryos. Malocclusion of jaw, lack of nostril, caruncle, eye and limb and head deformities (2 % of the embryos) were among other common forms.

Twins (0.1 % of the embryos) of equal size and twins of unequal size were also detected. Twins of equal size were of normal pigmentation and of late stage (26-29), but each was smaller in carapace length than a normal single embryo of the same stage. Unequal sized twins had one member which was much smaller than the other. Both were fully pigmented. Early stage twins were also detected. 'Siamese' embryos were also detected. These embryos show a single body with two heads. Head and scute abnormalities were much more common in albino embryos in comparison with non-albinos, because all the albino embryos showed abnormalities in their head, jaw, eye and nostril, whereas only 9.6% of the non-albinos showed head and scute abnormalities (Table 1).

DISCUSSION

Abnormalities of the scutes of the carapace and cephalic deformations are very common in our samples and have been reported elsewhere previously (Bustard, 1972; Ewert, 1979; Miller, 1985; Kaska, 1993). Twinning among turtle embryos has also been reported (Yntema, 1970, 1971; Ewert, 1979; Fowler, 1979; Blanck and Sawyer, 1981; Miller, 1985; Whitmore and Dutton, 1985; Eckert, 1990; Peters *et al.*, 1994; Tucker and Janzen, 1997). The percentage of twinning reported in these studies is between 0.01 % and 0.05 %.

Table 1. The number and frequency of the abnormalities observed in sea turtle embryos.

Abnormality observed	Σ %	*Caretta caretta* Sampled N:75	Predated N:270	Dead-in shell N: 1537	*Chelonia mydas* Sampled N:35	Predate N:105	Dead-in-shell N:1029
supernumerary	4.0		12	30			35
subnumerary	4.0		5	42		29	49
Head abnorm.	2.1		5	20		10	28
Jaw,nostril,eye	1.6			17			33
Albino	1.0			9			22
Twining	1.0			13	1		16

Our result, at 0.1 %, is well above these, although there is no obvious reason for this difference. Albino embryos have also been reported previously (Bustard, 1972; Miller, 1985). In this study, head and scute abnormalities were more common in albino embryos than in non-albino ones. The abnormalities observed among sea turtle embryos may be because of incubation conditions as well as genetical factors, but this is still unknown. Some malformations, such as albinism, cleft plate, and even absence or reduction of one flipper are not necessary lethal. Many aberrant embryos die in early stages in development. Of the aberrant turtle embryos which do develop, most are unable to break out of their eggs as a result of their deformities. Probably, because of this, many abnormal embryos were found dead in shell. The frequency of abnormalities is almost certainly higher in dead-in-shell embryos than in randomly sampled eggs (Table 1).

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PCR CONFIRMS ABSENCE OF PAPILLOMAVIRUS FROM SEA TURTLE FIBROPAPILLOMAS.

Joel K. Lackovich[1], Daniel R. Brown[2], and Paul A. Klein[3]
[1]Department of Molecular Genetics and Microbiology; University of Florida, Gainesville FL 32610, U.S.A.
[2]Department of Pathobiology; University of Florida, Gainesville FL 32610, U.S.A.
[3]Department of Pathology, Immunology, and Laboratory Medicine, University of Florida, Gainesville FL 32610, U.S.A. drbrown@biotech.ufl.edu

The etiologic agent of sea turtle fibropapillomatosis is unknown. Similar fibropapillomas are caused in many vertebrates by papillomavirus, a DNA virus of the family Papovaviridae. A possible association of papillomavirus with sea turtle fibropapillomas has not been thoroughly investigated. The polymerase chain reaction (PCR) molecular diagnostic test can detect minute amounts of papillomavirus. Two pairs of consensus degenerate PCR primers (MY09 + MY11 and CP-I + CP-IIG), and one pair of non-degenerate primers (GP5 + GP6), have a combined efficiency of detection of human papillomavirus (HPV) greater than 70%. Total DNA was purified from 26 fibropapillomas from 10 *Chelonia mydas* and 1 *Caretta caretta*, and assayed for papillomavirus by PCR using the 3 pairs of primers. The positive control was cloned HPV type 31. The PCR products were electrophoresed through ethidium bromide-stained agarose gels, and visualized by photography under shortwave ultraviolet illumination. While the positive control yielded the expected PCR products, no fibropapilloma was positive for papillomavirus. The ability of homogenized fibropapillomas to induce new fibropapillomas in experimentally inoculated *Chelonia mydas* has been shown to be abrogated by exposure of the homogenate to chloroform, to which papillomavirus are insensitive. Absence of papillomavirus from sea turtle fibropapillomas examined by electron microscopy, immunohistochemistry, or a nucleic acid probe, has been reported previously. The current finding extends those observations by applying the most sensitive molecular diagnostic test available to a large number of sea turtle fibropapilloma samples, and leads to the conclusion that papillomavirus are not the etiologic agent of sea turtle fibropapillomatosis.

ASSOCIATION OF A NEW CHELONID HERPESVIRUS WITH FIBROPAPILLOMAS OF THE GREEN TURTLE, *Chelonia mydas*, AND THE LOGGERHEAD TURTLE, *CARETTA CARETTA*

Joel K. Lackovich[1], Daniel R. Brown[2], Bruce L. Homer2, Richard L. Garber[3], Douglas R. Mader[4], Ritchie H. Moretti[4], Amy D. Patterson[4], Lawrence H. Herbst[5], Jorge Oros[6], Elliott R. Jacobson[6], and Paul A. Klein[7]
[1]Department of Molecular Genetics and Microbiology (College of Medicine), University of Florida, Gainesville FL 32610, U.S.A.
[2]Department of Pathobiology (College of Veterinary Medicine), University of Florida, Gainesville FL 32611, U.S.A.
[3]Pathogenesis Corporation, Seattle WA 98119, U.S.A.
[4]The Turtle Hospital, Hidden Harbor Marine Environmental Project, Marathon FL 33050, U.S.A.
[5]The Institute for Animal Studies, Albert Einstein College of Medicine, Bronx N.Y., 10461, U.S.A.
[6]Department of Small Animal Clinical Sciences (College of Veterinary Medicine), University of Florida, Gainesville FL 32611, U.S.A.
[7]Department of Pathology, Immunology, and Laboratory Medicine (College of Medicine), University of Florida, Gainesville, FL 32610, U.S.A.

Fibropapillomatosis (FP) is a growing threat to the survival of green turtle, *Chelonia mydas*, and loggerhead turtle, *Caretta caretta*, populations worldwide. Successful transmission experiments with filtered cell-free tumor homogenates have shown FP to be caused by a chloroform-sensitive subcellular infectious agent. A chelonid herpesvirus is a candidate for the etiology of this disease. Consensus primer PCR methodology was used to determine the frequency of association of the chlelonid herpesvirus with individual fibropapillomas of green and loggerhead turtles in Florida. Fibropapillomas and normal skin samples were obtained from 20 green and loggerhead turtles stranded along the Florida coastline. Eleven scar tissue samples from sites where fibropapillomas had been removed from 5 green turtles were also collected. By using primers targeted to a highly conserved region within the herpesviral DNA polymerase gene, 93 cutaneous and visceral tumors and 45 normal skin samples were tested individually. Over 95% of the fibropapillomas and only 7% of the normal skin samples from FP-affected turtles tested positive. Scar tissue tested positive in 1 out of 11 samples. Eleven normal skin samples from 3 FP-unaffected turtles all tested negative. To determine if the same virus infects both turtle species, an interior region of the herpesvirus DNA polymerase gene was sequenced from 6 log-

gerhead and 2 green turtle samples. Results predicted that loggerhead and green turtle viral sequences differ by only 1 of 61 amino acids. Phylogenetic comparisons showed that the partial sequence of the chelonid herpesvirus was most similar to the corresponding sequence of alphaherpesvirus. The data indicate the candidate chelonid herpesvirus has high prevalence only among turtles with FP, and that the same virus infects both green and loggerhead turtles.

NECROTIC LIMBS: AMPUTATION AND TREATMENT

Gail Schofield, Harikleia Kopsida, Dimitrios Dimopoulos, and Dimitris Margaritoulis
The Sea Turtle Protection Society of Greece, 35 Solomou St, GR-10682 Athens, Greece. stps@compulink.gr

INTRODUCTION

Loggerhead turtles, which inhabit the Greek seas throughout the year, are frequently found entangled in fishing nets and lines. Usually the fore flippers are caught, resulting in necrosis of the flipper, which may require amputation procedure. The case histories of six loggerhead turtles *(Caretta caretta)*, with necrotic flippers, are discussed, concerning their treatment and rehabilitation. The survival of turtles following amputation when returned to the wild is uncertain and may prevent successful mating, nesting and survival strategies.

The Sea Turtle Rescue Centre (STRC) in Athens was established in 1994, by the Sea Turtle Protection Society of Greece with the support of the Municipality of Glyfada. Injured and sick sea turtles are brought to the STRC from all over Greece, in co-operation with the Port Authorities, Olympic Airways, the Greek Railway Organisation, the bus and ferry companies, who provide complimentary transportation. The STRC has been receiving injured sea turtles since 1994. In that time, seventy sea turtles, mostly loggerheads *(Caretta caretta)*, have been admitted to the STRC. Of these, twenty-four have suffered from flipper injury as a direct result of fishing net and line entanglement, of which twenty-one have recovered.

Volunteers, from Greece and abroad, under the supervision of trained staff and associated veterinarians treat sea turtles at the STRC. The successful rehabilitation and release of the turtles is the main objective of all those working at the STRC. As a result of increasing knowledge and advice from sea turtle experts worldwide, the medical care provided by the STRC is in a constant state of improvement.

DIAGNOSIS, TREATMENT AND PATHOGENIC INFECTION

The vast change in treatment can be observed in the six cases of loggerhead turtles discussed below.

Name	Admitted	Released	Died	CCL/cm	Weight/kg	Sex
Leonardos	22/11/1995	31/12/1995		22.8	1.15	Unknown
Ioanna	13/7/1996	10/9/1996		21.5	1.12	Unknown
Oedipus	14/1/1997		16/1/1997	52.0	15.0	Unknown
Alanis	6/7/1997	5/9/1997		70.0	35.0	Female
Themistokles	22/10/1997	20/12/1997		78.0	55.0	Male
Krystina	18/11/1997	STRC		42.0	8.0	Unknown

Leonardos, was one of the first loggerhead turtles to be admitted to the STRC requiring flipper amputation. A fishing line was entangled around its right front flipper, which was held to the body by two millimetres of tissue. The flipper was swollen, but there were no visible signs of secondary pathogenic infection. The flipper was removed due to necrosis.

