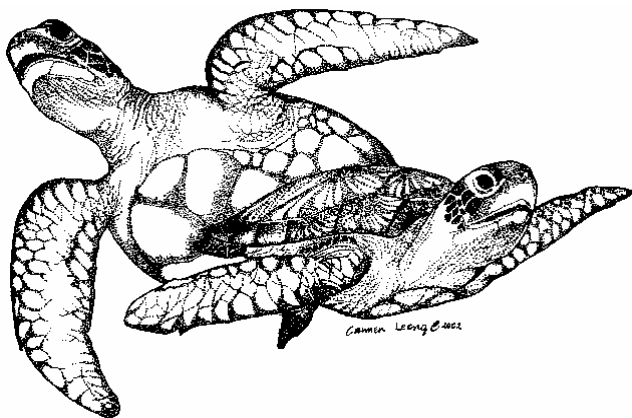




NOAA Technical Memorandum NMFS-SEFSC-536

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



**“Living with
Turtles”**

17 to 21 March 2003, Kuala Lumpur, Malaysia

Compiled by: Nicolas J. Pilcher

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

March 2006



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NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
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PRESIDENT'S REPORT ON THE 23RD ANNUAL SYMPOSIUM ON SEA TURTLE BIOLOGY AND CONSERVATION

Nicolas J. Pilcher

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The 23rd Annual Symposium on Sea Turtle Biology and Conservation was held between 17 and 21 March 2003 at The Legend Hotel in Kuala Lumpur, Malaysia, hosted by the Community Conservation Network, Hawaii, and WWF-Malaysia. The meeting was attended by slightly more than 300 participants representing 73 countries, a dramatic drop in participation from previous years brought about in no small part by the looming war in the middle east region and concerns over travel safety. For 22 years the Symposium had been an Americas-based event, even though it is the annual gathering of the “international” sea turtle society, and with the move to Malaysia, the Symposium hoped to raise the awareness among the general public of the plight of marine turtles in Southeast Asia, and share the enormous expertise of the world authorities on sea turtles with this so-far underrepresented region. Adopting the theme, “Living With Turtles”, the Symposium had a very personal flavour, and the smaller number of participants made it possible to make and renew acquaintances, and have time for discussion between sessions. While the travel safety concern excuse was often quoted, it was a pity, particularly to the large contingent of people who attended the event for the first time from underrepresented regions, that many of the household names linked to marine turtle biology and conservation were not present to share their knowledge and promote the global concerns on the plight of turtle populations.

The venue was ideal for the event, and the staff were attentive and keen to assist in bringing together what resulted in being a seamless event right from the very beginning. Notwithstanding the typically-higher price range of the hotel, the management were extremely flexible in pricing their services, food and beverage at reasonable costs to accommodate and even lower the typical prices encountered at several previous venues. I believe the room costs (USD 45 per night) and food costs (circa USD 10 per day) in many ways offset the higher travel costs encountered by a percentage of the participants.

The Symposium also included a number of side events, including the 10th Annual Reunion of Latin American Specialists spearheaded by Alejandro Fallabrino, the 2nd Meeting of Mediterranean Specialists put together by Dimitris Margaritoulis, each of which comprised over thirty participants, and the first meeting of the Advisory Committee to the Memorandum of Understanding on the Conservation and Management of Marine turtles and their Habitats of the Indian Ocean and South East Asia (IOSEA MoU), coordinated by Douglas Hykle. There was also a special lunch session on Freshwater Tortoises put together by Chuck Shaffer to take advantage of the location to address regional issues on the tortoise trade, a discussion session on the interactions between fisheries and marine turtles organized by Paolo Casale, from WWF Italy, and the annual meeting of the IUCN Marine Turtle Specialist Group (MTSG), spearheaded by Perran Ross.

The Special Session for 2003 was entitled “Indigenous Cultures and Marine Turtles” and was an attempt to bring together people from different ethnic backgrounds for whom turtles have a religious or cultural significance, and to address the issue of use versus conservation, or even their coexistence, providing time for discussions among the varied and opposing viewpoints.

A major component of the educational aspect of the Symposium was the Tagging and Telemetry Workshop, for which a number of companies contributed materials and effort. Stockbrands Pty. Ltd. (Australia) and National Brand and Tag Co. (USA), donated conventional flipper tags and applicators; Destron (EID Aalten B.V., Europe), Biomark (USA) and Trovan loaned of PIT tag readers and donated applicators and many PIT tags; and Sirtrack Pty. (New Zealand) and Telonics (USA) provided dummy satellite transmitters for attachment during the workshop.

Given the impending threat of war in the middle east region, many participants cancelled their registration and many more simply did not attend, creating a major problem in the development of the programme. Therefore, shortly before the event started, the committee completely rebuilt the programme to do away with the numerous gaps created by the cancellations. In the end we showcased over 70 oral presentations and 158 posters, and many parts of the world were represented for the very first time at the event. In an effort to maintain some of the standards that had been set during previous meetings, simultaneous translation was provided from Spanish to English and vice-versa during the entire event.

As occurs each year, the student awards competition again attracted a significant number of participants. The results of the student awards competition were as follows: Biology paper runner up - Fulvio Muffucci, Zoological Station of Naples: “Trace elements accumulation and tissue distribution in loggerhead turtles from the Western Mediterranean Sea”. Biology paper winner - Rusty Day, College of Charleston: “Mercury in loggerhead sea turtles in the southeast US: assessing health impacts and

developing monitoring strategies”. Biology poster winner - Eduardo Amir Cuevas Flores, Universidad de Merida: “Mapping and characterizing foraging habitat of immature hawksbill turtles in front of the biosphere reserve Ria Lagartos, Yucatan, Mexico”. Conservation paper winner - Yianna Samuel, Cornell University: “Underwater noise and anthropogenic disturbance in critical sea turtle habitat”. Conservation poster winner - Cathi Campbell, University of Florida: “Assessment of the Tortuguero, Costa Rica green turtle population”. I would like to take this opportunity to once again congratulate all the winners for the outstanding contributions.

This year the Society was the recipient of a number of grants from various organizations and Foundations. The Symposium managed to attract USD 127,000 in funding to support travel awards, the costs of hosting the event, and the simultaneous translation services. Support for this symposium came from many sources, reflecting the diverse nature of the group the international sea Turtle Society has become: the NOAA / National Marine Fisheries Service Southeast Fisheries Science Center and Office of Protected Resources, the David and Lucille Packard Foundation, the Western Pacific Fisheries Management Council, Fisheries and Oceans Canada (Science Branch), the World Wide Fund for Nature (UK), the Global Green Fund, RARE Center, the ASEAN Regional Centre for Biodiversity Conservation, the Homeland Foundation, and the Convention on Migratory Species.

In addition to the funds raised through grants, the Symposium also had some 35,000 to 40,000 in income from registration fees, sales and auctions, for an approximate total of circa USD 163,000, and experienced costs in the region of USD 148,000. When all was finally tabulated by our Treasurer, the Symposium contributed a sum of over USD 10,000 to the Society’s accounts.

Another initiative that took place during the 23rd STS was a membership drive for the International Sea Turtle Society, which is currently undergoing the transition from Annual Symposium to Society. Membership in the Society will provide voting privileges and discounts on registration fees for the annual symposia, and the fees will also go toward supporting the Marine Turtle Newsletter, which is a key information dissemination avenue for Society-related announcements and reports. I would encourage all who have not done so to sign up as members through the www.seaturtle.org website.

Finally, I would like to take this opportunity to thank once again the people who made this event possible through their contributions in time and dedication: Michael Coyne, who made the website available; Sam Sadove and Kartik Shanker for putting together the program; Brendan Godley and Matthew Broderick for arranging the Tagging and Telemetry Workshop; Chuck Shaffer for arranging the Freshwater Tortoise session; Paolo Casale for putting together the discussion session on Fisheries/Turtle Interactions; and Jeff Seminoff, Ana Barragan, Karen Eckert, Alan Bolten, Brendan Godley, and Angela Fromia for getting all the travel awards out to those in need. A great deal of appreciation goes to Ed Drane for helping keep accurate control of our finances, and to Manjula Tiwari, Leslie du Toit, Anny Chaves and Herda Hutabarat for translating all the announcements. Finally, I’d like to thank Matthew Godfrey, Kartik Shanker and Lisa Campbell for helping arrange the Indigenous Session, which was a highlight of the event.

The annual gatherings of our membership are a highlight of the year and also an important opportunity for us to share our ideas, knowledge and experiences. However, the Society should not limit itself to just meeting once a year. Both Rod Mast (president elect) and I have committed to developing plans for an expansion of the Society’s roles, and we welcome any feedback from the membership.

Finally, for me personally, putting together this Symposium was a wonderful experience. A significant addition to my workload, but an unforgettable experience nonetheless. I got to meet many new people, make many new friends (and probably some enemies along the way too), and generally felt it was a constructive effort and extremely rewarding. Given the nature of people who work with marine turtles, many of whom are personal friends of mine, this is not that hard to understand. I look forward to meeting as many of you as possible at our next venue in Costa Rica. I am sure it will be another memorable event!

SYMPOSIUM COMMITTEE

Organizers	Community Conservation Network WWF Malaysia
President	Nicolas J. Pilcher
Registration Coordinator	Carmen Leong Pilcher
Program Chair	Sam Sadove
Program Co-Chair	Kartik Shanker, Nicolas Pilcher
Web Master	Michael Coyne
Announcement Translators	Anny Chaves, Leslie du Toit, Manjula Tiwari, Herda Hutabarat, Matthew Godfrey
Freshwater Tortoise Session	Chuck Shaffer
Fisheries Interaction Session	Paolo Casale
Indigenous Session	Matthew Godfrey, Lisa Campbell, Kartik Shanker, Nicolas Pilcher
Student Awards	Anders Rhodin, Lisa Campbell, Jeanette Wyneken
Travel Committee Chair	Jeff Seminoff
Travel Committee	Brendan Godley, Angela Fromia, Karen Eckert, Alan Bolten, Ana Barragan, Nicolas Pilcher
Tagging Workshop	Brendan Godley, Matthew Godfrey, Nicolas Pilcher
Parliamentarian	Frank Paladino

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Dr. Pamela Plotkin
Dr. Anders G. J. Rhodin
Dr. Jeffrey Seminoff
Dr. Hiroyuki Suganuma
Dr. Pamela Plotkin

STUDENT AWARDS- 2003

Biology Paper (runner up)	Fulvio Muffucci , Zoological Station of Naples: "Trace elements accumulation and tissue distribution in loggerhead turtles from the Western Mediterranean Sea".
Biology Paper (Winner)	Rusty Day , College of Charleston: "Mercury in loggerhead sea turtles in the southeast US: assessing health impacts and developing monitoring strategies".
Biology Poster (Winner)	Eduardo Amir Cuevas Flores , Universidad de Merida: "Mapping and characterizing foraging habitat of immature hawksbill turtles in front of the biosphere reserve Ria Lagartos, Yucatan, Mexico".
Conservation Paper (Winner)	Yianna Samuel , Cornell University: "Underwater noise and anthropogenic disturbance in critical sea turtle habitat".
Conservation Poster (Winner)	Cathi Campbell , University of Florida: "Assessment of the Tortuguero, Costa Rica green turtle population".

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BEHAVIOR AND ECOLOGY

**REPORT ON SEA TURTLE CONSERVATION AND RESEARCH IN SOUTHEAST AND NORTHWEST
MADAGASCAR**

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In northwest Madagascar, from July to December 2000, evidence of nesting was recorded on 111 km of beach, and nesting turtles were tagged. Greens and hawksbills concentrated on different beaches. Levels of activity varied from densely nested (280 nests/km), to beaches with no evidence of nesting. To identify beaches important for conservation, an index of direct anthropogenic threats was developed from carapace numbers. Interviews conducted with residents to assess importance of turtle products in the local economy pointed to predominantly opportunistic exploitation. Along with exceptionally high nesting activity this suggests that implementation of conservation measures could have high positive impact on regional turtle populations.

In southeast Madagascar, Azafady Project Fanomena is working with coastal residents to collect data on marine turtle nesting activity in southeast Madagascar. In the 2001-2002 nesting season (November – February), 23 nests were observed in an intermittently surveyed zone of 96 km. Eleven of those were identified to species (loggerhead). Due to low awareness and concern for the national law banning sea turtle exploitation, only six of these nests were protected. On one beach, all four nests were protected by a community agreement encouraged by Project Fanomena and WWF Madagascar. In the 2002-2003 nesting season, local assistants from coastal villages undertook daily beach surveys in the same zone, where 29 nests were discovered, 17 of which were protected. Combined with information from previous studies, the low number of nests appears to confirm local observations of a decline in nesting rates.