The case of **Ioanna** indicates the possibility to save part of a flipper, if the necrotic region is localised. The left front flipper was injured from entanglement in plastic material. Necrosis was present at the tip of the dermal layer of the flipper leaving the carpel and metacarpel bones exposed. Two operations were successfully completed, removing only the localised necrotic regions, allowing the recovery of most of the flipper.

This treatment was applied to the case of **Alanis**, as both fore flippers contained areas of necrotic bone and tissue. The amputation of both flippers would have proved futile for the survival of the turtle. The left front flipper was at an advanced stage of necrosis as a result of fishing line entanglement, whereas the necrotic region of the right limb was localised to the epithelial tissue of the flipper. The tissue of the right front flipper was scraped away until healthy tissue was reached (Kapalko, 1997). The left fore limb was amputated, but due to incorrect wound management, i.e. the bone was left exposed, correctional operative treatment was required to cut back the bone and cover it with surrounding tissues (Kapalko, 1997).

Oedipus had extensive pathogenic infection and necrosis of his right front flipper. The secondary pathogenic infections had caused the loss of facial, carapace and plastron scutes as well as surrounding epithelial tissue, so much that bone was visible. The virulence of the pathogens, in combination with Oedipus' weakened immune system, indicate that death resulted from the rapid spread of septicaemia.

On arrival **Themistokles** had already lost most of the left front flipper, leaving the humerus bone and surrounding tissues exposed, following fishing line entanglement. This was at an advanced stage of gangrene infection. He was also suffering from an acute pathogenic infection of the jaw, facial and carapace scutes, skin and eyes. The humerus bone was cut back, to stop the spread of gangrene. After the first operation the bone was left exposed allowing gangrene to recur. A second operation was performed, but the bone and tissues still could not be properly sealed from the environment as there was very little remaining tissue masses, and that which was present was infected with an epithelial necrotic pathogen (Kapalko, 1997).

Krystina suffered from a swollen right front flipper, which was severed to the humerus bone by fishing lines. There was a region of localised necrotic tissue on the flipper, which caused a progressive loss of sensitivity over the days previous to the operation (Kapalko, 1997). The injury was further complicated with the presence of a secondary pathogenic infection on the flipper and surrounding body epithelial surfaces. On admittance to the STRC, Krystina was in a state of severe malnutrition, with a soft carapace and shrunken plastron covered in an ectoparasitic algal colony. This may have resulted from her body converting its resources to attack invading pathogens. This depressed state would have also increased her vulnerability to such invasion, inhibiting her natural biochemical and histological defense mechanisms, preventing recovery (George, 1997; Campbell, 1996). The right front flipper was amputated, under anaesthetic, close to the humerus joint, and the bone was sealed with a triple layer; of muscle, inner soft tissue and epithelial tissue, and secured with a layer of Superglue, to prevent entry of pathogens (Kapalko, 1997).

RECOVERY

Sea turtles with amputated fore and hind limbs are successfully rehabilitated and released into the wild by the STRC. **Leonardos, Alanis** and **Krystina** on arriving at the STRC used their injured flippers as an aid to swimming, buoyancy and balance. Following amputation, their ability to swim and dive was initially hindered. After about five days all three turtles were observed to swim, dive and rest on the bottom like a 'healthy' turtle. With **Krystina** and **Leonardos** it was observed that the hind left flipper in both cases was used to a much greater extent to facilitate the loss of the front right flipper. Following partial amputation of the flipper, **Ioanna** found it hard to move both fore flippers at the same time resulting in recurring rolling and yawing actions. **Themistokles** may have been without his left front flipper for a period of time before being found. This is because from arrival he had already adjusted to swimming and diving in water without the front left flipper. His swimming behaviour was very distinct; the tail and hind right flipper were used to help steer him about the pool. He used the hind left flipper to a much lesser degree.

On release, it was observed that the larger turtles, **Alanis** and **Themistokles**, had much greater difficulty in moving on land, and passing through the wave breakers. Sea turtle feeding, migratory and breeding 'success' after release remains uncertain and incidence of survival is thought to be low (Moein *et al.*, 1996). No sea turtle with this type of injury have been reported dead or returned to the STRC suffering from exhaustion and malnutrition (turtles are tagged on release for future identification). These observations indicate the need to intensively study the feeding, migratory and breeding 'success', of released sea turtles with lost flippers, to find their actual success in a free state.

DISCUSSION

Physical and biological factors contribute in determining if a sea turtle will survive from a flipper injury. These include sea turtle age, size, stress, health, including state of nutritional and immune system, and season, sea temperature and pollution (George, 1997; Campbell, 1996).

If necrotic regions of bone and tissue on a flipper are localised, and not complicated by the presence of virulent pathogenic attack and a weak immune system (Campbell, 1996), the turtle is likely to be able to combat the flipper injury resulting in the healing or loss of the limb. It is known that sea turtles lose flippers in the wild, without needing human aid for rehabilitation, because sea turtles with lost front and hind limbs have been observed emerging onto nesting beaches (pers. comm. STPS), or are admitted to the STRC for other reasons. Four cases of flipper loss, without human interference, have been recorded at the STRC to date. However, some sea turtle injuries may be complicated, by the entry of secondary virulent pathogenic infections via wounded tissues or epithelial surfaces (Campbell, 1996). If gangrene occurs, immediate amputation is necessary, otherwise the spread of septicaemia through the blood stream is inevitable, leading to the gross destruction of internal and external epithelial surfaces (Wiles, 1987), possibly resulting in fatality.

The recovery of sea turtles admitted to the STRC for flipper damage is about 88%. The success rate is high, however this cannot compensate for the number of sea turtle entanglements. Sea turtles with flipper injuries already represent about 35% of sea turtles admitted to the STRC. The release of such sea turtles to the wild with lost flipper may not actually help to maintain the viability of the Mediterranean loggerhead population, due to potential reproductive difficulties. Their subsequent release to a wild population is preferable to a lifetime in captivity. To just treat and rehabilitate turtles to the wild with the best medical care available is not the long term solution to handle or reduce the incidence of this problem, action needs to be taken to prevent entanglement in fishing nets and lines.

The rescue, rehabilitation and release of each sea turtle from the STRC makes people become aware of the plight of the sea turtle and its plight in today's anthropogenic dominated environment. The combined effort of the work of the STPS and STRC public awareness and education schemes, with the development of the Sea Turtle Stranding Network, will influence children, the fishermen and the general public all over Greece to protect the sea turtle and its environment.

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EPIBIOTA AND LOGGERHEAD HEALTH STATUS

M. Andrew Stamper[1], Ellery Foster[2], Sheryan P. Epperly[3], Joanne Braun-McNeill[3], and David W. Owens[4]
[1]College of Veterinary Medicine, North Carolina State University, Raleigh, NC 27606, U.S.A.
[2]Duke University Marine Laboratory, Beaufort, NC 28516, U.S.A.
[3]NOAA/National Marine Fisheries Service, Beaufort, NC 28516, U.S.A.
[4]Department of Biology, Texas A&M University, College Station, TX 77843, U.S.A. sepperly@hatteras.bea.nmfs.gov

A heavy epibiota load on sea turtles generally has been interpreted as an indicator of the compromised health of the individual. Such turtles have been referred to as "Barnacle Bills". However, no evidence has been presented to link epibiota load and health status conclusively. During November 1997, 56 loggerhead sea turtles, 50-70 cm SCL, were sampled from Pamlico and Core Sounds, N.C., U.S.A. Turtles were measured, barnacles were counted, epibiota were sampled to enable subsequent identification, and turtles were photographed and shell and epibiota patterns were analyzed with image analysis. Blood samples were drawn at capture and 29 blood parameters were analyzed. Hypotheses tested included (1)epibiota load does not increase as a function of turtle length, (2)epibiota load does not vary between sex in juveniles, and (3) epibiota load is not an indicator of the health of the turtle.

FIRST ASSESSMENT ON TUMORS INCIDENCE IN NESTING FEMALES OF OLIVE RIDLEY SEA TURTLE *LEPIDOCHELYS OLIVACEA*, AT LA ESCOBILLA BEACH, OAXACA, MEXICO.

Javier Vasconcelos, Ernesto Albavera, Elpidio M. López, Porfirio Hernández, and Cuauhtémoc Peñaflores
Instituto Nacional de la Pesca, Centro Mexicano de la Tortuga. P. O. Box 16, Puerto Angel, Oaxaca 70902, México. cmtvasco@angel.umar.mx

La Escobilla beach, located in the central region of the coast of Oaxaca, houses the most important sanctuary for the nesting of the olive ridley sea turtle in Mexico, and stands out as one of the beaches in which they come the most spectacular and numerous *arribadas* of the planet (Vasconcelos and Albavera, 1995).

In the recent years on this beach has been detected the presence of turtles with tumors similar to the papilomas found in other species. The frequency of sea turtles observed with this characteristics has been increasing apparently. In the face of this stage, a new task has arisen: identify the kind of tumor, quantify and evaluate their incidence in the nesting population.

The first observation of tumors in this beach took place in the last 1980´s; however these were not published neither reported. It was up to 1997 when we realized on the necessity of beginning a more sufficient revision of the problem. For this reason and having the orientation of the staff of the NMFS Laboratory in Hawaii, some surveying of the general characteristics of the tumors were carried out, in order to give form to a project which explain more to detail the main implications of the phenomenon.

Here they come the results of the initial stage of the work, in which the presence of tumors in olive ridley sea turtle were analyzed, in nesting females corresponding to the fifth *arribazón* of the season 1997 in La Escobilla beach, from August 23rd to 28th.

GENERAL OBJECTIVE

- To obtain a general view about the magnitude and characteristic of the tumors present in nesting females of olive ridley sea turtle *Lepidochelys olivacea*, at La Escobilla beach, in Oaxaca, Mexico.

PARTICULAR OBJECTIVES

- To evaluate the incidence of turtles with evident tumors in those females that come to nest during an *arribazón*.
- To identify the anatomical external areas of the olive ridley sea turtle in which it register the presence of tumors with highest frequency.
- To know the frequency distribution of the tumor sizes located in olive ridley sea turtles.

METHODS

At the beginning of the *arribazón* in La Escobilla beach were carried out surveys along the whole zone of *arribazón* looking for turtles with evident tumors in the anatomical external areas. These surveys were carried out walking toward both sides of the *arribazón* zone covering both high zone and the humid zone of the beach, during all night, every night of *arribazón*. Every time that a female was found with tumor, we proceeded to fill the field record carefully.