At community meetings, an awareness-raising booklet was used to present the national law banning marine turtle harvest and the reasons for the vulnerability of marine turtles to over-exploitation. An educational game/drama session about the sea turtle lifecycle was also used with village children. The project built capacity for revenue-generating aspects of sea turtle conservation by employing villagers and undertaking an ecotourism feasibility study. The project also supports community development initiatives to build trust and help people to meet basic needs. In several coastal villages, these activities led to reaffirmation or development of community agreements to apply the national law against turtle harvest.

NATURAL PREDATION BY CANIDS ON GREEN TURTLE NESTS: LIMITED TIME OF ACTION

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Natural predation on marine turtle nests at Kazanlı beach, Turkey, was studied during the 2001 nesting season. The beach, one of the main green turtle nesting grounds in the Mediterranean, is 4.9 km long. Every day turtle nests and predator tracks were counted, and a total of 105 nests (73 *Chelonia mydas*; 26 *Caretta caretta*; 6 unknown) were recorded. The total rate of predation either before or after hatching was 67.61%. Predators (dogs) attacked nests when hatching started, when the nesting season was already advanced. Most of predation events were recorded after the 5th week of incubation. The same timing of canid attacks on green turtle nests was observed in other Mediterranean nesting sites, representing a particular behaviour. This finding could be of

great benefit to green turtle conservation programmes in order to adapt best methods for nest protection from attacks by canids in a limited period within the nesting season. Studies to identify the cues that canids use to discover green turtle nest should be carried out in order to better understand their behaviour and to protect nests.

Acknowledgements

The study was performed and funded within the Action Plan for the Conservation of the Mediterranean Marine Turtle, adopted within the framework of the Mediterranean Action Plan of UNEP. The author would like to thank the Turkish Ministry of Environment of Ankara and Mersin, the Kazanlı Municipality for their support during the fieldwork. A special thank to Camil Aymak and Olcay Tunğba` for their hard and continuous work on the field. The author is grateful to Barbaros Agcagil, Ersoy Seugi, Sandro Massi, Mazal Goulding, Nilüfer Arac, and Ben Gunn for their voluntary work. The author thanks all the people that have helped to realise the project: the Major and Ahmet of Kazanlı Municipality and their staff, Niyazi Cakmak, Zubeyir Guvel, Recep Metin, Muruvet, İrfan Ekmekci, Hakan Baykal, Umit, Ebru Coskun, Mr.Hentati, Atef Ouerghi, Giovanni Torchia, Prof. Serap Ergene Gozukara. Thanks to Prof. Yakup Kaska for his interest and scientific support to the project. A thank you to the Soda-Chrome factory for their donation of bicycles. Thanks for the attention and interest of the media, and the Rotary and Rotarct club of Mersin. The author is grateful to the local community of Kazanlı, to the children and to the Bus cooperative for their daily memorable support during our stay in the village.

HOMING, MIGRATION, AND NAVIGATION IN JUVENILE SEA TURTLES *

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Although the orientation cues used by hatchling sea turtles have been studied extensively, little is known about the mechanisms of orientation and navigation that guide older turtles. Experiments were conducted to investigate (1) whether juvenile loggerhead and green sea turtles would exhibit homing and migratory orientation in a laboratory setting and (2) whether homing might be accomplished using map-based navigation. Turtles were captured in inshore waters and displaced to a testing location, where they were allowed to swim while tethered in an experimental arena. Loggerhead and green turtles captured to the northeast of the testing site from May through September oriented in a direction that corresponded closely with the most direct path back to their capture site. Loggerheads captured to the southwest of the testing site at the same time of year also oriented in the direction of their respective capture location. Both loggerhead and green turtles tested during October and November oriented southward, a direction consistent with the migratory orientation observed in juvenile turtles in the wild at that time of year. These results indicate that the orientation behavior of loggerhead and green turtles in the arena setting accurately reflects that of wild turtles, thus setting the stage for future study of the factors underlying homing and migration in sea turtles. In addition, the results show that loggerheads are capable of homing after displacement to an unfamiliar location. Assessment of the navigational cues available to the turtles during transport and testing suggests that juvenile loggerheads are capable of map-based navigation.

OCCURRENCE, GROWTH AND OVERALL BODY CONDITION OF JUVENILE GREEN TURTLES (*CHELONIA MYDAS*) IN THE EFFLUENT DISCHARGE CHANNEL OF COMPANHIA SIDERÚRGICA DE TUBARÃO (TUBARÃO STEEL COMPANY), VITÓRIA, STATE OF ESPÍRITO SANTO, BRAZIL, 2000-2002

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Introduction

Juvenile and adult green sea turtles (*Chelonia mydas*) are found in feeding areas along most of the Brazilian coast. However, there is scant information about this species in the State of Espírito Santo. This study was undertaken by Projeto TAMAR, the

Brazilian sea turtle conservation program, in partnership with Companhia Siderúrgica de Tubarão (CST, Tubarão Steel Company), after a significant number of green turtles were found to inhabit the effluent discharge channel of the steel plant. The objective was to analyze, through mark and recapture, movement patterns and growth rates, and also to assess the overall body condition of the turtles in that area.

Methods

The study area is located 14 km north of Vitória, the State of Espírito Santo capital (20°16'S, 40°13'W). The effluent discharge channel is 500 m long, 33 m wide and averages 2 m in depth. Domestic and industrial effluents, after being treated and then mixed with the sea water used in the steel plant cooling, are discharged into the sea. Between February 2000 and February 2001, monthly average sea water temperature at intake was between 19°C (September) and 26°C (April-May). Monthly average water temperatures at discharge were 7-10°C higher than those at intake. The increase in temperature and the availability of organic matter in the water make possible a noticeable growth of algae, on which green turtles feed. Fieldwork was carried out weekly, from 11 August 2000 to 10 August 2002, but none was carried out in May 2001. Turtles were captured by means of cast nets or by hand. They were then measured (curved carapace length (CCL) and width), weighed and double tagged on the front flippers (monel tags, National Band and Tag Co., USA, style 681). Overall body condition and presence or absence of tumors were determined visually, through physical examination of the turtle. Overall body condition was classified as 'Normal', 'Underweight', or 'Emaciated' following Walsh (1999).

Results and Discussion

Temporal distribution of the captures: In July 2002, fieldwork amounted to 8.5 h, but no turtle was captured in that month. A seasonal pattern in the captures was apparent, with a peak occurrence around the late winter or early spring (Fig. 1).

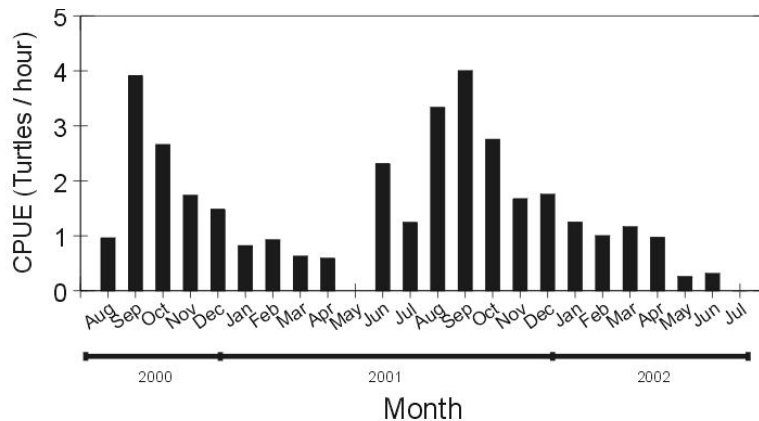


Figure 1. Temporal distribution of the captures: CPUE (individual turtles / hours of fieldwork) by month (n = 294). Multiple captures of one same turtle in each month were not considered in the construction of the graph.

Turtle size: Average CCL was 39.8 cm, SD = 5.3 cm, maximum = 56.7 cm, minimum = 28.0 cm (n = 157), which correspond with juvenile turtles, having a CCL well below that of nesting females in the Western Atlantic, which is generally in the range of 87-108 cm (Hirth 1997, converting straight carapace lengths (SCLs) into CCLs by means of the equation $CCL = (1.0672 \times SCL) - 0.3138$ (Teas 1993)). The CCL distribution was not significantly different from a normal one (Kolmogorov-Smirnov one sample test, n = 157, p = 0.786). There was no significant difference in CCL among months (Kruskal-Wallis Test, p = 0.746), so no seasonal pattern regarding turtle size was apparent.

Overall body condition: Most of the turtles (93.5%) were classified as "Normal", 3.6% as "Underweight" and 2.8% as "Emaciated". CCL was not significantly different among the three categories (Kruskal-Wallis test, n = 139, p = 0.332).

Presence or absence of tumors: Most turtles (80.6%) were without any tumors, and 19.4% had some tumor present. CCL was significantly different between the two categories (Mann-Whitney test, n = 139, p < 0.001); turtles with tumors had a higher average CCL (43.2 cm, SD = 4.3 cm, n = 27) than those without tumors (38.7 cm, SD = 5.4 cm, n = 112).

Displacements from the study area: Two green turtles tagged at the study area were found about 100 km north of that area. One turtle, tagged on 4 October 2000 (CCL = 44 cm), was found dead 13 days later, incidentally captured in a gill net. The other turtle, tagged on 14 September 2001 (CCL = 46 cm), was found dead about 10 months later – apparently from a gunshot wound to the carapace.

Maximum recapture interval (time between the first and last captures of one same turtle: Fig. 2 indicates that many turtles stay in the study area for at least two years. More fieldwork will be needed to determine a maximum period of stay for green turtles in the study area, and the relationship between length of stay and environmental conditions.

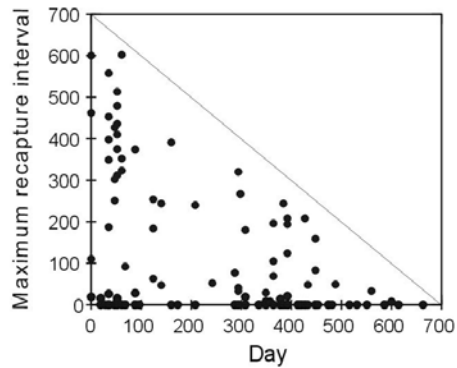


Figure 2. Distribution on the maximum recapture interval (time between the first and last captures, in days) of each turtle by the day when the first capture occurred. Each point represents one individual (n = 157). Days are counted from the first day when fieldwork was carried out (which is day = 0). A total of 68 turtles were captured two or more times, and 89 were captured just once (they are indicated by interval = 0). The diagonal line shows the maximum possible recapture interval for each day.

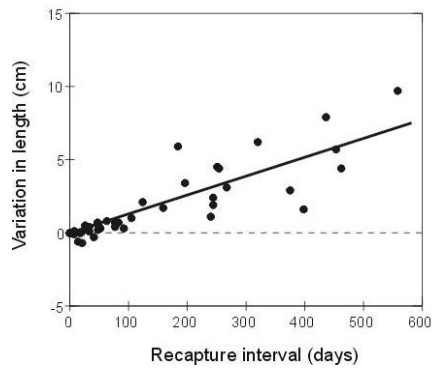


Figure 3. Variation in curved carapace length (CCL, cm) by maximum recapture interval (days) of each turtle, only for turtles that never had any record of tumors (n = 101). The horizontal dashed line indicates no variation in CCL. The solid line is a linear regression through the origin: $Y = 0.01298X$.

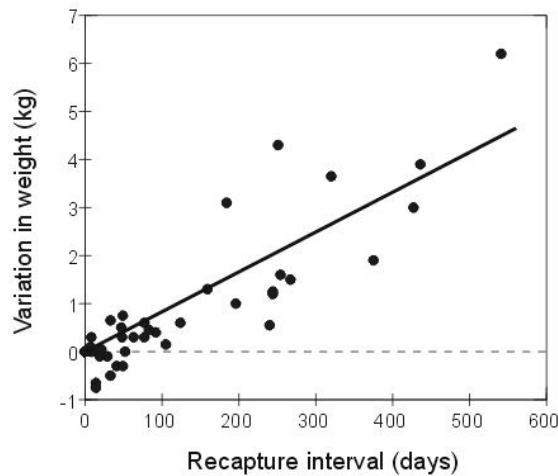


Figure 4. Variation in weight (kg) by maximum recapture interval (days) of each turtle, only for turtles that never had any record of tumors (n = 89). The horizontal dashed line indicates no variation in weight. The solid line is a linear regression through the origin: $Y = 0.008299X$.

Variation in CCL and weight: The average CCL growth rate was 4.7 cm / year (Fig. 3), and the average weight gain was 3.03 kg / year (Fig. 4).

Acknowledgments

Projeto TAMAR, a conservation program of the Brazilian Ministry of the Environment, is affiliated with IBAMA (the Brazilian Institute for the Environment and Renewable Natural Resources), is co-managed by Fundação Pró-TAMAR and is officially sponsored by Petrobras. We would like to thank the Companhia Siderúrgica de Tubarão (Tubarão Steel Company) for the continued support to this research.

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POPULATION SIZE AND DISTRIBUTION OF *CHELONIA MYDAS* AND *ERETMOCHELYS IMBRICATA* IN THE LAGOONS OF LAKSHADWEEP ARCHIPELAGO, INDIA

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Green (*Chelonia mydas*) and hawksbill (*Eretmochelys imbricata*) turtles were studied in the offshore waters of Lakshadweep Islands from July 2001 to February 2002. Both species were present in the lagoons throughout the year. Of the 35 green turtles captured, 69% were immature (CCL range 40 - 60 cm) and of the 17 hawksbill turtles captured, 77% were between the CCL size range of 35 cm and 60 cm, which is considered to juvenile to sub-adult size class. Nocturnal activities for juvenile were apparent in both species. The lagoons of the Lakshadweep islands were found to be a developmental habitat for both species of sea turtles. The study found significant correlation between occurrence of green turtle and abundance of seagrass. The role of developmental habitats in the life history of both species is also discussed.

GREEN TURTLE (*CHELONIA MYDAS*) HATCHLING EMERGENCE FROM NATURAL NESTS IN CHAGAR HUTANG, REDANG ISLAND, TERENGGANU

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A total of 24 nests were monitored from July to October 2002 on Chagar Hutang beach in Redang Island, Terengganu, to determine the emergence time of green turtle (*Chelonia mydas*) hatchlings. Time of each emergence event was recorded and the sand temperature at 15 cm below sand surface was monitored from 1800 to 0800 hours the following morning. Generally emergence events were nocturnal. 57.14% of all emergence events occurred between 2000 - 2300 h. Nocturnal emergence is believed to be one of the strategies to avoid hyperthermia and daytime active predators. Hourly mean temperature was observed to decline steadily throughout the study. A steep decrease was observed between 2100-2200 h which coincided with the peak emergence activities. Emergence of green turtle hatchlings appeared to occur at a threshold temperature of 27.1°C and ceased at temperatures higher than 33.8°C. Some 96.4% of all emergence events occurred below 33°C. Temperature decreased between initial and final emergence therefore sand temperature may not be the only cue to trigger emergence. Further investigations are needed to identify the specific thermal information or other possible cues used by hatchling to emerge. This study also found that size of hatchlings did not affect the time of hatchling emergence.

THERMAL CONDITION IN NESTS OF VARYING CLUTCH SIZES OF THE GREEN TURTLE (*CHELONIA MYDAS*) IN REDANG ISLAND, TERENGGANU

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A study on the influence of clutch size on incubation temperature of green turtle (*Chelonia mydas*) nests was conducted at Chagar Hutang on Redang Island, Malaysia from May to October 2002. Temperatures were measured every two hours using miniature self-recording temperature loggers placed in the center of each clutch in relocated nests containing 0, 5, 25, 50, 75, and 100 eggs throughout the incubation period. Incubation temperatures were not constant and showed a gradually increasing trend as incubation progressed. The increase occurred through a series of crests and troughs. Overall, nest temperatures were lower later in the season (August/October) compared with the early part of season (May/July). Data allowed inferences about metabolic heating in nests of *C. mydas*. The effects of metabolic heating on nest temperature became evident after the first third of incubation. Metabolic heating in nests appeared to be influenced by clutch size and the effect increased as the incubation progressed until hatching. Large clutches (75 and 100 eggs) were subjected to relatively high increases of incubation temperatures which recorded as much as 1.64-2.42°C and small changes in range of 0.7-0.9°C were demonstrated by nests with lower number of eggs (5 and 25 eggs). In all the nests, incubation temperature reached its maximum after approximately 45 days of incubation. Clutch size may significantly impact the incubation temperature but may not be the sole factor.

EARLY SWIMMING SPEED OF HAWKSBILL HATCHLINGS

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This study evaluated early swimming speed of hawksbill hatchling. Hatchling swimming speed were correlated with morphological factors such as foreflipper surface area (FSA), hind limb surface area (HSA), total limb surface area (FSA + HSA = TSA), body weight, Straight Carapace Length (SCL) and Straight Carapace Width (SCW).

The average swimming speed for 50 hawksbill hatchlings (5 hatchlings each from 10 nests) was 0.611 km/h (0.170 m/s). Three swimming locomotor patterns were observed; powerstroking, rear flipper kick and doggy paddling. The average swimming speed for powerstroking hatchlings was 0.779 km/h; doggy paddling, 0.480 km/h and rear flipper kicking, 0.324 km/h. Hawksbill hatchlings are much slower swimmers than other sea turtle hatchlings (leatherback, 0.91 km/h; loggerhead, 1.28 km/h; green turtle, 1.57 km/h, Wyneken, 1997). Over 50% of the hatchlings used the powerstroke, suggesting a swimming adaptation mechanism for hatchlings to escape from predator-rich near-shore waters, however it is important to note the turtles were generally extremely slow or did not move.

Correlation analyses indicated a significant relationship between swimming speed and FSA ($r=0.239$, $p<0.05$), TSA ($r=0.522$, $p<0.05$), SCW ($r=0.523$, $p<0.05$) and SCL ($r=0.373$, $p<0.05$), whereby total limb surface area and carapace length and width significantly influenced the hatchlings' swimming speed. When morphological characteristics were compared visually, the hawksbills' fore and hind flippers were relatively smaller than are those of *Chelonia* or *Dermochelys*, although further work is needed to evaluate these differences. Presumably the smaller size hawksbill hatchlings are unable to swim against strong current or tides and remain more or less inactive to prevent exhaustion.

**RESEARCH ON NESTING ECOLOGY OF GREEN SEA TURTLES ON WAN-AN ISLAND, PENGHU
ARCHIPELAGO, TAIWAN: A TEN-YEAR REVIEW ***

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Wan-an Island is a major green sea turtle nesting site in Taiwan. With support from the Council of Agriculture, a project on research and conservation of green sea turtle has been carried out since 1992. The nesting beaches was formally declared as a national wildlife protected area in early 1995. From 1992 until 2002, the nesting ecology of green sea turtles on Wan-an Island was studied. The nesting season lasted from mid-May to late October, with a peak in July and August. The nesting population ranged from 2 to 19 females. The size of nesting females ranged from 84.9 to 115 cm SCL. Each turtle emerged 1 to 20 times and deposited 2 to 5 nests per season. The nesting success ranged from 45 to 100%, and was influenced mainly by the beach compactness 30 cm below the surface. The incubation period ranged from 48 to 56 days, and hatching success ranged from 49 to 87%. Satellite telemetry studies revealed that the nesting population is a shared natural resource among nations in East Asia. Support from the Government, NGOs, press media and private industries has generated a public awareness campaign for wildlife conservation. A Sea Turtle Exhibition and Conservation Hall was opened on the island in late September 2002 which will act as a stepping stone for more collaborative activities between research and conservation entities.

**NEST SITE FIDELITY OF GREEN TURTLES ON THE REKAWA TURTLE ROOKERY IN SOUTHERN SRI
LANKA**

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Introduction

All species of marine turtles migrate from their feeding grounds to nesting sites and return back with a high degree of accuracy (Miller, 1997). With the use of tagging and satellite telemetry, it has been found that marine turtles can migrate thousands of km between feeding and nesting grounds (Balazs, 1980). Green turtles migrate across international borders, while flatbacks rarely migrate beyond the Australian continental shelf (Limpus and Miller, 1993). Migration is an important and integral part of the turtles' life history strategy and the majority of migrating, adult female green turtles exhibit regional homing and strong nest site fixation in their re-nesting activities (Mrosovsky and Provanca, 1992). The short and long-range orientation and navigation mechanisms remain unknown (Hirth, 1997). Lohmann et. al. (1997) put forward a hypothesis for the turtle navigation mechanisms which include:

1. The chemical imprinting hypothesis including chemosensory cues in long-distance navigation and chemical cues in natal beach recognition
2. Magnetic map hypothesis.

But none of this has been confirmed. All species of turtles migrate to varying degrees. Using genetic studies it has been demonstrated that marine turtles return to their region of birth, but may not necessarily return to the beach of birth (Miller, 1997.). When a female turtle returns to the region of its birth and selects a nesting beach, the turtle will tend to re-nest within close proximity to its previously laid nest during the same nesting season. The inter-nesting intervals range from 12-15 days for loggerheads, greens, black turtles, hawksbills and olive ridleys. For the flatbacks it is 13-18 days and for leatherbacks, 9-10 day intervals.

Most of the turtle populations have individuals that display both regular and irregular re-nesting behaviour (Hughes, 1982). In Rekawa, eight green turtles nested within the same 2 km stretch of beach, in the same nesting season, and this was repeated in the next nesting season, which occurred after a gap of 2.5 to 3.5 years (Ekanayake et al., 2001).

Materials and Methods

A 2050 m stretch of beach on the project site (Rekawa beach) was marked by wooden posts at 50-meter intervals starting from 0 to 41 from right to left. Each post was marked with a number and the distance in meters that the post represented. Five nesting hawksbills were observed about one kilometre away from the survey area. All nesting turtles were tagged when they were covering their egg chamber. Two kinds of tags were used: Dalton Flexi Rototags (plastic, Dalton Supplies Ltd., England) and Titanium tags (metal, Stockbrands Co Pty. Ltd., Western Australia). A number and the TCP address were printed on both tags. When a turtle nested, the nesting site was recorded relative to a pair of beach posts. The distance to the nest from the vegetation line was also measured for some of the green turtle nests. The number of turtles attempting to re-nest within a single fifty-meter interval was observed.

Results

Six hundred and sixty four turtles from five species were observed nesting within the beach posts. Of these, 483 turtles (74.8%) re-nested at least once within the site and 163 turtles (25.2%) nested only once. Of the five species, only the green turtles came ever re-nested within the same 50 m interval, of which 230 nested at least twice in same location and one laid eight times in the same location.

Discussion

The remigration intervals for green turtles in Sarawak (Malaysia) was three years, Heron Island (Australia) 4.6 years, Melbourne (Australia) two years and Tortuguero (Costa Rica) three years. We recorded a remigration interval for eight green turtles of 2.5 to 3.5 years in Rekawa beach.

When a turtle returns to its region of birth and selects a nesting beach, the turtle has a tendency to re-nest in relatively close proximity (0 to 5 km) to the original nest during the consequent nesting attempts within that nesting season. Green turtles especially show a high degree of nest site fidelity (Miller, 1997). According to our observations, 74.8% of turtles came to re-nest in the Rekawa beach at least once during the same nesting season and were mostly green turtles (the re-nesting occurrence for olive ridley was only 5.6%, for leatherbacks 39% and for loggerheads 16.6%). Based on these results it is clear that the green turtles have a high degree of nest site fidelity, but because 92.3% of the total number of turtles that nested in Rekawa (648) were green turtles, it is difficult to state conclusively that other turtles do not also have a high degree of nest site fidelity, given the low numbers that were observed.

The number of re-nesting events for the green turtles within a same location is shown in Table 1. We observed 313 green turtle re-nesting events in the same location of which 230 nested at least twice and nested eight times at about two weeks intervals. This suggests the turtle was able to identify and remember the nesting location for a long period. While some of these turtles laid in the other locations of this beach, what is noteworthy is the degree of nest site fidelity, whereby they returned to the place where they nested earlier. Miller (1997) states that the green turtles show a high degree of nest site fidelity among the marine turtles, and the observations made during this study confirm the findings of Miller (1997).

Table 1. The number of re-nesting times for the green turtles within a single fifty meter interval (same location)

Frequency of re-nesting within same location	Number of turtles re-nested within same location
1	*283
2	230
3	60
4	17
5	5
6	0
7	0
8	1

* No re-nesting

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HATCH RATES OF THE LEATHERBACK TURTLE (*DERMOCHELYS CORIACEA*) ON TWO MAJOR NESTING BEACHES IN SURINAME

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Introduction

Leatherback nest numbers in Suriname, South America, are amongst the highest world-wide, with estimated numbers of nests of 14,300 in 2000, 30,000 in 2001 and 12,750 in 2002 (Hilterman and Goverse 2002, 2003). Peak nesting occurs between April and August. Nest survival and hatch rates were determined in 2001 and 2002 for the two major leatherback nesting beaches, Babunsanti and Matapica. Babunsanti is in the Marowijne river estuary. Matapica is on the Atlantic coast. Beach morphology, sand type, salinity, sand turn-over, and vegetation cover differ between the beaches. The objective was to determine hatchling recruitment for Suriname and to see if differences in hatch success were typical for the beaches.