The anatomical areas revised in each turtle were the following: eyes, pick, neck, front fins, back fins, cloaca-tail, shields and the area where the male catch the female with its nails during the mating (where frequently a scar is marked).

Every located tumor was measured with metric flexible ribbon, in order to locate it in any of the following categories in accordance with Balazs (1991): C1, less than 1 centimeter; C2, between 1 and 4 centimeters; C3, between 4 and 10 centimeters and C4, more than 10 centimeters.

Every turtle checked was counted, writing in the field record how many female seemingly healthy were observed before finding one with tumor. This value was denominated *frequency of sighting*. In this way the estimate of the percentage of the population which presents tumors was obtained, being the total checked turtles the sample size.

RESULTS

The sample size for six nights of *arribazón* was 9,201 and it was located among them to 133 with tumor. Corresponding to this, the 1.445% of the revised turtles presented at least one tumor at any size (Figure 1). Considering the total nesting esteemed (155,000) during the *arribazón* in which the sampling was done (Centro Mexicano de la Tortuga, 1998), this work covered the 5.9% of the nesting females in that period.

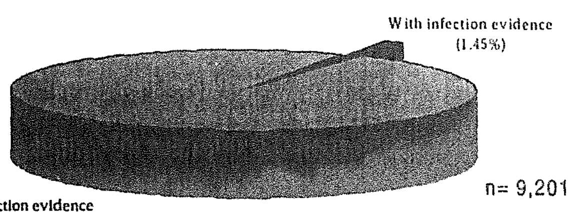

Figure 1. Percentage of turtles with evidence of tumors, to the total turtles checked during the survey.

The frequency of turtles with tumor were located in values between 1 and 496. The value *frequency of sighting* value was 69.18 (standard deviation 77.34).

Table 1 shows a summary of the tumors distribution located in the different anatomical regions of the turtle.

Table 1. Distribution of tumors in the different anatomical regions of the olive ridley sea turtle.

REGION	FREQUENCY	PERCENTAGE
Right eye	8	5.71
Left eye	7	5.00
Pick	2	1.43
Neck	48	34.29
Fin front right	90	64.29
Fin front left	89	63.57
Fin back right	12	8.57
Fin back left	2	1.43
Cloaca-tail	0	0
Shield	29	20.71
Scar mating area	4	2.86

The dimensions of the seen tumors also varied. The categories with the high frequency were C2 and C1, noting that C3 and C4 has frequencies clearly low (Figure 2).

DISCUSSION

The accomplished sampling points out an incidence of tumors in nesting females of olive ridley sea turtle about 1.44% at this beach. At the current terms is not possible to presume which is the real magnitude of the problem, because of the ignorance about the biological, ecological and ethological implications of this illness in populations of olive ridley sea turtle. Taking the incidence of fibropapilomas in green turtle *Chelonia mydas* as reference, species for which populations have been reported with up to 92% of infected turtles (Balazs, 1991 and George, 1997), the problem does not seem to be very severe. However, considering the size of the population of turtle olive ridley which nests in The Escobilla, besides presently work was only revised external tumors in adult females exclusively, the matter should be taken with reserves.

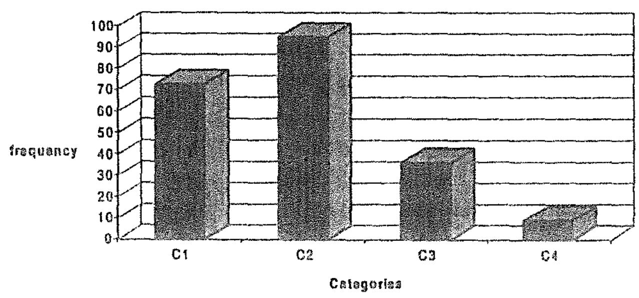

Figure 2. Fr equency tumors by size category.

The anatomical areas in which identified the high number of tumors was the front fins, noting that in more than the 60% of the cases this illness was located at this region. Also, the neck was one of the areas with high frequency (34%). This shows that the anterior portion of the turtle's body had the high level of manifestation of the illness. Immediately, the frequencies seen in shields, back fins and eyes were those that they followed in order of importance, with values about 20.7, 8.5 and 5%, respectively. Remains scar mating area and the pick with very small values, and the tail with zero appearances.

It is important to note that only the 7.8% of the turtles with tumors did not have any in the front fins and neck, what suggest these is probably the first areas for infection, starting from where the illness begin to spread on the rest of the body.

Finally, the size of the tumors is another factor which requires more research, because like it is shown in graph number 3, the tumors with measurement between 1 and 4 centimeters were the most abundant, followed by the tumors less than 1 centimeter. The frequency decreases significantly at the tumors between 4 and 10 centimeters, even swooping more the frequency tumor size over than 10 centimeters.

CONCLUSIONS

- · It is significant to find that more than one percent of the nesting females which arrived at La Escobilla beach reveals the presence of this illness. Because of this witnesses of tumors in olive ridley sea turtle is a fact that will study and thoroughly pay attention in order to know better and try to control this illness.
- · The areas of the turtle body with high affectation at this initial stage of the study were: previous fins, neck and shields. It will be useful to consider this fact in the search of the probable routes of infection and spread of the illness.
- · The tumors size minor than four centimeters are the most abundant in the nesting females that they came to nest during this *arribazón*, probably because the problem is still in the beginning.

ACKNOWLEDGMENTS

This work had the valuable collaboration of the doctors George Balazs and Alonso Aguirre from the National Marine Fisheries Service, in Honolulu Laboratory. Also, the contribution during the surveying process at La Escobilla of the Camp staff, with the special intervention of Aarón Olivera, Luz María Rodríguez, Margarita Alvarado and Yaritza Hernández.

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SATELLITE TRACKING OF HAWKSBILL TURTLES NESTING IN THE HAWAIIAN ISLANDS

George H. Balazs[1], Lawrence K. Katahira[2], and Denise M. Ellis[3]
[1]National Marine Fisheries Service, Southwest Fisheries Science Center, Honolulu Laboratory, 2570 Dole Street, Honolulu, Hawaii 96822-2396 U.S.A.
[2]Hawaii Volcanoes National Park, P.O. Box 52, Hawaii National Park, Hawaii 96718 U.S.A.
[3]Joint Institute for Marine and Atmospheric Research, c/o 2570 Dole Street, Honolulu, Hawaii 96822-2396 U.S.A.

Few studies have been undertaken using satellite telemetry to determine post-nesting migrations of hawksbill turtles, Eretmochelys imbricata. Additionally, none of the work reported to date has taken place in the Pacific region (Byles and Swimmer, 1994, Groshens and Vaughn, 1994). In the Hawaiian Islands the hawksbill, known as honu'ea, is a rare and endangered species (Balazs, 1978; Balazs *et al.* 1992; 1994). An estimated total of not more than 30 females nest in the best of years at 10 beach sites found exclusively on the islands of Hawaii, Maui, Molokai and Oahu. Hawksbills are not known to reside or nest in the Northwestern Hawaiian Islands, where green turtles, *Chelonia mydas* (honu), seasonally migrate to breed from throughout the archipelago (Balazs, 1976).

Kamehame, a small remote beach at 19° 8.8'N, 155° 28.2'W on the southeastern coast of the island of Hawaii, hosts a major portion of all hawksbill nesting in the Hawaiian Islands. Since 1989, females arriving here have been monitored, tagged, and protected by biologists from the nearby Hawaii Volcanoes National Park (Katahira *et al.*, 1994). However, no tagged turtles have been recorded away from the nesting beach. In addition, there are almost no reports of adult hawksbills being sighted by divers anywhere in coastal waters. Knowledge of the whereabouts of marine foraging habitats occupied by Hawaiian hawksbills is essential to adequately understand, protect, and manage this local population. The principal objective of the ongoing study reported here is to locate the resident feeding areas of hawksbills. Satellite telemetry using the Argos system was initiated at Kamehame in 1995 to accomplish this goal.

METHODS

Telonics ST-3 transmitters were attached to two nesting hawksbills during late August 1995. Deployment was scheduled to coincide with the latter part of the nesting season. Transmitters were programmed with a duty cycle of six hours on, six hours off. The units were turned on at a time computed for the latitude and longitude of Hawaii to synchronize with optimum satellite overpasses. Each 765 g transmitter was safely and securely attached to the carapace using Silicone Elastomer and thin layers of fiberglass cloth soaked with polyester resin. The turtles were harmlessly confined in a prone position inside a portable plywood pen during the attachment process. The same procedure successfully used to satellite-track the reproductive migrations of green turtles

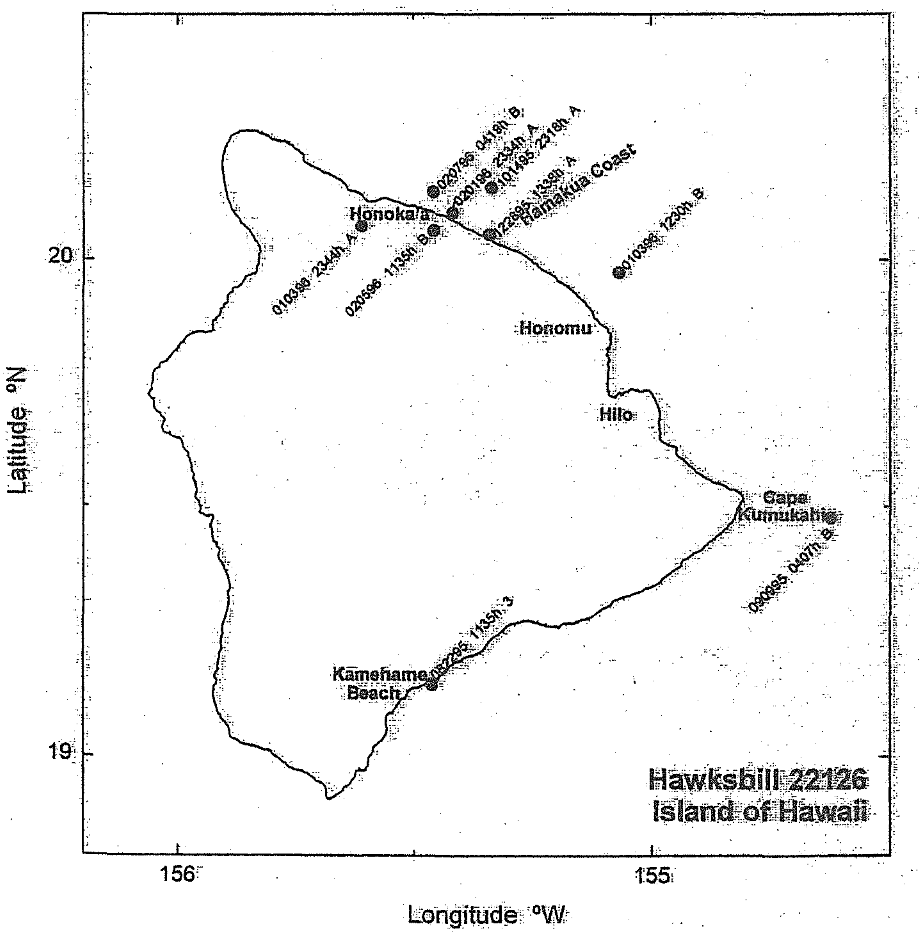

Figure 1. Post-nesting migration of hawksbill 22126 from Kamehame Beach to the Honoka'a region of the Hamakua Coast, Island of Hawaii. A minimum distance of 200 km was traveled. The month, day, year, time, and LC designation as supplied by Argos are listed for each position.