Methods and Materials

In 2002, a random selection of 162 nests on Matapica and 188 nests on Babunsanti were marked by triangulation. Nests were excavated three days after first hatchling emergence or 75 days after oviposition in the case of non- or unnoticed emergence. Hatch success (H%) = empty shells / total number of eggs (empty shells + pipped eggs + all non-hatched eggs, yolkless eggs not included). Successful nests are defined as nests from which one or more eggs had hatched. Emergence success (E%) was calculated by subtracting dead hatchlings and stragglers from the number of empty shells. Nests that had possibly been disturbed during marking were excluded for the determination of overall *in situ* hatch rates.

Results

For both years, hatch rates were remarkably higher on Matapica than on Babunsanti (Mann-Whitney U, $p < 0.001$). In 2002, on Babunsanti, 25.9% of the marked nests failed to hatch. Of the successful nests, hatch success was 34.9% and emergence success was 33.2%. On Matapica, 12.0% of the nests failed to hatch, and hatch success of the successful nests was 63.7% and emergence success was 63.0% (Table 1, Fig. 1). On Babunsanti, 93% of all nests showed signs of mole cricket predation. On Matapica, this was 83%. Egg predation per nest by the mole cricket, embryonic mortality of non-predated eggs, and the fraction of pipped hatchlings were significantly higher on Babunsanti ($p < 0.05$) (Fig. 2). Mean clutch size was 85.0 ± 18.2 yolked eggs and 31.9 ± 18.0 yolkless eggs. The mean incubation period was 67.0 ± 2.3 days ($n=123$) on Matapica and 64.8 ± 3.2 days ($n=86$) on Babunsanti.

Discussion

Hatch rates as shown in the present study were significantly higher than previously reported for Surinam beaches (Hoekert 2000, Whitmore and Dutton 1986) and considered more reliable and representative because of a more random and less disturbing way of marking nests. The low hatch rates found on Babunsanti may be replicated on other beaches in the Marowijne river estuary like Yalimapo in French Guiana and may have a significant impact on population recruitment, as 15,000-30,000 nests are laid

annually on these beaches alone. Matapica, and probably other oceanic beaches in the area, are very important in terms of leatherback hatchling production and should receive more attention from a conservation point of view.

Table 1: Average hatch success and standard deviation per nest for marked and un-marked leatherback nests.

2002	Matapica	Babunsanti
Marked nests (all nests)	56.0 ± 30.8 (n=108)	25.8 ± 24.4 (n=158)
Marked nests (successful nests only)	63.7 ± 24.2 (n=95)	24.9 ± 22.1 (n=117)
Un-marked nests (successful nests)	66.9 ± 19.4 (n=126)	42.5 ± 21.1 (n=220)

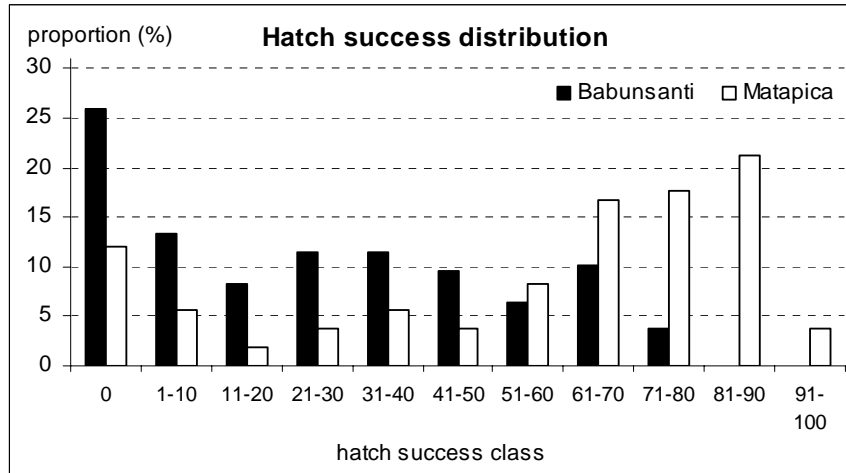


Figure 1: Frequency distribution of hatch success of the marked nests on Matapica and Babunsanti.

Hatchling production for 2002 was calculated by multiplying the number of nests for each of the beaches by the mean number of eggs and the mean hatching success. The overall number of leatherback hatchlings produced in 2002 was calculated at 471,308, of which 454,401 emerged on the sand surface.

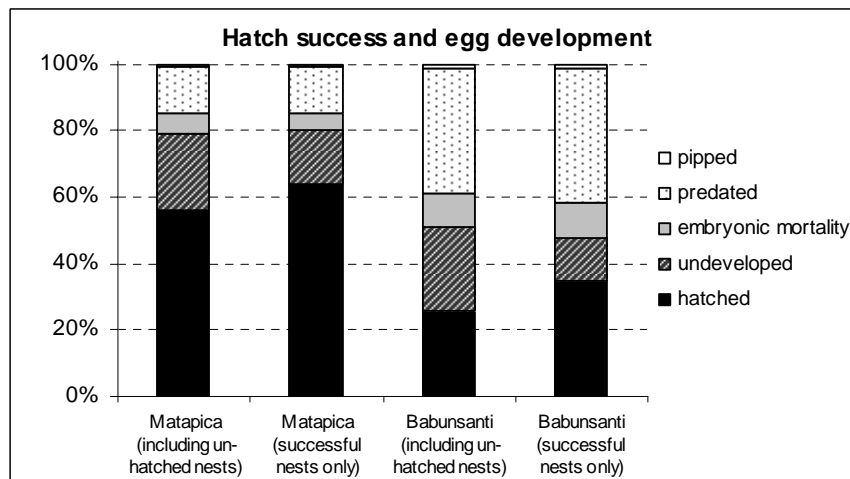


Figure 2: Average hatch success and egg development per nest for the marked nests (including and excluding unsuccessful nests) on Matapica and Babunsanti. Eggs in the category “predated” have been ruptured by the mole cricket or ghost crab.

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for the leatherback program in Suriname. We further thank all volunteers and students that participated in the PIT tag and nest-monitoring program.

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SAND TEMPERATURE PROFILES OF THREE MAJOR LEATHERBACK (*DERMOCHELYS CORIACEA*) NESTING BEACHES IN SURINAME 2000-2002

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Introduction

Suriname is situated on the northern coast of South America between Guyana and French Guiana. The dynamic beaches of eastern Suriname and western French Guiana support one of the largest leatherback nesting colonies worldwide, with estimated nest numbers for Suriname alone of 14,300 in 2000; 30,000 in 2001 and 12,750 in 2002 (Hilterman and Goverse 2003). Peak nesting in the area occurs between April and August (rainy season). Since 2000, sand temperature profiles have been recorded in one or more years for the major nesting beaches: Babunsanti, Matapica, Kolukumbo and Samsambo, all of which have very different beach topography. The objective was to assess spatio-temporal variation in sand temperature profiles and thus sex-ratio of the hatchlings.

Methods and Materials

Temperature data loggers were used to record sand temperatures every two hours during the peak nesting season. The loggers were placed at 75 cm (average estimated clutch centre depth) at three different beach zones (High, Mid, and Low perpendicular to the spring tide line) in a protected enclosure on each of the beaches. Data were grouped by 10 day time-bins for which the average was calculated. To compare the different sites and years, an ANOVA followed by Tukey multiple comparison tests were used.

Results

Sand temperature profiles significantly differed between beaches and years. A significant difference between beach zones was seen at Babunsanti. The only beach of which the sand temperature was above the pivotal temperature for leatherbacks (29.5°C, Rimblot-Baly 1987) for most of the season for two consecutive years was Samsambo. In 2002, the sand temperature was below the pivotal temperature for leatherbacks on all three beaches for most of the season. Most nests on Babunsanti are laid in the low and mid zones, on Kolukumbo on the mid zone and on Matapica and Samsambo on the mid and high zones.

Discussion

If we assume that the thermosensitive period for the determination of hatchling sex occurs between day 20-40 of the incubation (Desvages et al. 1993), we estimate that:

- I. Predominantly males were produced in 2002 on all beaches except for nests laid after early July on the Mid zone of Babunsanti and Kolukumbo, and in 2001 on Matapica and the Low zone of Babunsanti;

II. Predominantly females were produced on Samsambo in 2001/2000, in 2001 on Babunsanti for nests laid after half May and in 2002 on Babunsanti and Kolukumbo for nests laid after early July. Sand temperatures were not measured on Kolukumbo in 2001, but as the temperature profiles for 2002 of the Mid zones on Babunsanti and Kolukumbo are very similar the same could be expected for 2001. Different beaches have a different sex ratio production and further studies are needed to determine if patterns on certain beaches are typical for those beaches.

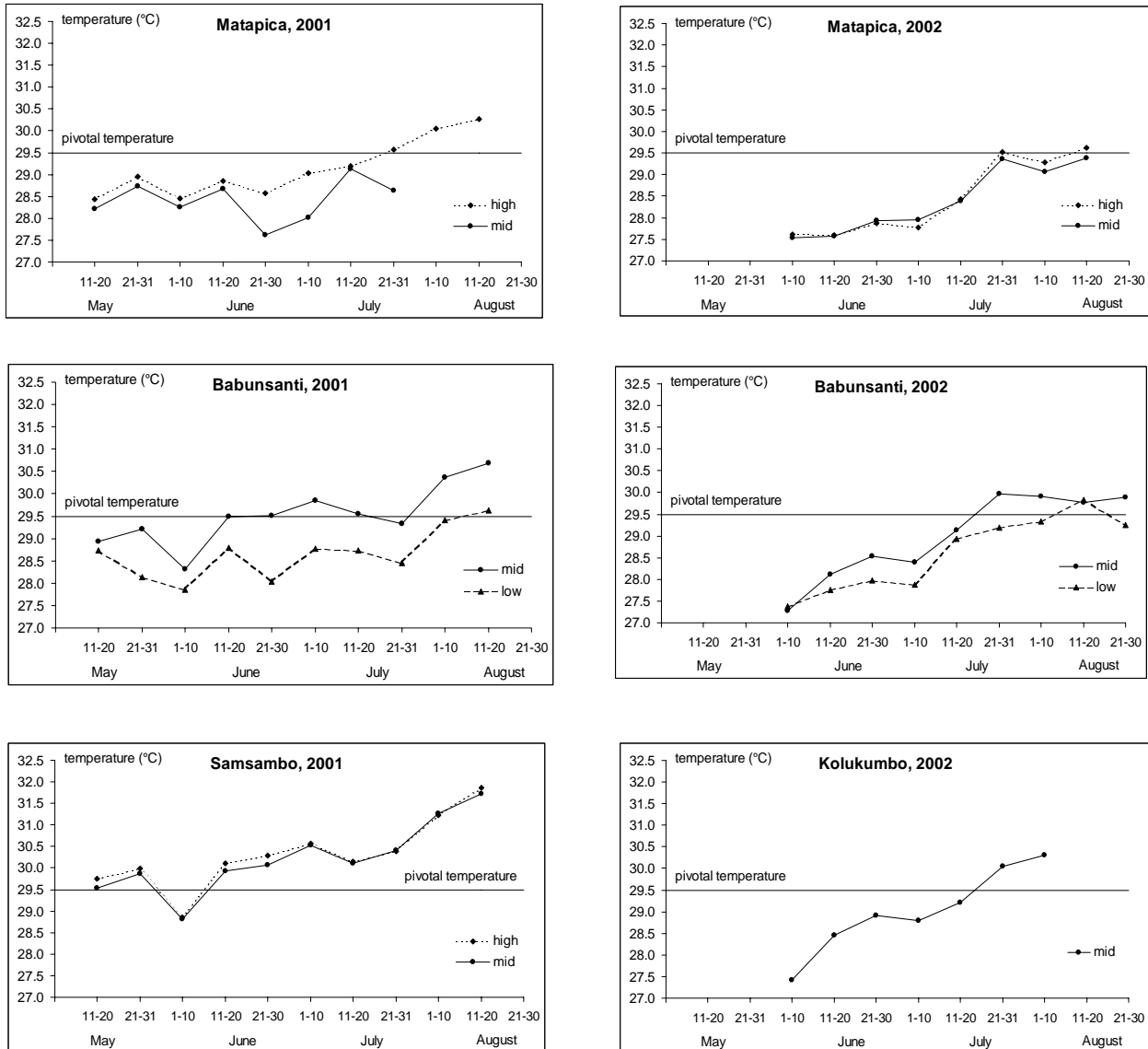


Figure 1-6: Sand temperature profiles at nest depth (75 cm) during the 2001 and 2002- nesting seasons on different beach zones on three beaches.

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EVIDENCE THAT THE MAGNETORECEPTION SYSTEM OF SEA TURTLES IS LOCATED IN THE HEAD

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While it has been well established that sea turtles are able to detect and orient to the earth's magnetic fields, little is known about how the magnetoreception system works in turtles or in any animal. In an attempt to locate the region of the body where magnetoreception takes place, four groups of hatchlings were tested under conditions in which turtles are known to rely on magnetic orientation to maintain a consistent heading. The control group had a tiny piece of magnetically-inert brass on its head, mid carapace and posterior carapace while each experimental group had a tiny magnet in one of the positions and brass in the other two. The magnetetic field produced by the magnets was stronger than the earth's field directly next to a magnet but decreased rapidly with distance. Each turtle was tethered in dark, circular, water-filled arena and exposed to a light in the east. After one hour the light was turned off and the orientation of the turtle was monitored for a one-hour test period. Control turtles (with all brass) were significantly oriented to the east during the test period; this is consistent with many previous experiments. Turtles with a magnet on the posterior carapace were also significantly oriented to the east while groups of turtles with a magnet on the head or mid-carapace were randomly oriented. These results indicate that the magnetoreception system responsible for magnetic orientation in sea turtles is located in the anterior region of the body, most likely in the head.

HATCHLING SEA TURTLES HAVE AN INNATE SENSE OF OFFSHORE DIRECTION THAT EMERGES AFTER SEVERAL HOURS OF SWIMMING *

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Laboratory experiments have shown that hatchling sea turtles can establish a heading while swimming toward an environmental cue such as light or waves and maintain that heading after the stimulus is removed. This ability may be useful during the early part of the offshore migration. However, nothing is known about how hatchlings from beaches that do not face an appropriate direction toward deep water adjust their initial heading to one that more is consistent with further offshore movement. This set of experiments tested whether turtles might have an innate directional preference that eventually emerges.

The orientation of four groups of hatchling loggerheads was compared under conditions in which they are known to use magnetic orientation to maintain a consistent heading while swimming. Turtles exposed to light in the east continued to orient eastward (the appropriate offshore direction) after the light was removed. Turtles exposed to light in the west initially oriented westward but became eastwardly oriented several hours after the light was removed. Turtles swimming in darkness were initially randomly oriented but became eastwardly oriented after several hours. Control turtles with a magnet attached to their carapace were randomly oriented.

These results demonstrate for the first time that, while using magnetic orientation, hatchling turtles eventually switch from a near-shore environmentally-derived heading to an innate offshore magnetic heading. Furthermore, the results indicate that hatchlings may eventually adopt an appropriate magnetic heading even in the absence of other environmental cues.

DIET PREFERENCES BY EAST PACIFIC GREEN TURTLES (*CHELONIA MYDAS*) IN BAHÍA MAGDALENA, MEXICO

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Introduction

Surprising gaps remain in our knowledge about diet preferences and food selection of sea turtles. Some of these gaps can be generalized to Ocean basins or populations inhabiting broad geographic ranges. Some authors have reported food preferences of green turtles in Australia (Garnett et al., 1985; Brand-Gardner et al., 1999), in Hawaii (Balazs, 1980), in the Caribbean (Bjorndal, 1980) and at an Arabian feeding ground (Ross, 1985), however, little is known about diet preferences by green turtles along the Eastern Pacific Ocean. This regionally important population has exhibited an extreme decline in numbers over the last 30 years and is listed as endangered throughout its range (National Marine Fisheries Service and US Fish and Wildlife Service, 1998). As variation in diets in green turtles in different foraging grounds may affect net nutritional gain, understanding diet selection is critical for assessing habitat quality and thus make decisions on which habitats must be protected.

Objectives

- 1) Compare the diet of the green turtles captured in different seasons in the Estero Banderitas.
- 2) Determine if the green turtles are feeding selectively over the available resources in the Estero Banderitas.

Materials and Methods

Study Site: Estero Banderitas is a mangrove channel located on the northwestern side of Bahía Magdalena (24°15'N to 25°20'N and 111°20'W to 112°15'W), Baja California Sur; it is characterized by a series of large and small islands lined with mangroves and sandy beaches. Estero Banderitas is fairly shallow with a depth ranging from 0.5m to 8m. Surface water temperatures (SST) in the region experience substantial seasonal variation, reaching a maximum of 28°C in late summer (September) and a minimum of 19°C in March (Lluch-Belda et al., 2000).

Vegetation sampling: Each season the bottom cover of the marine vegetation was estimated along three 50 m transects (perpendicular to the coast) at two different locations. Along each transect, the vegetation was collected from five randomly selected 0.25 m² quadrates (total of 30 quadrates) to estimate the above-ground biomass. Regression analyses were used to detect the relationship between the above-ground biomass and percent cover of plant species.

Diet analyses: Samples of recently ingested food items were collected by conducting gastric lavage (Forbes and Limpus, 1993) of live-captured turtles in the Estero Banderitas during Fall and Winter. Diet items were quantified by volume (V) and frequency of occurrence (F) (Hyslop, 1980). Volume percentages of food items consumed were arcsine root transformed for statistical analyses and then a two-way ANOVA was conducted between seasons (Winter and Spring) and principal diet components. A Tukey HSD multiple comparison test for unequal n was used when significant differences.

Diet selection: Dietary selection was determined with an assessment procedure formulated by Johnson (1980). This procedure provides a measure of the relationship between availability of a food resource and the utilization of that resource, which are expressed as Tbar values (averaged rank differences). The smallest Tbar value indicates the most preferred resource.

Results

Vegetation composition and abundance: Sixteen plant species were identified along transects. Percent cover and above-ground biomass showed a positive correlation ($R^2 = 0.62$) so percent cover was considered to be a good estimator of the species availability within the study area. In winter *Amphiroa* sp. was the predominant species along transects (10.8 ± 10.8 %) followed by *Asparagopsis taxiformis* (5.0 ± 1.8 %). During spring *Caulerpa sertularioides* and *Amphiroa* sp. were present in mean percent cover of 6.7 ± 3.7 % and 4.8 ± 4.8 %, respectively (Fig. 1).

Turtle capture and diet composition: A total of 20 turtles (mean SCL =57.3 cm; SE = 2.5; range = 38.8 – 79.4 cm) were live-captured in the Estero Banderitas. Gastric lavage samples were collected from a subset of 15 of these turtles. Diet of green turtles was composed by 9 prey items (7 species of algae, fragments of mangrove roots and an unidentified sponge), but only 7 of these items were considered major diet constituents (Table 1).

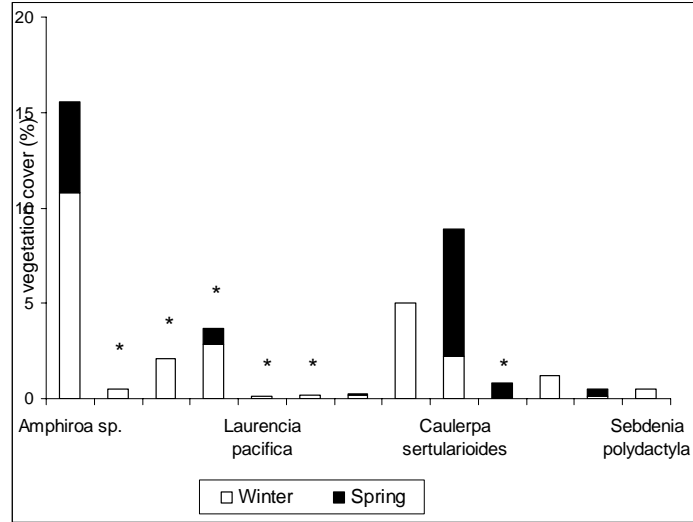


Figure 1. Seasonal variation (Winter and Spring) of algae species collected in Banderitas Channel, Bahía Magdalena, Mexico. Values represent the average percent cover from 6 transects each season. (*) indicate species consumed by black turtles in this region.

Table 1. Seasonal variation (winter and spring) in the diet of green turtles *C. mydas* captured in the Estero Banderitas Bahía Magdalena, Mexico. Values represent percent relative volume (% V), frequency of occurrence (% F), and n = number of stomachs.

Diet component (Winter)	Tbar (1),(2)	Rank
<i>Codium amplivesiculatum</i>	-4.7 a	1
<i>Gracilaria textorii</i>	-3.1 b	2
<i>Ulva lactuca</i>	-2.0 c	3
<i>Chondria nidifica</i>	-0.9 d	4
<i>Gracilaria pacifica</i>	1.2 e	5
<i>Caulerpa sertularioides</i>	2.5 e	6
<i>Asparagopsis taxiformis</i>	3.5 f	7
<i>Amphiroa sp.</i>	4.5 g	8
Diet component (Spring)	Tbar (1),(2)	Rank
<i>Codium amplivesiculatum</i>	-2.9 a	1
<i>Gracilaria textorii</i>	-2.4 ab	2
<i>Laurencia pacifica</i>	-1.1b	3
<i>Gracilaria pacifica</i>	-0.8 c	4
<i>Amphiroa sp.</i>	2.4 d	5
<i>Caulerpa sertularioides</i>	3.2 f	6

Diet analyses: Green turtles from the Estero Banderitas demonstrated seasonal (Winter and Spring) differences in the mean relative volumes of food items consumed ($F_{6,91} = 6.5$, $p < 0.000$) (Table 1). Gastric lavage samples collected during Winter were dominated by *G. textorii* (V = 51.3 % and F = 88.9 %) and *C. amplivesiculatum* (V = 27.8 % and F = 55.6 %). In Spring occurred

the opposite, *C. amplivesiculatum* (V = 78.6 % and F = 100 %) was the most abundant and frequent component of the diet ($p < 0.0002$) and *G. textorii* (V = 13.6 % and F = 66.7 %) was the second (Table 1).

Diet selection: In winter *C. amplivesiculatum*, *G. textorii*, *U. lactuca*, and *C. nidifica* were consumed more than available (selectively eaten) based on negative Tbar values (Table 2a), while in spring only three algae were selectively eaten: *C. amplivesiculatum*, *G. textorii* and *L. pacifica* (Table 2b). *C. amplivesiculatum* was the most preferred species followed by *G. textorii* in both seasons, but significant differences in ranks ($W = 1.74$, $p < 0.05$) between these species were only found during Winter. *A. taxiformis*, *C. sertularioides* and *Amphiroa* sp. were avoided (Table 2) despite their great abundance in the study area (Fig. 1).

Table 2. Dietary selection of marine algae by green turtles in the Estero Banderitas, during Winter (n = 9) and Spring (n = 6). (1) Negative Tbar indicates use>availability. (2) Taxa not sharing common letters differed in preference ($p < 0.01$).

Diet item	% V	No.	% F	% V	No.	% F
	Mean (SE)			Mean (SE)		
<i>Gracilaria pacifica</i>	17.6 (11.7)	3	33.3	1.5 (1.0)	2	33.3
<i>Gracilaria textorii</i>	51.3 (12.5)	8	88.9	13.6 (7.8)	4	66.7
<i>Chondria nidifica</i>	1.0 (1.0)	1	11.1	-	-	-
<i>Laurencia pacifica</i>	-	-	-	4.7 (4.7)	1	16.7
<i>Ulva lactuca</i>	2.2 (2.2)	1	11.1	-	-	-
<i>Codium amplivesiculatum</i>	27.8 (11.1)	6	55.6	78.6 (8.8)	6	100.0
<i>Unidentified poriferan</i>	-	-	-	1.5 (1.5)	1	16.7

Discussion

If we compare the composition and abundance of turtle's diets with the results obtained from the Johnson's test some differences appear. For example, in winter *C. amplivesiculatum* was the most preferred species (Johnson test), even though *G. textorii* was the predominant species recovered from diet samples. In this particular case the availability of *G. textorii* in the environment was higher than *C. amplivesiculatum* resulting in a much stronger selection of *C. amplivesiculatum*. These results indicate that ecological interpretations of the results may be inaccurate without the knowledge of the composition and abundance of the available vegetation in the environment.

In conclusion, immature green turtles in the Estero Banderitas fed over a variety of resources, but demonstrated preferences for some specific food resources, which fluctuated in availability and abundance throughout the year. Seasonal changes in vegetation coincided with dietary changes across seasons. In this respect the availability of certain resources influenced the selection of the food. Nevertheless, there are a great variety of resources available that are not consumed by green turtles in this region, which indicates that the turtles are feeding selectively on certain species regardless of whether they are less abundant in the environment. Based on these results, it is recommended that sea turtle conservation plans along the Baja California Peninsula include Pacific coastal mangrove channels with a high diversity of algae species as priority areas for protection.