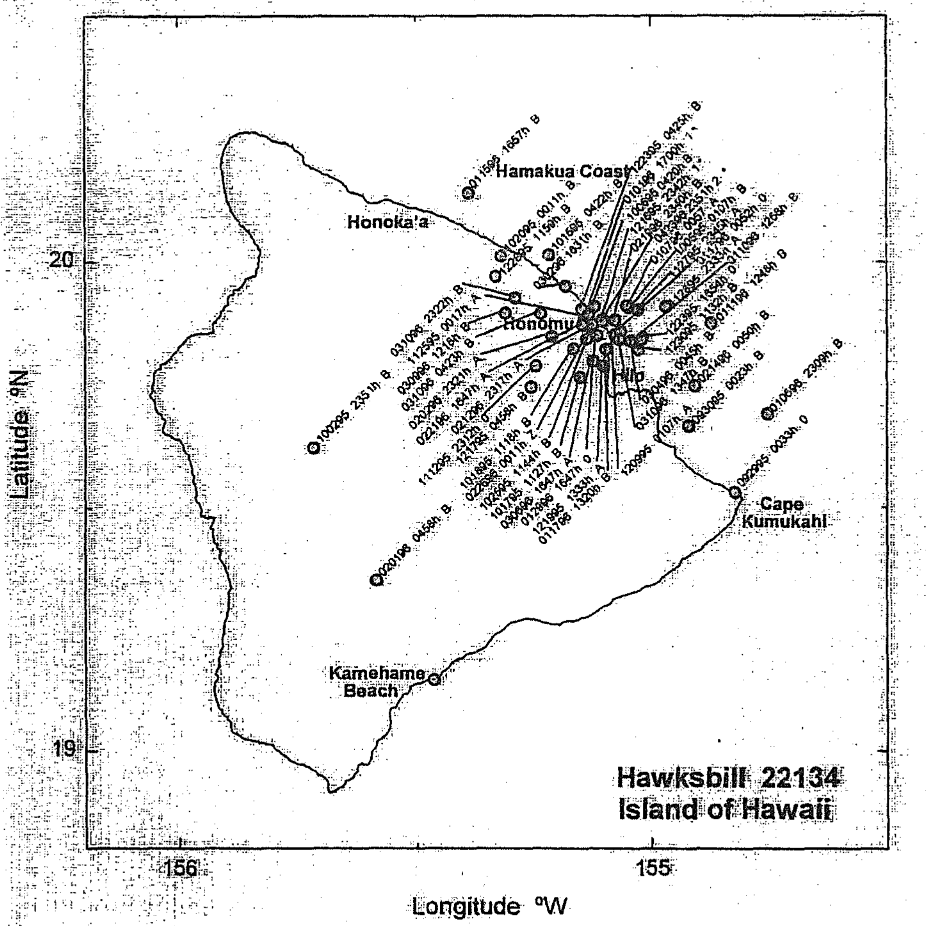

Figure 2. Post-nesting migration of hawksbill 22134 from Kamehame Beach to Honomu on the Hamakua Coast, Island of Hawaii. A minimum coastal distance of 135 km was traveled. The month, day, year, time, and LC designation as supplied by Argos are listed for each position.

in the Hawaiian Islands was carried out with hawksbills in the present study (Balazs *et al.*, in press).

RESULTS

Hawksbill 22126- This turtle was equipped with a transmitter on 8/22/95 after an unsuccessful nesting attempt. She measured 88 cm in straightline carapace length (SCL). Earlier in the season she had been recorded at Kamehame on four occasions. Flipper tags (N439/N440) showed that she had originally nested at this same site in September 1991 and was resighted nesting there again in 1993. On 8/24/95, two days after being released with the transmitter, she came back ashore at Kamehame and successfully nested.

During the following seven months 90 transmissions were relayed by Argos from hawksbill 22126; however, only eight supplied location data of latitude and longitude (Fig. 1). The remaining reports were limited to diving data showing that the turtle was usually surfacing only 9-12 times during each 12-hour period computed by Argos. Individual dives frequently lasted more than 50 minutes. The eight positions were minimally sufficient to show that the turtle had traveled to the windswept northeastern side of the island known as the Hamakua Coast. A position on 9/9/95 off the eastern point of Cape Kumukahi indicated that the turtle had taken the shortest route around the island. This post-nesting migration involved a coastal distance of about 180 km. Two of the eight positions were during February 1996, thereby demonstrating an extended residency by the turtle along the Hamakua Coast.

Hawksbill 22134- A transmitter was deployed on hawksbill 22134 on 8/24/95 after an unsuccessful nesting attempt. During the previous month this 83 cm SCL female had been flipper-tagged (B773/B774) at Kamehame when encountered there for the first time. On 8/29/95, five days after transmitter attachment, the turtle emerged again to successfully nest at this same site. During the next eight months, over 100 transmissions were relayed by Argos, 50 of which included positions of varying levels of usefulness (Fig. 2). Three of the reports were locations of high accuracy (LC 1 or LC 2) occurring during December 1995 and January and April of 1996. These data, used in combination with many of the other positions, conclusively demonstrated that the turtle had also traveled to the Hamakua Coast and, like the other hawksbill, had taken the shortest route around the island. The LC 1 and LC 2 positions placed the turtle in the nearshore waters of Honomu, a minimum coastal distance of about 135 km from Kamehame. The infrequent surfacing intervals revealed by Argos for this turtle were similar to those recorded for hawksbill 22126.

Positions shown in Figures 1 and 2 illustrate that Argos data must be carefully interpreted when tracking sea turtles, especially in studies where only short movements result. Positions received from Argos designed as LC 1, 2, and 3 are defined as quite accurate. However, no definitions of accuracy are given by Argos for LC 0, A, B, and Z positions. For these data the responsibility rests with the researcher to judge reliability and usefulness. Positions supplied may be reasonable and acceptable in one transmission, and totally unacceptable for the same LC designation when received at other times. The positions shown in the interior of the island in the accompanying figures are clearly inaccurate, hence serve to emphasize this important point.

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SATELLITE TELEMETRY OF MIGRANT MALE AND FEMALE GREEN TURTLES BREEDING IN THE HAWAIIAN ISLANDS

George H. Balazs[1] and Denise M. Ellis[2]

1 National Marine Fisheries Service, Southwest Fisheries Science Center, Honolulu Laboratory, 2570 Dole Street, Honolulu, Hawaii 96822-2396 U.S.A.

2 Joint Institute of Marine and Atmospheric Research, c/o 2570 Dole Street, Honolulu, Hawaii 96822-2396 U.S.A.

Satellite telemetry using the Argos system was conducted during 1995 for the first time on adult male green turtles, *Chelonia mydas* (honu), breeding in the Hawaiian Islands at French Frigate Shoals (24°N, 166°W). In addition, a nesting green turtle was satellite-tagged in 1995 to expand upon data obtained during 1992 and 1993 when five other migrant females were successfully tracked by satellite to their resident foraging pastures (Balazs, 1994; Balazs *et al*,. 1994).

The goal of this work is to develop detailed maps of the specific routes taken by males and females between breeding and foraging areas and to determine swimming and diving behaviors during the migrations. When viewed in conjunction with environmental, geomagnetic, and other factors, these data will provide insight into the navigational mechanisms of green turtles in the Hawaiian Islands. The satellite telemetry studies of green turtles by Liew *et al.* (1995) and Papi *et al.* (1995) in Malaysia, and Schroeder *et al.* (in press) in Florida, constitute parallel lines of important research.

METHODS

Telonics ST-3 backpack transmitters were placed on two adult males during early June 1995 and on a nesting female in late September 1995. The deployment schedules were planned to coincide with estimated departure times from French Frigate Shoals for periods of mating and nesting. The transmitters were programmed with a duty cycle of six hours on, six hours off. The units were turned on at a time of day computed to synchronize with optimum satellite overpasses for the region of deployment.

The transmitters were safely and securely attached to the carapace using thin layers of fiberglass cloth and polyester resin. The transmitters measured 17 x 10 x 3.5 cm with the antenna extending 13 cm from the top. At special request to the manufacturer, the full length of the antenna was sheathed in tubing to provide added protection against damage. Silicone Elastomer, a two-part quick curing-rubber product, was also incorporated to properly mount the transmitter

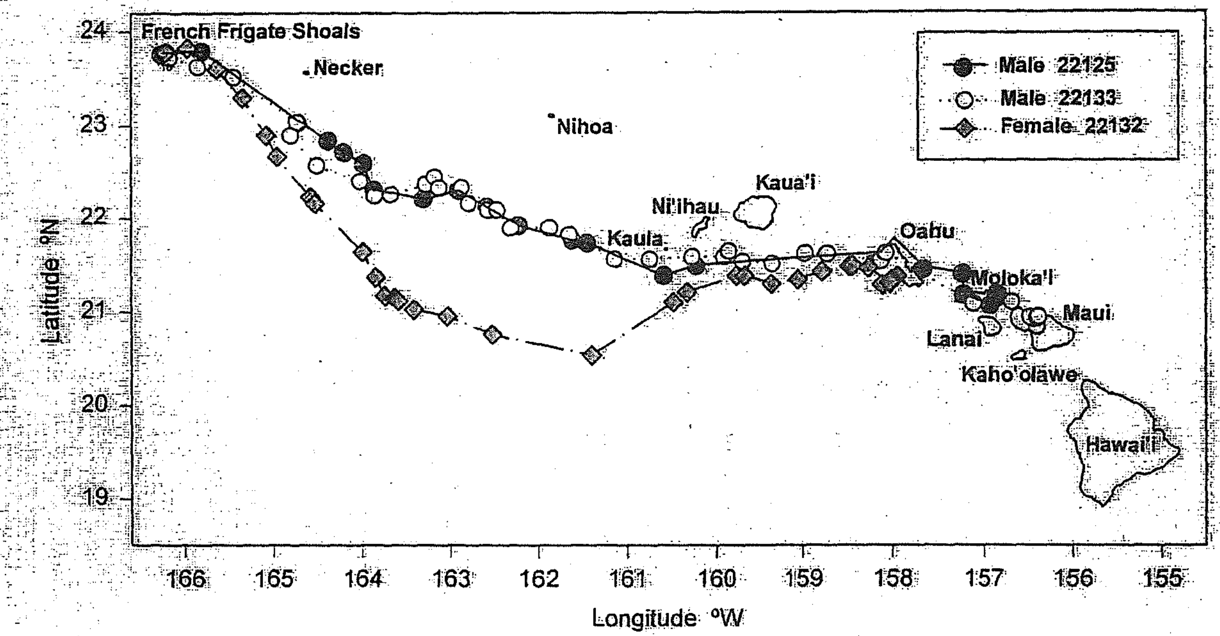

Figure 1. Post-reproductive migratory routes of adult male and female green turtles from French Frigate Shoals to Molokai, Maui, and Oahu in the main Hawaiian Islands.

against the carapace before applying the fiberglass. During the attachment process turtles were harmlessly confined in a prone position using a shaded portable plywood pen. Step-by-step directions for the entire attachment procedure are set forth in Balazs *et al.* (in press).