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HATCHING SUCCESS OF THE GREEN TURTLE, *CHELONIA MYDAS* EGGS IN RELATION TO CLUTCH SIZE AND SEASONALITY IN REDANG ISLAND, TERENGGANU, MALAYSIA *

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The hatching success and clutch size for relocated and natural nests of the green turtle, *Chelonia mydas*, were examined in Chagar Hutang Beach, Redang Island, from April to October 2002. Relocated nests with specific clutch size were used to examine the hatching success of green turtle eggs with respect to different clutch size. Eggs were split into five different clutch sizes that is 5, 25, 50, 75, and 100 eggs per clutch. Every nest throughout the nesting season was marked and left to incubate *in situ* until emergence. The nests were then excavated and analyzed after an incubation period of around 45-60 days. There was no significant correlation between clutch size and hatching success for the relocated nests based on correlation analysis. Therefore hatching success is not thought to be influenced by clutch size. In comparison, on randomly selected natural nests with around the same clutch size as the relocated nests, the relocated nests had higher mean hatching success than the relocated nests. Two Factor ANOVA with replicate analysis indicated there was no significant difference between the relocated and natural nests, no significant difference within the different clutch sizes and no interaction between clutch size and the natural or relocated nests.

A total of 423 *in situ* nests were analysed, where the average hatching success for the whole season was 78.8% with an average clutch size of 94.26 ± 8.98 eggs. About 77.32 % of all deposited eggs produced healthy hatchlings. The number of nests increased as the season progressed and peaked during the 13th week (June 24th - 30th) at 31 nests but started to decrease rapidly after the 21st week (August 19th - 25th) until the end of the season. The mean hatch rate per week remained almost constant between 70 to 100% throughout the season but was low during the 20th, 21st, 22nd (August 12th - September 1st) and 25th weeks (September 16th - 22nd). The mean clutch size per nest also remained almost constant throughout the season but with a slight decline after the 21st week (August 19th - 25th). Therefore it can be concluded from this study that hatching success is not influenced by clutch size.

FOOD INTAKE AND RETENTION TIME IN GREEN TURTLES (*CHELONIA MYDAS*) FROM THE GULF OF CALIFORNIA: PRELIMINARY DEVELOPMENT OF A DIGESTIVE MODEL

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Introduction

The green turtle (*Chelonia mydas*) is the only herbivorous sea turtle species (Bjorndal 1997) and its diet is strongly tied to marine algae and/or seagrass resource availability (Bjorndal 1980; Bjorndal 1985). At the Bahía de los Angeles foraging area in the central Gulf of California, the main diet component of the East Pacific green turtle is the red alga *Gracilariopsis lemaneiformis*, comprising nearly 90% of the turtles' diet (Seminoff 2000; Seminoff et al. 2002a). The prevalence of this red alga in the diet of green turtles reflects its local abundance; with an annual biomass of 160-300 metric tons, it is the most common alga at the study area (Pacheco-Ruiz et al. 1999). Dense stands or 'pastures' occur over roughly 15 ha of sandy bottom habitat along the shallow-water margins of the bay (Pacheco-Ruiz et al. 1999), and green turtles congregate daily over these pastures for foraging

(Seminoff et al. 2002b). However, there is a commercial algae harvesting operation that is targeting this alga for export to foreign markets. Currently there are no established limits for the harvest of *G. lemaneiformis* in this temperate foraging area (A. Resendiz, pers. comm.).

A more complete knowledge of the degree to which green turtles and other local herbivorous marine species depend on the local *G. lemaneiformis* pastures will be necessary to develop ecologically responsible harvest quotas. Understanding the amount of alga consumed on a daily basis will be of great value in determining the harvest limits for this alga. However, these aspects remain unknown for green turtles in the Gulf of California. The goals of this study were to determine the daily intake, gut retention time, and develop a digestive model for green turtles held captive at the Vida Silvestre Sea Turtle Research Station in Bahia de los Angeles. The difficulty of monitoring green turtles on a daily basis in this area would prohibit our ability to study these parameters in the wild. Therefore, using captive animals served as a proxy to determine preliminary estimates for intake, retention time, and a digestive model.

Methods

This study was conducted from 16 June 2002 to 12 August 2002 at Bahia de los Angeles, Baja California, Mexico. Four captive turtles, housed at the Vida Silvestre Sea Turtle Research Station, were examined during this study. We measured straight-line carapace length (SCL) and body mass of each turtle. Green turtles were acclimated to a 100% *G. lemaneiformis* diet for at least one week prior to beginning a feeding trial. During this period of acclimation all four turtles were housed in the same circular tank (7 m diameter; 1 m water depth). During feeding trials, each turtle was isolated in a smaller tank (4 m diameter, 1 m water depth) and studied for at least 35 days. Water temperature was measured daily at feedings. Two trial intervals occurred during the summer of 2002 with two turtles, in isolation, studied concurrently during each interval. Intake, gut retention time, and digestive modeling studies were run concurrently (see below). Intake. – To determine the amount of food ingested by an individual turtle each day we placed a known amount of *G. lemaneiformis* into each turtles' enclosure daily for five or more weeks. The alga was collected from the bay then cleaned, drip-dried using a salad spinner, and weighed before being offered to the turtles. Prior to food placement, the orts (i.e. remaining food) from the previous day were removed from the tank, drip-dried, and weighed. Food remained in the tanks until new food was offered the next day. Daily intake was calculated as (Mass original food – Mass orts).

Gut retention time – To determine gut retention time (i.e. time elapsed between ingestion and defecation), each turtle was fed a series of dietary markers along with their normal daily rations. The markers were biodegradable, indigestible lengths of colored plastic flagging. Sixteen markers were tied around the alga and presented with the food to the turtle for the first four days of each trial. For each of the first four days of the intake trial, a different colored dietary marker was introduced. During the remaining weeks of the trial the turtle was fed unmarked food. Feces collection and examination to recover dietary markers began the day after feeding of dietary markers and continued until the end of each trial. Tanks were checked for markers every 8 hours. Gut retention time was calculated as ($T_{\text{egestion}} - T_{\text{ingestion}}$), where T equals the time in days. Mean gut retention time was calculated only for those markers that were excreted by the end of the study; those not excreted were noted but not included calculations.

Digestive Modeling – To develop a preliminary idea of the digestive model for green turtles in this study, the order in which dietary markers of different colors were excreted was recorded and compared to the order of initial consumption. The sequence of egestion was used to infer whether turtles have a 'plug and flow' or mixing model of digestion (Penry and Jumars 1987).

Results

Green turtle SCL and mass ranged from 60.60-72.70 cm (mean = 65.13, SD = 5.45) and 33.60-59.10 kg (mean = 41.82, SD = 11.93), respectively. Water temperature ranged from 20.20-29.50°C, (mean = 26.62, SD = 1.87). Temperature did not have a significant role in the amount of food consumed.

All intake values are given in dry weight of *Gracilariopsis lemaneiformis*. Intake ranged from 0-266 g/day (mean = 103.76, SD = 44.42). Intake for CM987 (SCL = 60.00, mass = 34.09) was measured for 57 days; average intake was 52.24 ± 46.33 g/day (range = 0-157 g/day). Intake for CM920 (SCL = 61.80, mass = 33.64) was measured for 57 days; average intake was 159.29 ± 69.78 g/day (range = 0-266 g/day). Intake for CM922 (SCL = 65.40, mass = 40.56) intake was measured for 35 days; average intake was 92.49 ± 69.29 g/day (range = 0-236 g/day). Intake for CM991 (SCL = 72.70, mass = 59.09) was measured for 35 days; average intake was 111.06 ± 62.37 g/day (range = 0-220 g/day).

Retention time of dietary markers in the gut ranged from 5 to 35+ days (mean days for initial passage of treatments = 15.40, SD = 0.52). CM922 had a mean of 14.75 days (SD 2.36) for the initial passage of treatments, CM991 had a mean 15.33 days (SD 7.37) for initial passage of treatments, CM987 had initial passage of treatments occurring with a mean of 16.00 days (SD 1.41), and CM920 had a mean of 15.50 days (SD 7.78) for initial passage of treatments

All turtles except CM991 excreted treatments in a different order in which they were fed. CM922 was presented with markers in the following order: pink, green, orange, blue; markers were first excreted in the following order: green, pink, blue, orange. CM991 was presented with markers in the following order: orange, blue, pink, green and were initially excreted in the following order: orange, blue, pink. CM987 was presented with markers in the following order: blue, pink, blue, green and first excreted in

the following order: pink, blue, green. CM920 was presented with markers in the following order: orange, green, orange, pink and were first excreted in the following order: orange, pink, green, orange.

Discussion

Intake varied for each individual turtle. With the exception of CM920, turtles with a greater mass had greater intake per day. According to this study a turtle with a mass of 40 kg would consume approximately 100 g/day (dry mass) of *G. lemaneiformis* equivalent to ~1.25% of its body mass daily. These findings are consistent with other studies focusing on Caribbean green turtles feeding primarily on seagrass. Bjorndal (1980) found that a 66-kg sea turtle consumed 218 g/day (dry mass), equivalent to 1.6% of its body mass and Thayer (1982) reported that a 64-kg green consumed 280 g/day equaling 2.2% of its body mass. Fenchel (1979) found that a 170-kg turtle consumed 0.6% of its body mass daily. Intake in this study is in the lower range of these daily values. The turtles we studied are in captivity and therefore do not move as much as wild turtles which is possibly why they require less food.

Gut retention time varied greatly within each turtle, however, the mean days for initial passage of treatments among all turtles ranged from 14.75-16.00 days. While turtles did egest the markers as soon as five days after being fed they often did not excrete all of the markers after 30+ days of initially being fed treated food. Transit times range from 2.80 to 21.20 days for free-feeding reptiles on foliage diets (Bjorndal 1997). In our study the transit times fall within this range. Juvenile green turtles took more than a week to empty their guts on a diet of animal matter (Hadjichristophorou and Grove 1983). Our turtles were fed a completely herbivorous diet and transit times for plant matter are far greater in duration than those of animal matter. Davenport and Oxford (1984) showed hatchling green turtles to have a gut retention time between 19 and 23 days, with a total gut clearance within 27 days of being fed trout pellets. Our turtles often did not have a total gut clearance by 27 days however they were larger turtles and were being fed a completely herbivorous diet.

Three out of four turtles commonly excreted markers in a different order in which they were fed. This, along with the prolonged passage of all dietary markers, provides support that green turtles are not restricted to a 'plug and flow' model of digestion. While one turtle followed a plug and flow model of digestion the others did not. The turtles in this study appear to exhibit a mixture of a plug and flow model as well as a model similar to that of a continuous-flow, stirred-tank reactor (Penry and Jumars 1987).

The digestive model of an organism is useful because it shows how attributes of the gastrointestinal tract relate to each other. This provides insights into the presence or absence of food mixing as it passes through the digestive tract. Digestive models can also help to identify attributes of the gastrointestinal tract that determine the rate and efficiency of nutrient extraction from food which is important in understanding the feeding ecology of an organism (Karasov and Cork 1996).

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ECOLOGY OF JUVENILE SEA TURTLES IN THE NORTHEASTERN GULF OF MEXICO *

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Introduction

The northern Gulf of Mexico has recently become an area of great interest for the conservation of three sea turtle species; *Chelonia mydas*, *Caretta caretta*, and *Lepidochelys kempii*. In the northeastern Gulf, along Florida's northwest coast, St. Joseph Bay (21 km x 9 km) provides substantial developmental habitat for sea turtles. This bay opens to the north, with the southern portion consisting of deep channels surrounded by shallow seagrass beds. Sand flats and seagrass beds provide foraging areas, while the deep channels serve as corridors for sea turtle movement. Seagrass beds primarily consist of *Thalassia testudinum*, or turtle grass. In 2001, the largest sea turtle stranding event documented in the United States occurred within St. Joseph Bay (pers. obs., Foley unpubl). In 2003, another small cold stun event occurred in this same Bay. Through the mark/recapture study described here, we determined population structure, growth rates, and residency patterns of turtles within this Bay. We also address the theory of ontogenetic shifts within the Gulf of Mexico, as well as examine the effects of cold-stun events on juvenile sea turtle growth rates.

Methods

In 2001, we initiated an in-water study of sea turtles inhabiting St. Joseph Bay. Visual surveys were first conducted to identify areas within the Bay utilized by sea turtles. Habitat transects were then used to determine what habitat types were present in each netting site. Strike netting was initially used to capture turtles, however, we used predominantly set netting techniques to calculate Catch Per Unit Efforts (CPUE). The values were then be used for comparisons across Florida.

Results

A total of 170 juvenile sea turtles were captured during 2002, include individuals from all three species: 84 % green turtles (n = 142), 4% loggerhead turtles (n = 7), and 12% Kemp's ridley turtles (n = 21).