RESULTS

Detailed satellite tracking was successfully accomplished for the post-reproductive open ocean migrations of the two males and one female, as shown in Figure 1. The results are summarized as follows:

Male 22133

This turtle was equipped with a transmitter on 6/7/95 after being found basking ashore during the daytime at East Island, French Frigate Shoals (see Whittow and Balazs, 1982). The turtle measured 87 cm in straightline carapace length (SCL). A flipper tag (6038) revealed that the turtle had been originally identified 13 years earlier on 6/8/82 while basking at this same site. The turtle was seen there again on 6/4/84. On 6/19/95, 12 days after transmitter deployment, the turtle departed French Frigate Shoals and traveled 1200 km to the southeast on a journey lasting 30 days. On 7/19/95 the turtle arrived at Kahului Bay, an important foraging and underwater resting areas for green turtles on the northern coast of Maui (see Balazs *et al*,. 1987). The voyage mainly occurred over water thousands of meters deep, out of sight of land, and against prevailing winds and currents. The turtle's swimming speed averaged 1.7 km/hour. After reaching Kahului Bay, satellite transmissions continued for only 12 days before terminating on 8/1/95. During the migration the Argos system relayed 33 positions deemed suitable for tracking a turtle for an extended distance across the high seas.

Male 22125

A transmitter was attached to this 86 cm SCL turtle at East Island after it was captured while basking ashore on the afternoon of 6/8/95. Four days later on 6/12/95 the turtle departed on a 1050 km migration to the southeast that lasted 26 days. On 7/8/95 the turtle arrived in coastal waters of Panahaha on the southern shore of the island of Molokai. This area is known as prime foraging and underwater resting habitat for green turtles. The journey of male 22125 also occurred against prevailing winds and currents over deep water and mainly without benefit of visual contact with the Hawaiian Islands. Also, like male 22133, the turtle followed a route around the north shore of the island of Oahu before continuing eastward. The average swimming speed was 1.7 km/hour, identical to male 22133. During the migration, the Argos system relayed 21 positions judged acceptable for the purposes of this research. After arriving at Molokai the transmissions sporadically continued for nearly six months before terminating in late December 1995.

As illustrated in Figure 1, exceedingly similar oceanic pathways were taken by both males, even though they were never in contact with one another, and their final destinations were different.

Female 22132- A transmitter was deployed on this 98 cm SCL turtle after she came ashore to nest at East Island on the night of 9/22/95. A flipper tag had been applied three months earlier during a previous nesting on East Island. Female 22132 departed on 9/26/95 traveling 1050 km to the southeast taking 23 days at an average swimming speed of 1.9 km/hour. The trip was completed on 10/19/95 with her arrival along the Ewa coastline near the entrance to Pearl Harbor on Oahu's southern shore. The Argos system relayed 28 positions of relatively high quality during the migration. After reaching the Ewa coastline, transmissions continued on nearly a daily basis for over six months, thereby clearly demonstrating the turtle's extended residency to this area.

The migratory pathway of female 22132 was substantially farther to the south than the routes followed by the two male turtles. However, the route of female 22132 was very similar to three of the four post-nesting females satellite-tracked in past years migrating from French Frigate Shoals to Oahu (Balazs, 1994; Balazs *et al.*, 1994).

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GROWTH RATES AND RESIDENCY OF IMMATURE GREEN TURTLES AT KIHOLO BAY, HAWAII

George H. Balazs[1], Marc Rice[2], Shawn K.K. Murakawa[3], and George Watson[2]

[1]National Marine Fisheries Service, Southwest Fisheries Science Center, Honolulu Laboratory, 2570 Dole Street, Honolulu, Hawaii 96822-2396 U.S.A.

[2]Hawaii Preparatory Academy, P.O. Box 428, Kamuela, Hawaii 96743 U.S.A.

[3]Joint Institute for Marine and Atmospheric Research, c/o 2570 Dole Street, Honolulu, Hawaii 96822-2396 U.S.A.

Long-term studies of green turtles, *Chelonia mydas* (honu), in nearshore waters of the Hawaiian Islands have been underway to obtain comprehensive information on growth rates, food sources, habitat use, developmental and reproductive migrations, underwater behaviors, health status, and population trends (Balazs, 1980, 1982, 1991, in press; Balazs *et al.*, 1987, 1993, 1994a, 1994b; Russell and Balazs, 1994). The Hawaiian Archipelago includes 132 islands and reefs extending for 2400 km across the North Pacific. However, the eight main islands at the southeastern end of the chain account for nearly all coastal benthic habitats suitable for foraging and resting by post-pelagic green turtles. Adult males and females residing throughout the chain migrate to breed at isolated French Frigate Shoals (23° 47'N, 166° 12'W) situated at the mid-point of the archipelago (Balazs, 1976, 1980, 1983). Systematic monitoring at this site for 23 consecutive seasons (1973-95) has documented an approximate threefold increase in the number of nesting females (Fig. 1). This encouraging sign of population recovery is attributed to protection extended in 1978 under the U.S. Endangered Species Act. Similar increases have been seen for immature turtles inhabiting nearshore waters of the main islands, such as reported here for Kiholo Bay.

METHODS

Kiholo Bay and the adjoining 2 hectare mixohaline lagoon known as Wainanali'i Pond are located at 19° 52'N, 155° 55'W on the western coast of the island of Hawaii (Kay *et al.*, 1977). This site constitutes one of 16 resident areas for green turtles under investigation throughout the Hawaiian Islands. Kiholo Bay has been periodically visited for tagging since 1980 involving 27 expeditions lasting from 1 to 4 days. Since 1987, students and science instructors from the Hawaii Preparatory Academy have served as essential field assistants in the accomplishment of this work. Turtles have been harmlessly hand-captured while snorkeling at night or by using large-mesh tangle nets carefully tended to prevent injury from forced submergence. Turtles have also been intensively monitored by sonic telemetry at selected intervals to determine daily foraging and resting schedules (Laber and Waller, 1994).

RESULTS

As of December 1995, 313 green turtles of immature sizes ranging from 33.2 to 71.5 cm in straightline carapace length have been captured and tagged at Kiholo Bay. Nearly all of the turtles were caught by hand while they were resting on the bottom within Wainanali'i Pond or by net while they were passing through the pond's narrow entrance channel. The number of turtles captured on each trip during recent years has increased considerably. For example, during the late 1980s 11 to 37 turtles were captured on each visit. During the 1990s, from 40 to 85 turtles have been captured each time with equal or reduced capture-effort. On recent trips, it has sometimes even been necessary to terminate netting because too many turtles were being caught, thereby exceeding the capacity to expeditiously handle them. Besides green turtles, three juvenile hawksbills have been captured, tagged, and resighted within Wainanali'i Pond.

Of the 313 turtles, 210 or 67.1% have been recaptured one or more times, and 202 (64.5%) provided growth increments ranging from 3 months to 14.4 years. Multiple recaptures of the same turtles yielded 528 growth increments. Recaptures consisted of 32% being recaptured once, 27% twice, 35% 3-5 times, 6% 6-8 times, and one turtle recaptured 13 times (over 7.3 years). The 528 increments, shown in Figure 2 by 5-cm size classes, resulted in an overall mean growth rate of 1.7 ± 1.0 cm/yr. The 50-55 cm size class exhibited the highest mean growth rate (2.0 ± 1.1 cm/yr). When only one growth increment was used for each of the 202 recaptured turtles (i.e., growth between initial and most recent capture) the overall mean growth rate was 1.5 ± 0.8 cm/yr.

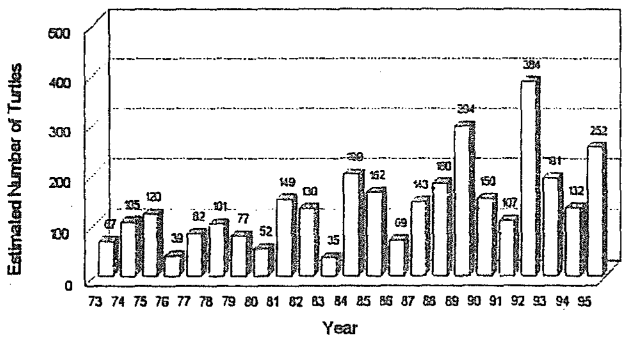

*Figure 1. Historical trend for 23 nesting seasons, 1973-95. East Island accounts for 50% or more of all green turtle nesting at French Frigate Shoals. *1988-92 counts based on saturation tagging throughout the nesting season.*

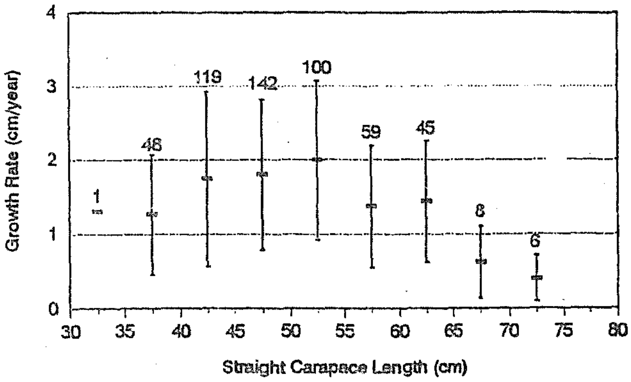

Figure 2. Mean growth rates, standard deviations, and number of growth increments for nine size classes of green turtles at Kiholo Bay, Hawaii. The mean rate of growth for 528 increments (202 turtles) was 1.7 ± 1.0 cm/year.

Only four turtles (1.3%) tagged at Kiholo have been recaptured elsewhere. Two were found at Kahalu'u Bay 35 km to the south, one at Keawa Nui Bay 12 km to the north, and one at Puako 16 km to the north. The turtle resighted at Puako was recaptured later back at Kiholo Bay. None of the turtles captured at Kiholo over the 14.4-year period were found to have been tagged elsewhere. This is in spite of the fact that 236 green turtles have been tagged since 1990 at other study sites within 16 km to the north, and 50 km to the south, of Kiholo Bay. In addition, 217 green turtles have been tagged at Punalu'u Bay since 1976 on the east coast of the island of Hawaii (Balazs *et al.*, 1994b). Considered together, these data provide strong evidence in support of extended residency for turtles inhabiting discrete coastal sites on the island of Hawaii. Similar findings have resulted from work conducted elsewhere in foraging pastures throughout the Hawaiian Islands.

Sonic telemetry of 10 green turtles involving 500 hours of monitoring (270 hours diurnal and 230 hours nocturnal) revealed extremely limited movements in the turtles' daily cycles at Kiholo Bay. Nights were spent inside Wainanali'i Pond where the turtles are known to rest under submerged lava rock ledges or on the silty bottom where the maximum depth is less than four meters. During the early morning, usually just before sunrise, the sonic-tagged turtles would leave the pond to feed on Gelidium and other benthic algae in the adjacent nearshore waters of the bay.

None of the turtles captured at Kiholo Bay or anywhere else along the western coast of the island of Hawaii have had tumors indicative of fibropapillomatosis or evidence of any other disease. However, since 1988, nine carcasses have been recovered suggestive of fatalities from gillnet fishing that commonly occurs at Kiholo Bay.

Terrestrial emergences by green turtles are occurring with increasing frequency on the smooth lava rock bordering Wainanali'i Pond (see Balazs in press). All turtles examined ashore engaged in this behavior have been healthy and vigorous. Terrestrial basking by green turtles has been known for centuries in the remote Northwestern Hawaiian Islands (Whittow and Balazs 1982). However, until recently, emergence of this nature has been exceedingly rare in the main islands, and never before recorded at Kiholo Bay.

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PLASMA TESTOSTERONE DYNAMICS IN THE KEMP'S RIDLEY SEA TURTLE

Michael S. Coyne and André M. Landry, Jr.
Department of Wildlife and Fisheries Sciences Texas A&M University College Station, Texas 77845, U.S.A.

Testosterone (T) radioimmunoassay techniques, used successfully in sexing green and loggerhead sea turtles (Bolten *et al.*, 1992; Wibbels *et al.*, 1991), were evaluated in determining plasma T concentration of 149 Kemp's ridley sea turtles (*Lepidochelys kempii*) captured along the upper Texas and Louisiana coasts during 1993-95. Thirty-nine of these ridleys were laparoscoped as a control on this sexing technique. Plasma T concentrations of the laparoscopied individuals were < 12 pg/ml for females (n = 19) and > 18 pg/ml for males (n = 20). Applying these criteria to the entire captured lot of 21.6 to 64.6 cm (SCL) ridleys produced 75 females, 69 males, and 8 indeterminates. Males less than 40 cm SCL and all females exhibited no significant variation in plasma T across carapace length. However, these smaller males did exhibit significant variation in plasma T across capture month (Student's t = 2.0066). Males greater than 40 cm SCL exhibited a significant exponential increase in plasma T concentration (ANOVA: F = 39.1666, p < 0.0001). Observed differences in plasma T dynamics amongst male ridleys suggest that Ogren's (1989) definition for Kemp's ridley age classes be redefined in terms of physiological development as juveniles < 40 cm SCL, Subadults 40 - 60 cm SCL, and adults > 60 cm SCL.

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FOURTEEN YEARS OF NESTING AT THE ARCHIE CARR NATIONAL WILDLIFE REFUGE

Ehrhart L.M., D.A. Bagley and L.T. Uong
Dept. of Biology, University of Central Florida, P.O. Box 162368, Orlando, FL 32816

At 16,918 nests, loggerhead nest production set a new record for the Brevard County portion of the Archie Carr NWR in 1995. This total exceeded the previous high, seen in 1994, by 15% and constitutes an overall density of 606 nests/km. It exceeded the comprehensive average of the past 13 years (1982-1994) by 6,200 nests (57%). Comparisons with another good nesting beach of similar extent, nearby in central Brevard County (6,037 nests; 309 nests/km), provide perspective on the relative magnitude of nesting at ACNWR. Green turtles adhered to the well-known pattern of biennial "highs" and "lows" and, following the record high in 1994 (1107 nests), deposited only 103 nests at ACNWR in 1995. There were two leatherback nests within the ACNWR boundaries and one other just to the north in central Brevard County. The Carr Refuge took a direct hit by Hurricane Erin on the night of 1-2 August and that was followed by a procession of storms that lasted until mid-September. Effects of tropical weather systems are usually not felt on the Brevard coast until about Labor Day, after most loggerhead nests have hatched. Erin came a full month earlier, while 60% of the nests were still incubating. The storms of August washed out many study nest markers, making it difficult to quantify the loss, but available data suggest that somewhat more than 8,000 nests were washed out or exposed and then destroyed by predators. Acquisition of lands for the Carr Refuge is about 80% complete but commercial and residential development are rampant in the area. Procurement of the remaining lands needs to be expedited if the quality of this critical nesting habitat is to be preserved. We thank the U.S. Fish & Wildlife Service and the Richard King Mellon Foundation for their support of our research on the Carr Refuge nesting beach.

ESTIMATING THE TIME BETWEEN HATCHING OF SEA TURTLES AND THEIR EMERGENCE FROM THE NEST

Matthew H. Godfrey[1,2], and N.Mrosovsky[1].
[1]Department of Zoology, University of Toronto, Toronto, Ontario M5S 3G5 CANADA
[2]Current address: Projeto TAMAR, Caixa Postal 2219, Salvador, Bahia 40210-970 Brazil
(fax: 55-71-876-1067; email: godfrey@zoo.utoronto.ca)

The interval between when sea turtles hatch from their eggs and actually emerge from the nest is thought to be several days long. It is an important period for the hatchlings, for they must synchronize their efforts to escape the nest. Previous descriptions of the hatch to emergence interval have relied on manipulation in some way, including introducing some kind of recording device into the nest or placing a glass plate against the side of the egg mass. In an effort to describe this interval more accurately, we looked at the relationship between incubation period and incubation temperature of eggs of loggerhead (*Caretta caretta*) turtles, both in the lab and in nests *in situ*. By comparing incubation period in the laboratory (time until hatching) to incubation period in natural nests (time until emergence from the nest), at similar temperatures (i.e. similar developmental rates), we assumed that the differences between lab and natural nests would be the hatching to emergence interval. From our calculations, the mean hatching to emergence interval was 4.1 days, which is similar to previously published studies.

DO BEACH UMBRELLAS AFFECT SEX RATIO?

Matthew H. Godfrey[1,2], R. Barreto[3,4], and N. Mrosovsky[1]
[1]Department of Zoology, University of Toronto, Toronto, Ontario M5S 3G5 CANADA
[2]Current address: Projeto TAMAR-IBAMA, Caixa Postal 2219, Salvador, Bahia 40210-970 BRAZIL (Fax: 55-71-876-1067; email: godfrey@zoo.utoronto.ca)
[3]Faculty of Environmental Studies, York University, Toronto, Ontario M3J 1P3 CANADA
[4]Current address: IUCN/SSC Sustainable Use Initiative, 1400 16th Street NW, Washington, D.C. 20036 U.S.A.

BACKGROUND

The direction of sexual differentiation of turtle hatchlings is affected by the sand temperature prevailing during incubation. Human practices which alter sand temperature can potentially affect sex ratio. For instance, shade from condominiums (Mrosovsky *et al.*, 1995) and exotic trees (Schmelz and Mezich, 1988), smoke from oil well fires (McCain *et al.*, 1993), and exotic sand used for beach renourishment (Schulman *et al.*, 1994), all may reduce beach sand temperature. It has been suggested that shade from beach umbrellas may also reduce sand temperature and therefore affect sex ratio (e.g. Poland *et al.*, 1995; Broderick and Godley, 1993).

THE STUDY

We studied the effect of a beach umbrella on sand temperature on two nesting beaches in South America. The first study site was on Matapica beach in Suriname, which runs east-west. This beach is primarily used by leatherbacks and green turtles, and is not frequented by tourists. The second site was Praia do Forte, Bahia, Brazil. It runs north-south, is primarily a loggerhead nesting beach, and is popular with tourists. For both beaches the methodology was the same.

We measured sand temperatures at 30 and 60 cm depths, both directly under the umbrella and at an adjacent control site in full sun. Mean daily temperatures over a number of days were recorded using digital thermistors (Godfrey and Mrosovsky, 1994). The data were compared using repeated measures ANOVA and Tukey-Kramer post tests.

RESULTS

For both beaches, there was a small but significant mean daily sand temperature reduction caused by umbrella shade only at the 30 cm depth. There was no difference at 60 cm.

IMPLICATIONS

1) The results indicate that the effects of shade from beach umbrellas on sex ratio would only come into play for very shallow nests. Therefore, eggs from turtles which tend to have deeper nests (e.g. leatherbacks, green turtles) would be less affected than those from shallow nesters (e.g. ridleys).

2) Even at 30 cm depths, the cooling effect of the beach umbrella was small, on the order of 0.5 °C. Therefore, sex ratio would be affected only if beach temperatures were already close to the pivotal sand temperature (that temperature at which 50% of each sex is produced).

RECOMMENDATIONS

This study suggests that the effects of beach umbrellas on sex ratio would be limited. However, this work is based on small sample sizes. It would be useful to perform a similar but more extensive study on a nesting beach where umbrellas and turtles often mix.