Twenty-five turtles were captured using initial strike netting methods, while 145 turtles were subsequently captured using set netting techniques. A total of 149 hours were spent set netting in 2002. CPUE was calculated as 7.65 turtles captured/ km net hour.

Forty-three turtles, (25.2 % of total captures) were recaptures, and included 30 juveniles from the 2001 cold-stun event. Recaptures were all green turtles, with the exception of one loggerhead captive reared in Galveston, TX. Growth rates were calculated for all recaptured green turtles, whether cold-stunned or non-stunned animals.



Figure 1. Growth rates of juvenile turtles in St. Joseph Bay, Florida. Initial data indicate that with each non-lethal cold stun event growth rate decreases.

Discussion

St. Joseph Bay is an important developmental habitat for several species of sea turtles. Although the dominant species found is the green turtle, Kemp's ridley's and loggerheads are also present. The St. Joseph Bay study site is the only area in northwest Florida in which CPUE can be calculated. When comparing this CPUE of 7.65 turtles/km hr, to three other sites on Florida's east coast, St. Joseph Bay had the second greatest CPUE in the entire state of Florida during 2002 (Ehrhart unpubl., Provanca et al. unpubl., In-water Research Group, unpubl).

Through comparison of the mean size (SCL) of green and Kemp's ridley turtles throughout the Gulf of Mexico, it appears that developmental migration occurs throughout this region. Size (SCL) increases as turtles move from west to east. Initial results from St. Joseph Bay support the theory of ontogenic shifts in juvenile sea turtle populations.

Twenty-five percent of all captures have been recaptures. All recaptured turtles that had originally been tagged during this project were recaptured within 50 m of their original capture location, indicating site fixity in this population of green turtles. Of the recaptures, 71.4 % were originally tagged during the 2001 cold-stun event in St. Joseph Bay, giving further evidence of site fixity. After the cold-stun stranding, they were released into the Gulf of Mexico, and had to travel a minimum swim distance of 56 km to return to St. Joseph Bay. The fact that these turtles were again captured in SJB indicates that these turtles display homing capabilities and exhibit site fixity to this area.

Another minor cold-stun event occurred in St. Joseph Bay during 2003, in which 43 turtles stranded. Eleven of these turtles were originally tagged during the 2001 cold stun event. All recapture data has allowed us to calculate growth rates for turtles that have (1) not been in a cold stun event (2) withstood one cold-stun event, and (3) withstood two cold stun events (Figure 1). Our calculations indicate that there appears to be a negative effect on juvenile turtle growth rates. Sea turtles that survive cold stun event(s) appear to have slower growth rates than turtles that have not been in a cold stunning. Also, there is a cumulative effect on growth rates; the greater number of cold stun events, the slower the growth of these turtles once they recover. It is possible that current management techniques are exacerbating these effects. Cold-stun turtles from St. Joseph Bay have repeatedly been released approximately 50 km from their stranding site once rehabilitated. After this release, these turtles had to expend energy to return to St. Joseph Bay: energy which may otherwise have been used on development and not locomotion. This extra energy expenditure, coupled with possible unknown cold stun effects on the physiology of juvenile green turtles may be causing the observed decrease in growth rates. Further research is needed to fully understand the effects of cold stun events on juvenile turtles in the northeastern Gulf of Mexico.

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JOHN R. HENDRICKSON AND THE SEA TURTLES: FROM MALAYA AND SARAWAK TO MEXICO TO MARICULTURE *

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After completing his graduate work at the University of California at Berkeley, John R. Hendrickson (1921-2002) took his first academic position at the University of Malaya in Singapore in 1951. In 1959 he moved to the Chair position in Zoology at the new University of Kuala Lumpur where he worked until 1963. It was in Malaya that he began his sea turtle research career which spanned nearly four decades. His publication record includes at least 59 titles with 20 refereed journal articles on sea turtles and 7 reports to various agencies on sea turtle conservation topics. His most important work on the green turtle in Malaya and Sarawak (Proc. Zool. Soc. Lond. 130: (4) 455-535) is a classic manuscript in the traditional methods of field observation, analysis and deduction. This paper included several distinctively insightful observations (some firsts) in sea turtle biology including data on metabolic heating of the nest, hatchling emergence adaptations, the use of monel metal flipper tags, a detailed nesting ethology, seasonality of nesting cycles, multiannual cycles in individual nesting, courtship and copulation offshore, extreme annual

fluctuations in numbers of nesters in this species, the socially facilitated migration hypothesis and an extensive discussion of strategies for conservation of sea turtles. Other contributions with coauthors included work on captive breeding, nutrition, endocrinology, living tags, mariculture and a definitive redescription of the flatback sea turtle placing it firmly in the genus *Natator*. Hendrickson often took controversial views and was well known to think out of the box.

**REPRODUCTIVE ECOLOGY OF GREEN (*CHELONIA MYDAS*) AND LOGGERHEAD (*CARETTA CARETTA*)
TURTLES ON THE KARPAS PENINSULA OF CYPRUS**

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Introduction

Two sea turtle species (*C. mydas* and the *C. caretta*) nest on Mediterranean beaches (Mrosovsky, 1983), and both *C. mydas* and *C. caretta* come to Cyprus’ beaches, the third biggest island in the Mediterranean, to lay their eggs (Groombridge and Whitmore, 1989; Demetropoulos and Hadjichristophorou, 1989; Groombridge, 1990; Broderick and Godley, 1992, 1993, 1994, 1995; Godley and Kelly, 1996). About 300 to 400 female *C. mydas* and 2,000 female *C. caretta* turtles nest in the Mediterranean (Groombridge, 1990), and approximately 30% of *C. mydas* and 10% of *C. caretta* turtles choose the beaches of the northern part of Cyprus to nest (Broderick and Godley, 1995; Godley and Kelly, 1996; Glen et al., 2001). Ronnas Bay and Alagadi beaches on the northern coastline of Cyprus have been recently reported to be the 3rd and 5th most important nesting beaches, respectively, for *C. mydas* in the Mediterranean (Kasperek et al. 2001).

Conservation and monitoring efforts were initiated in 1992 and have continued to date, with the co-operation of the Marine Turtle Research Group from Swansea University, the North Cyprus Turtle Protection Society, and the Turkish Cypriot (TC) Environment Services. The work along the Karpas Peninsula has been conducted since 1996 by the TC Environment Services. The “Monitoring and Protection of Sea Turtles” project, which has been carried out on the Karpas beaches since 1999, has been supported under the Bi-Communal Development Programme by USAID and UNDP through UNOPS.

Materials and Methods

Monitoring was carried out on 11 beaches in the Karpas Peninsula (5 in north, 6 in south Karpas) during the 1999-2002 seasons. Monitoring on some beaches was conducted for one or three seasons only. Monitoring and conservation work started in late May and continued until the end of September. The Golden (I and II), Ronnas (consisting of a series of seven small beaches), and Ay. Philion beaches were monitored between 2100 and 0600 At 30-minute intervals throughout the nesting season. The remaining eight beaches were monitored during the day only. Nesting turtles were identified and tagged using plastic tags, and carapace measurements were recorded. During 2002, PIT tags were used for the first time. Based on experiences from previous years, all eggs deposited on Golden (I and II), Ronnas and Ay. Philion beaches were moved to a hatchery, set up in a fenced area, within 12 hours of nesting, in order to prevent flooding of the nests. The nests on Ronnas beach were monitored 24 hours a day following the first hatching and the safe arrival of the hatchlings to the sea was ensured. After the last hatchling had left, the nests were excavated by hand to accurately determine the number of eggs, hatchlings, and fertilized and unfertilized eggs. Nests where hatching did not take place were excavated 60 days after nesting to determine the number of eggs and possible causes of the hatching failure.

Results and Discussion

A total of 1,666 *C. mydas* emergences were recorded in the Karpas beaches over the four nesting seasons, 575 of which resulted in nests. The nesting success rate for *C. mydas* ranged from 30% to 38%, with an average of 34.5%. The number of *C. mydas* nests recorded in the Karpas beaches ranged from 67 to 239 nests per season, with an average of 162 nests per season. The maximum number of *C. mydas* nests was recorded in 2000. Assuming that female turtles nest every 3 years, we anticipated observing another peak year 2003 season. The number of nests suggests that the Karpas beaches may host up to 80 *C. mydas* adults per season, assuming that the females nest an average of 3 times each season. The number of *C. mydas* nests on north Karpas beaches (439 nests; 76.3% of total) was significantly higher than that on south Karpas beaches (136 nests; 23.7% of total). Ronnas and Ay. Philion beaches in north Karpas are the most important nesting sites for *C. mydas* in the Karpas Peninsula, with an average of 67 and 34 nests per season, respectively. The north Karpas beaches are preferred as nesting sites due to the beach characteristics, which have sharp and high inclination and sufficient sand depth. In south Karpas, Golden and Dolphin beaches are the most important nesting sites, with an average of 18 and 12 nests per season, respectively.

A total of 57,510 *C. mydas* eggs were recorded in the Karpas beaches. Of these, 37,403 produced hatchlings, most of which were able to reach the sea, except those subject to predation (e.g., foxes, stray dogs, crabs, etc.). The hatching success rate for *C. mydas* ranged between 57% and 69%, with an average of 65%. The success rate increased from 1999 to 2002 and can be attributed to the hatcheries and prevention techniques that were implemented during the recent conservation and monitoring efforts. The remaining eggs were either destroyed by flooding, were unfertilized or contained undeveloped embryo.

The number of *C. caretta* emergences recorded in the Karpas beaches was significantly lower (326) than those for *C. mydas*, 114 of which resulted in nests. Similar to *C. mydas*, the nesting success rate for *C. caretta* over the four seasons ranged between 27% and 41%, with an average of 35%. The number of *C. caretta* nests recorded in the Karpas beaches ranged from 17 to 45 nests per season, with an average of 34 nests per season. The maximum number of *C. caretta* nests was recorded during the 2002 nesting season. The recorded number of nests suggests that the Karpas beaches may host up to 15 *C. caretta* adult females per season. The number of *C. caretta* nests recorded in north Karpas and south Karpas beaches was 54 nests (47.4% of total) and 60 nests (52.6% of total), respectively. Golden beach in south Karpas and Ronnas beach in north Karpas are the main nesting sites for *C. caretta* in the Karpas Peninsula, with an average of 12 and 7 nests per season, respectively).

A total of 7,804 *C. caretta* eggs were recorded in the Karpas beaches. Of these eggs, 4,675 produced hatchlings, which mostly were able to reach the sea. Similar to *C. mydas*, the hatching success rate for *C. caretta* ranged between 55% and 64%, with an average of 59.9%.

The peak nesting season for *C. mydas* was between late June and mid-July, while for *C. caretta*, it was in June.

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ESTIMATING STAGE DURATIONS AND AGE AT MATURATION IN LOGGERHEAD (*CARETTA CARETTA*) SEA TURTLES FROM THE WESTERN NORTH ATLANTIC USING SKELETOCHRONOLOGY

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To better understand the population dynamics of loggerhead sea turtles, we used skeletochronology to estimate growth rates and stage durations for the Western North Atlantic population. We recovered humeri from five juvenile loggerhead sea turtles that were captured alive, measured, tagged and released as part of an ongoing mark-recapture program in Core and Pamlico Sounds, North Carolina, USA. The five turtles subsequently stranded dead at least two years after initial capture. We estimated somatic growth from skeletal growth marks under assumptions of 0.5, 1.0 and 2.0 growth marks deposited annually. The results clearly demonstrated that the assumption of 1.0 growth mark/year resulted in the estimation of somatic growth closest to the observed growth. The results also served to validate the use of dimensions of skeletal growth marks for the estimation of somatic growth. We used this relationship to estimate growth rates in wild, unknown history loggerhead sea turtles that stranded dead along the U.S. mid-Atlantic coast. We presented evidence of a settlement line in loggerhead humeri marking the transition from the pelagic to benthic habitats at the 19th Annual Symposium on Sea Turtle Biology and Conservation, and therefore we were able to estimate growth rates specific to each habitat. Linear and non-linear fits through the data resulted in estimates of 14 year average

pelagic juvenile stage duration and 17 year average benthic juvenile stage duration. Combining these estimates, we found an average of 31 years was required to reach 90 cm SCL, the approximate size at which loggerheads begin to mature.