ACKNOWLEDGMENTS

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THE MALAYSIA/PHILIPPINES TRANS-BOUNDRY MARINE PARK: A MONUMENTAL STEP TOWARD TURTLE RESEARCH AND CONSERVATION

Nicolas J. Pilcher[1] and Datuk Lamri Ali[2]
1 Institute of Biodiversity and Environmental Conservation, Universiti Malaysia Sarawak, 94300 Kota Samarahan, Sarawak, East Malaysia
[2]Sabah Parks, P.O. Box 10626, 88806 Kota Kinabalu, Sabah, East Malaysia

Thousands of marine turtles nest on the small, coral-fringed islands straddling the Malaysian / Philippine border, 40 km north of Sandakan, East Malaysia. Data collected by Sabah Parks personnel on the Malaysian islands indicates continuous nesting throughout the year with a peak during June to August. Although nesting is predominantly by greens (*Chelonia mydas*), hawksbills (*Eretmochelys imbricata*) are also found, and to a lesser extent Olive Ridleys (*Lepidochelys olivacea*).

Under the auspices of Sabah Parks Department, conservation of marine turtles in Sabah has been active since 1966. Sabah Parks has operated hatcheries at the three islands of the Turtle Island Park since then, and have released more than 6 million hatchlings to the surrounding waters since then. The number of nesting adults, which had declined drastically since the 1920's, has slowly increased since the Park's inception.

Due to the proximity of the neighboring Philippine islands, and the knowledge that many of the eggs one these islands were being sold legally in the Philippines and illegally in Malaysia, a joint marine park, encompassing both turtle rookeries, was proposed and will finally be gazetted in 1996 (Fig. 1). One of the primary goals in the establishment of the trans-boundry park is to support research into further conservation and management measures. Conservation measures are now being implemented on both sides of the border in an effort to curb the decline of the nesting populations worldwide and to collaborate on research into efficient management guidelines. Since that time, legislature in the Philippines that now limits the number of eggs collected from natural nests has contributed significantly to local conservation.

Recent DNA-study findings by Australian biologists

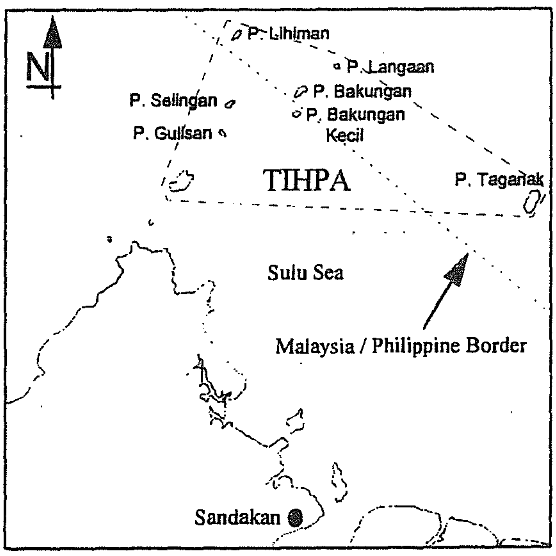

Fig. 1. Proposed Turtle Islands Heritage Protected Area off Sabah, East Malaysia.

confirmed that the turtles nesting on these islands were indeed of similar origin and it has been suggested that they represent an Evolutionary Significant Unit (ESU). Current research by the Universiti Malaysia Sarawak is aimed at ensuring conservation measures by the Park Rangers in the hatcheries are in keeping with natural nesting activities and conditions, with particular regard to incubation temperatures. Where possible, methods to enhance hatchling survival are being implemented.

A MODEL FOR SALT GLAND SECRETION IN THE GREEN SEA TURTLE, *CHELONIA MYDAS*

Richard Reina
Division of Botany and Zoology, Australian National University, A.C.T. 0200 Australia

Very little is known about the control of salt gland secretion in sea turtles. *In vivo* and *in vitro* techniques were used to investigate the role of cholinergic and adrenergic stimulation as possible control modifiers of salt gland activity. The *in vivo* technique measured salt gland response to injection of methacholine and adrenalin in salt loaded turtles. *In vitro* techniques included measurement of oxygen consumption of salt gland cells and immunohistochemical localisation of adrenergic nerves.

There was a dose dependent inhibition of the salt gland *in vivo* by methacholine, with duration of inhibition increasing with dose from 1 to 10 $mg.kg^{-1}$. In addition, some residual inhibition was evident after secretion had commenced, with the total rate of secretion reduced in comparison to control animals.

Adrenalin also exerted a profound, dose dependent inhibitory influence on salt gland activity *in vivo*. The minimum dose effective in inhibiting secretion was 25 $\mu g.kg^{-1}$ and the period of inhibition increased with doses up to 500 $\mu g.kg^{-1}$. When secretion recovered, it resumed at control rates and did not display any residual inhibition.

Adrenalin did not affect the oxygen consumption rate of salt gland cells *in vitro*, but it did increase the rate of consumption by turtle cardiac cells. Cells from both active and inactive salt glands consumed oxygen at about 15 $\mu l.min^{-1}.g$ wet $weight^{-1}$.

The presence of adrenergic nerves within the salt gland was shown by the presence of tyrosine hydroxylase. Adrenergic nerves were found to be present around the main collecting area of secretory fluid, and also running between lobes of the gland.

The role of adrenergic and cholinergic influences on salt gland activity will be discussed in the context of a model for regulation of salt gland function. They do not appear to fit the typical sympathetic/parasympathetic antagonistic model generally seen in exocrine glands.

ELECTRON MICROSCOPIC ANALYSIS OF VASCULAR CARTILAGE CANALS IN THE HUMERAL EPIPHYSIS OF HATCHLING LEATHERBACK SEA TURTLES, DERMOCHELYS CORIACEA

Johannes A.G. Rhodin[1], Anders G.J. Rhodin[2], James R. Spotila[3]
[1]Department of Anatomy, University of South Florida, Tampa, FL 33612 U.S.A.
[2]Chelonian Research Foundation, Lunenburg, MA 01462 U.S.A.
[3]Department of Bioscience and Biotechnology, Drexel University, Philadelphia, PA 19104 U.S.A.

Cartilage canals in the growing humeral epiphysis of leatherback sea turtle hatchlings, *Dermochelys coriacea*, were investigated using a combination of light microscopy and transmission electron microscopy. Canals contained large interconnected vascular sinusoids near the leading tip, supplied by several feeding arterioles and drained by multiple venules. Individual capillary sprouts were not found. The metachromatic staining of the cartilage matrix was reduced in a marginal zone in front of and on the sides of the canals.

Epiphyseal matrix was not calcified in front of and near the leading tip of the growth cone, but many chondrocytes in these regions showed signs of cell death and nuclear pyknosis, a condition apparently unique to the leatherback and not previously reported in other vertebrates. Many fibroblastic cells, rich in granular endoplasmic reticulum, as well as macrophages, monocytes, and occasional multinucleated chondroclasts, occupied interstitial space in the tip of the canal between sinusoids and cartilage matrix. Near the base of the canal, surrounding cartilage matrix was calcified and chondrocytes hypertrophic and disintegrating. Involvement of the sinusoids and the cells near the tip of the canal in the process of cartilage resorption and canal formation is discussed in relation to the rapid growth of leatherback turtles.

BETWEEN A ROCK AND A HARD PLACE: COASTAL ARMORING AND MARINE TURTLE NESTING HABITAT IN FLORIDA

Barbara A. Schroeder[1] **and Andrea E. Mosier**[2]

[1]Florida Department of Environmental Protection, Florida Marine Research Institute, 19100 SE Federal Highway, Tequesta, FL, 33469, U.S.A. (Current Address: National Marine Fisheries Service, Office of Protected Resources, 1315 East West Highway, Silver Spring, Maryland, 20910, U.S.A)

[2]Florida Department of Environmental Protection, Florida Marine Research Institute, 100 Eighth Avenue, SE, St. Petersburg, FL, 33701, U.S.A. (Current Address: Florida Fish and Wildlife Conservation Commission, Florida Marine Research Institute, 100 Eighth Avenue, SE, St. Petersburg, FL, 33701, U.S.A.)

The deliberate "armoring" or hardening of the ocean shoreline, with the sole purpose of protection of upland structures is rapidly degrading marine turtle nesting habitat in Florida. Development of the coastal strand and the resulting placement of structures on the primary and secondary dune (or equivalent), are the first steps toward coastal armoring. Coastal armoring is exhibited in many different forms. For the purpose of this paper, and with marine turtles specifically in mind, we offer the following definition of coastal armoring. Coastal armoring is any rigid or frangible structure placed parallel to the shoreline on the upper beach with the sole purpose of protecting upland structures or property. Other structures (i.e., groins, jetties) also present threats to marine turtles and their nesting habitat, but are outside the scope of this paper.

We define five categories of coastal armoring: (1) bulkheads and seawalls; (2) revetments; (3) sandbags and geotextile tubes; (4) soil retaining walls; and (5) dune reconstruction. The first category, bulkheads and seawalls, is the most common type found in Florida. These structures are vertical, non-permeable, and are most commonly constructed of concrete or steel sheetpile with a concrete cap. Regardless of the construction material, both designs extend several meters above the beach surface and are anchored well below grade. The second category of coastal armoring, revetments, are structures that are sloping in design (negative slope toward the ocean) and may be semi-permeable or non-permeable. These types of structures have a negative slope toward the ocean and extend many meters above grade and generally extend below grade as well. Semi-permeable structures include rock revetments and construction rubble revetments. Non-permeable revetments primarily include soil-cement step revetments and concrete waffle-type structures. These types of revetments form a solid fused sloping barrier along the shore. Bulkheads and seawalls may be combined with a rock revetment forming a "combination" structure. An example of this type of structure, and one that is not uncommon is a steel sheetpile wall, with a concrete cap, and a toe scour revetment, placed lower down against the wall with the purpose of preventing undermining of the seawall at it's lowest vertical extension.

The third category of armoring includes sandbags and geotextile tubes. These structures are sand filled fabric bags and are generally installed in a sloping configuration. Large sandbag installations usually include tie-straps that connect bags together with the goal of helping to hold the loose bags in place. The straps are back into the dune in a deadman-type system. Geotextile tubes are elongated sandbags that may stretch the entire length of a coastal armoring project with multiple tubes installed one on top of the other in a sloping configuration. The fourth category of armoring is soil retaining walls, which are considered less permanent than the aforementioned types. They are frangible, primarily constructed of vertically placed wood panels (boards) and are

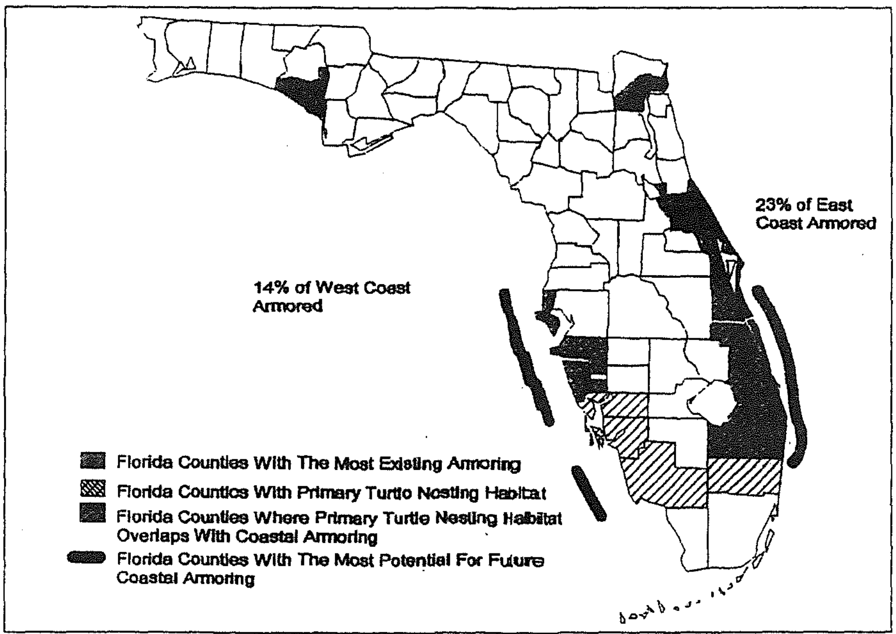

Figure 1. Percentage shoreline armored in the State of Florida

designed to fail under certain storm conditions. It is important to note however that "failure" generally means that sediment will pass through or under the structure with the retaining wall remaining in place. The fifth and final category of armoring is dune reconstruction. We consider this as armoring, in our analysis, because some dune reconstruction projects consist of large mounds of compact sediment, often sacrificial in nature, which when placed on narrow, eroded beaches, serve as impenetrable barriers to beach users, including turtles. We note that many dune reconstruction projects are beneficial, when conducted properly and for the purposes of actually re-building a functioning dune.

There are four broad consequences to the beach/dune system that can result from coastal armoring. Coastal armoring structures cause a reflection in wave energy which can increase erosion seaward of these structures, the intensity of longshore currents can be increased, moving sand away from the site more rapidly and in greater quantities, the natural exchange of sand between the dune and beach is prevented, and wave energy is concentrated at the ends of armoring structures which can exacerbate erosion at adjacent, unarmored beach. Any factors which affect the beach/dune system have the potential, either directly or indirectly, to affect nesting turtles, incubating egg clutches, hatchlings, and their habitat.

Coastal armoring structures can affect marine turtles in a variety of ways including: prevention of access to suitable nesting sites; the permanent loss of nesting habitat; abandonment of nesting attempts due to interaction with the structure; interference with proper nest cavity construction and nest covering; increase in clutch mortality resulting from frequent inundation and/or exacerbated erosion. In addition, armoring structures can impede and/or trap nesting females and hatchlings. These impacts are witnessed regularly at nesting beaches where coastal armoring structures are in place.

Coastal armoring in the state of Florida, USA, is not an isolated occurrence. In 1990, at the direction of the Governor and Cabinet and as a direct result of a permit application for armoring in the heart of the globally important loggerhead rookery on the east coast of Florida, an analysis of existing and potential coastal armoring was conducted by the Florida Department of Natural Resources (FDNR) Division of Beaches and Shores (Clarke, 1992). This analysis, which does not include soil retaining walls or sandbags and geotextile tubes, showed that existing armoring was concentrated in five areas of the state (Fig. 1). The total armored coastline currently encompasses 22.7% of the east coast and 13.9% of the west coast, with existing armoring concentrated in five areas of the state, three on the east coast, one in southwest Florida, and one in the panhandle. The potential for armoring was based on calculations using models of various storm frequency and intensity, and even the most conservative model (from the standpoint of turtles), produced alarming results. The most potential for additional armoring encompasses most of the southeast and southwest coasts of the state. This same area includes virtually all of the primary nesting beaches for loggerheads, green turtles, and leatherbacks in Florida.

There are four recent landmarks relative to coastal armoring regulation in Florida. The first, in December 1990 was the issuance of a FDNR policy on armoring, which provided criteria by which armoring applications would be evaluated, provided general protection to marine turtles, and contained specific language prohibiting armoring within the Archie Carr National Wildlife Refuge and within critical habitat if designated under the U.S. Endangered Species Act. This policy was an outgrowth of the Governor and Cabinet's directive to the FDNR to report on the status of armoring and to develop a policy to guide permit review. The policy was in effect until July 1994, when it was determined to be no longer applicable or enforceable, primarily as a result of the merger of the state's two principal environmental agencies to form the Florida Department of Environmental Protection (FDEP) as an agency solely under the Governor and not under the Governor and Cabinet. In October 1995, a new Florida Statute addressing coastal armoring structures, enacted by the Legislature, became effective. This legislation was a direct result of lobbying by developers, beachfront property owners, and their advocates. The Statute sets the stage for more permissive armoring rules and includes a provision for emergency armoring without prior permitting. The determination of emergency is left to local governments. This Statute led to the drafting of a coastal armoring rule by FDEP, the draft rule is currently under review and is expected to be published as a proposed rule in the near future. There are no hearings currently scheduled and it will be up to those interested in the rule and it's consequences to call for public hearings.

Coastal armoring threatens the recovery and long-term viability of marine turtles in the southeast U.S. at a level on the scale of that posed by commercial fisheries. The effects of coastal armoring on marine turtles are however more insidious - carcasses are not evident on the beach to draw public attention to the problem. Beachfront property owners are closely following and advocating a permissive armoring rule, and local governments are following the issue closely also.

The placement of structures on the shoreline eventually creates an erosion problem which often leads to coastal armoring. Armoring primarily protects the private interests of a very few, at a very high public environmental and recreational cost. Alternatives to this destructive practice include continual beach nourishment (an expensive activity which can also threaten nesting turtles, hatchlings, and habitat) or retreat (Pilkey *et al.*, 1984). It is imperative that the State of Florida adopt a more thoughtful policy, which seriously takes into account the beach/dune ecosystem including the non-negotiable need that marine turtles have for intact nesting habitat and which recognizes the long-term effects of shoreline manipulation not only on the ecosystem but on the recreational value of beaches as well. Unfortunately, this is currently not the case (Schmahl and Conklin, 1991). The long-term impacts of coastal armoring on marine turtle recovery should alarm and serve as a call for action to all marine turtle researchers and managers.

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DEVELOPMENT AND EVALUATION OF A SEXING TECHNIQUE FOR HATCHLING SEA TURTLES

Thane Wibbels[1] and Robert LeBoeuf[2]
[1]Department of Biology, University of Alabama at Birmingham, Birmingham, AL, 35294-1170, U.S.A.
[2]Department of Physiology and Biophysics, University of Alabama at Birmingham, Birmingham, AL, 35294, U.S.A.

The primary focus of many sea turtle conservation programs is the protection of turtles and eggs on the nesting beach (Magnuson *et al.*, 1990). A possible problem associated with these efforts is the fact that a sea turtle's sex is determined by the incubation temperature of the egg (Mrosovsky, 1983). This aspect of sea turtle's biology has the potential of producing highly biased sex ratios which could significantly alter the effectiveness of nesting beach programs (Mrosovsky and Yntema, 1980; Morreale *et al.*, 1982; Mrosovsky, 1983; Wibbels *et al.*, 1989; Mrosovsky *et al.*, 1992). The effects of such biases on reproduction in a population would not be evident for many years, since sea turtles require a prolonged period to reach sexual maturity. Thus, there is a need to monitor hatchling sex ratios. Unfortunately, there is no external indication of the sex of hatchling sea turtles.

Previous studies suggests that hatchling sex ratios can fluctuate seasonally, yearly, and even interclutch differences in pivotal temperature (temperature producing a 1:1 sex ratio in reptiles with temperature-dependent sex determination) have been noted (Mrosovsky *et al.*, 1984; Mrosovsky, 1988, 1994; Etchberger *et al.*, 1991; Ewert *et al.*, 1994; Lang and Andrew, 1994). Therefore, accurate estimation of hatchling sex ratios from a given nesting beach may require a comprehensive approach. A prerequisite to conducting such studies is a practical and nonlethal technique for accurately sexing large numbers of hatchlings.

We are currently developing a hatchling sexing technique based on the hormone "mullerian inhibiting substance" or MIS (Cate *et al.*, 1986; Donahoe *et al.*, 1987). In vertebrates, both male and female embryos develop mullerian ducts which form the oviducts in females (i.e. fallopian tubes and uterus). Male vertebrates begin producing MIS during late embryonic development and this hormone stimulates the degeneration of the mullerian ducts. Previous studies indicate that MIS levels are high in young males, but not in females. For example, in humans, MIS in males is extremely high at birth and remains high for six years or more, whereas levels are very low or nondetectable in females (Hudson *et al.*, 1990).

The production of a MIS assay for sexing hatchling sea turtles requires recombinant turtle MIS and an antisera which specifically binds turtle MIS. Therefore we initially cloned the cDNA for turtle MIS. To accomplish the cloning, we adopted a PCR-based strategy. Degenerate primers based on the structure of chicken and mammalian MIS were used in the PCRs. RNA was isolated from embryonic testes for the production of cDNA template. 5' and 3' RACE were used to isolate the 5' and 3' noncoding regions of the cDNA. Sequencing was performed on a Perkin Elmer Applied Biosystems 377 automated sequencer. The turtle MIS clone was inserted into a pET vector expression system in order to produce the MIS protein (i.e. the hormone). The MIS protein was used to test four different MIS polyclonal antisera. The results indicate that two of the four antisera specifically bind turtle MIS. These two antisera were used to develop "enzyme linked immunosorbent assays" (ELISAs) for turtle MIS. Two "direct" ELISAs for turtle MIH were developed. Each of these two "indirect" ELISAs utilizes a single antisera. Since two antisera specifically bind MIH, we are also developing a "sandwich" ELISA which utilizes both antisera. Sandwich ELISAs are significantly more sensitive than indirect ELISAs and should thus optimize the sexing technique.

We are currently validating the MIS assay using blood samples from hatchling sea turtles. Over the past two years we have evaluated blood sampling techniques for hatchling sea turtles (Wibbels *et al.*, submitted). Hundreds of blood samples were routinely taken from blood sinuses located in the necks of hatchlings. The bilateral cervical sinus (Owens *et al.*, 1978; Owens and Ruiz, 1980) was the primary location used to obtain blood. No change in the behavior of the hatchlings was noted following the sampling, and no mortality was associated with the sampling. This included a study in which over 100 hatchlings were held for several days after hatching.

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