**ASPECTS OF THE POPULATION DYNAMICS OF GREEN TURTLES (*CHELONIA MYDAS*) AT CULEBRA
ARCHIPELAGO, PUERTO RICO**

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In-water studies were conducted from 2000 to 2002 for green sea turtles (*Chelonia mydas*) at Culebra Archipelago, Puerto Rico. The main objective of this study was to assess important biological parameters for the recovery of this species. Some of these parameters were population structure, sex ratios, catch per unit effort (CPUE), growth rate and health assessment. Our results indicated a population structure composed of juvenile and sub-adult turtles (mean SCL = 48.6 cm, range: 28.4-83.0 cm). Sex ratios will be determined by the use of testosterone levels but results are not yet available. Capture and recapture of 21 individual turtles yielded a growth rate faster than other aggregations across the Caribbean and Atlantic region (mean = 5.38 cm per year). The CPUE has been stable for the past two years. Finally, animals with fibropapilloma tumors (GTFP) were captured at a particular study site (Puerto Manglar). These aggregations of green turtles at the foraging grounds of Culebra are the most important for Puerto Rico and today this area is threatened by urban and tourism development.

CONSERVATION AND MANAGEMENT

COMMUNITY-BASED AWARENESS PROGRAMME FOR THE CONSERVATION OF SEA TURTLES IN BANGLADESH *

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Bangladesh's coast supports nesting of five species of sea turtles: the Olive ridley, green, hawksbill, loggerhead and leatherback. Habitat loss, trawl fishing and lack of awareness have been identified as the major threats for sea turtles in Bangladesh. Some agencies are involved at a limited scale in the conservation of these marine lives. Many people, especially the fishermen, are not aware of the importance of sea turtles and the need for their conservation. Law enforcement is not adequate and there is no use of TEDs in Bangladesh. As a result, the populations of marine turtles has declined over the years. A community-based awareness programme among the fisher groups, marine resource managers and other stakeholders would be a useful activity for conserving these important threatened species. To address these issues, a community-based awareness programme has been proposed which promotes an awareness programme including: importance of marine turtles and conservation needs; use of TEDs; laws related to marine turtles; tools for community people and managers. Effective community participation can only and essentially save the turtles.

CONSERVATION AND MANAGEMENT NEEDS OF TWO TURTLE SPECIES OF THE ARABIAN GULF *

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Increasing awareness of the need for environmental protection and sustainable management of natural resources in the Arabian Gulf has led to conspicuous achievements in the areas of conservation of marine wildlife and habitat. Out of the five sea turtles species reportedly found in the Arabian Gulf, the hawksbill and the green are the most common species to nest and forage in the area among the GCC country's mainland and islands. However, detailed information regarding the nesting of these species is scarce. In this paper, data on nesting beaches, nesting processes and hatchling morphometry with respect to the hawksbills of the Arabian Gulf are discussed. Over the past five years, habitat utilization, migration and dive patterns in both *Chelonia mydas* and *Eretmochelys imbricata* has been investigated using satellite tagging in the coastal water of United Arab Emirates.

The nesting season of the hawksbill turtle, *Eretmochelys imbricata*, extended from late March in UAE to early September in Kuwait. The average incubation period was 59.9 days, clutch size 58.6 eggs, and hatching success 68.1%. The mean egg size was 38.6 mm in diameter, mean curved carapace length of breeding females was 69.8 cm and mean curved carapace width 63.1 cm. The average straight carapace length of the hatchlings was 3.9 cm and straight carapace width was 3.7 cm, with 11.9 g in body weight. A close relationship between the emergence time and tidal cycle was found in the present study.

Increasingly, data gathered on carapace size and clutch size from this work concluded that the Arabian Gulf hawksbill populations are smaller in size and have smaller clutch sizes compared to other ranges of its distribution. Maintaining a sustainable environmental development and economic growth demands we pay attention to our future needs and challenges such as population control, alternative energy sources, sustainable management of natural resources such as water, fisheries and fossil fuel, environmental research and literacy, stabilizing climate, reuse/recycle economy and pollution regulatory legislation and taxes. The public needs to understand more about sea turtle management, and resource management usually requires more information, not more husbandry.

INTERNATIONAL ACTION AND PROGRESS ON SEA TURTLE LONGLINE BYCATCH MITIGATION

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Environmental issues have an increasing influence over fisheries-management decisions and policies in many States. One of the most crucial concerns is that of the incidental take of non-target marine species in fishing operations. It is now recognised that there is no single comprehensive technical or management solution that can be applied to mitigate this problem of bycatch. There are, however, many useful scientific lessons that have been learnt from past experiences and may be applied to future actions (Hall 1996). Less attention has been paid to the legal and political aspects of marine wildlife conservation associated with bycatch mitigation.

Marine wildlife, such as sea birds, cetaceans and marine turtles, are highly migratory species, crossing national jurisdictions and the high seas. As such, activities in one jurisdiction affect the status of the species in another. Those States with strict conservation laws frequently feel that they are shouldering an unfair burden, both in terms of responsibility for the conservation of marine wildlife and in terms of the impact these laws and regulations have on competitiveness in the national and global markets. To combat this perceived inequality the USA has, on several occasions, reverted to the use of unilateral sanctions to further its environmental agenda and to "level the playing field".

Trade sanctions, though rarely a first choice policy tool, have been used on many occasions in regard to a range of issues so as to encourage one State to adopt or alter its behaviour to meet with the expectations of another. In the marine arena, use or threat of trade embargoes by the USA has been affected through, *inter alia*, the Pelly Amendment in relation to Japanese whaling (Pub. L. No. 92-219, 85 Stat. 786 (1971)), and the emplacement of yellowfin tuna import embargoes on nations that fish by a method of "setting-on-dolphins" resulting in cetacean bycatch (Pub. L. No. 92-522, 86 Stat. 1027 (1972)). Though the application of embargoes is irregular and its impact varies from product to product, USA trade and sanction policies will continue to have a major influence on fisheries management decisions in exporting nations.

One of the best known examples of USA extension of domestic legislation into the international arena through the threat and eventual implementation of embargoes, is the "turtle-shrimp dispute". Herein a prohibition was placed on prawns imported from countries that did not have sea turtle conservation measures equivalent to those of the USA (Pub. L. No. 101-162, 103 Stat. 1988, 1037 (1989), section 609). Section 609 certification is available to countries with a fishing environment that does not pose a threat of incidental takings because of an absence of sea turtles within its jurisdiction, the use of only harvest methods which do not pose a threat to sea turtles, or where commercial harvest occurs exclusively in areas where sea turtles do not occur. Certification is also available to harvesting nations that provide documentary evidence of the adoption of a regulatory program governing the bycatch of turtles in shrimp trawling operations to the effect that requirements to use turtle excluder devices (TEDs) are comparable in effectiveness to those in the US – that is, a 97 percent turtle exclusion rate, and credible enforcement including monitoring, compliance & appropriate penalties.

The USA law was opposed by a coalition South East Asian countries, and resulted in a World Trade Organisation dispute (WTO 1998a, 1998b, 2001a, 2001b). The plaintiff States were supported in their application by a broad range of countries, including Australia, who filed a third party submission to each of the four suits. The final result was that the USA law and embargoes were, in the main, found to be WTO compliant. In so doing the WTO found that several conditions had to be met in order to qualify for an Article XX(g) exemption to international trade rules. These included:

1. Provisional justification for using Article XX(g) by showing that:
 - a. sea turtles were endangered world wide, and that shrimping was the greatest source of mortality – hence leading to the conclusion that sea turtles were exhaustible natural resources
 - b. the measure is "related to" the conservation of an exhaustible natural resource; that is, it must be "aimed primarily" at the conservation objectives and show "a close relationship between means and ends". To do so there must be "sufficient nexus" between the law and the environment of the enacting State.
2. Final justification by showing that the measure does not contravene the chapeau. In this regard:
 - a. a State can not be required to adopt a particular technology, if other technologies have equal effect;
 - b. the regulating State must take into account differences in the prevailing conditions in other countries;
 - c. before enacting trade measures nations should attempt to enter negotiations with the exporting state;
 - d. countries affected by trade measures should be allowed equal and sufficient time to make adjustments;
 - e. due process, transparency, appeals/review procedures and other procedural safeguards must be adhered to.

Conservation and Management

Over the past several years, the problem of the incidental capture of sea turtles in longline fisheries has become a central issue in USA fisheries management and conservation policy (Crouse 1998, 1999). The problem of sea turtle longline bycatch was first reported in the western Atlantic Ocean in the early 1980s (Witzell 1984). The primary bycatch species of sea turtle were critically endangered loggerheads and leatherbacks, though the catch of other species has also been recorded. Over the last two years the USA has closed a significant portion of its Western Pacific longline fishery, and has championed the issue of the incidental take of sea turtles in the international arena. Domestic USA developments have occurred in both the courts and legislature as well as through research into gear development to mitigate the incidental take (Gerrior 1996). There has been consideration by the USA of the potential use of sanction action (per comm), and as domestic mitigation measures become compulsory these discussions are likely to intensify.

To be sure, there have been calls for the negotiation of specific international accords on this issue from some sectors of the US public and government, as well as for the extension of domestic laws to countries whose longline fisheries bycatch sea turtles. The 14 June 2001 Atlantic NED Biological Opinion, instructed NMFS to: "focus efforts on the broader impacts that occur to loggerhead and leatherback populations throughout the Atlantic by using its available legal authorities to pursue bilateral or multilateral agreements for the protection and conservation of sea turtles with other nations whose commercial longline fleets may affect sea turtle conservation."

From past actions the likelihood of US trade action is likely to depend on several conditions being met. Influences on the possible legitimacy of trade action includes the potential of gear remedies to mitigate longline sea turtle bycatch, and the extent of US efforts to engage the international community on the issue.

In terms of the former, action in the US has, by and large, been through partial swordfish fishery closures. Gear development and method modification is still underway. Developments and trials for the mitigation of sea turtle longline bycatch to date include fishery closures (area, seasonal, and real time management), or a reduction of effort. Gear modifications include hook distance from floats, variations on bait type, hook type (for example offset large circle hooks) and method variations such as altered soak time, and the time of day of set. Progress is good, but to date no proven mitigation measures that could be transferred compulsorily to foreign countries as a condition of trade have been devised.

In terms of engagement of the international community, sea turtle longline bycatch has been raised internationally at the UN Food and Agriculture Organisation (FAO), the Convention for the Conservation of Migratory Species of Wild Animals (CMS) and other fora. Under Appendix I of the CMS, which lists species considered to be endangered, take is strictly prohibited and obstacles to migration must be removed and threats mitigated. All species except the flatback are listed thereunder. Two conventions have been created under the CMS. These are the Memorandum of Understanding on the Conservation and Management of Marine Turtles and their Habitats of the Indian Ocean and South-East Asia (IOSEA), and the Memorandum of Understanding on the Conservation of Marine Turtles of the Atlantic Coast of Africa. Also under the CMS are several resolutions or recommendations relating to bycatch which require attention to seabirds, turtles and marine mammals, and improving the conservation status of leatherback sea turtles. Though the US is not party to the CMS it is a signatory and provides funding to the IOSEA. In the Western hemisphere and independent to the CMS is the Inter-American Convention for the Protection and Conservation of Sea Turtles, which the US is a party to.

Action has also been taken under the FAO Code of Conduct for Responsible Fisheries. Though a non-binding instrument, this has strict bi-annual reporting mechanisms. The Code of Conduct includes fisheries management measures to ensure the protection of both target and non-target species, associated or dependent species; the use of selective fishing gear and minimise waste, discards and catch of non-target species, and reduce impacts of fisheries on species associated or dependent upon the target species; application of the precautionary principle in conserving, managing and exploiting fisheries resources; and improved understanding by collecting and exchanging data with all relevant groups. Also at the most recent FAO Committee of Fisheries Meeting a Technical Consultation on sea turtles has been committed to within the next two years.

In addition to action at intergovernmental fora and trade incentives, there have been a series of resolutions and meetings in relation to sea turtle capture in longline fisheries worldwide. The IUCN Resolution on incidental capture of marine turtles in pelagic longline fisheries, 1998, requested FAO conduct a technical consultation to assess the magnitude of the problem, and urged countries developing Seabirds Plans of Action to ensure measures do not negatively impact turtles, and to develop an International Plan of Action addressing the impacts of longline fisheries on marine turtles. Two years later the American Society of Ichthyologists and Herpetologists issued a Resolution Supporting Protection of the Pacific Population of Leatherback Turtles, 2000, and urged immediate action to reverse population declines, and ensure the continued survival of Pacific populations of leatherback sea turtles. That same year the Annual Symposium on Sea Turtle Biology and Conservation issued a resolution that urged use of adequate technologies proven to reduce longline sea turtle incidental capture and mortality, increased collection and distribution of information, no expansion of fisheries activities until further research has been conducted, and for all nations to adopt the FAO Code of Conduct on Responsible Fisheries.

Subsequently three meetings have been held, each with a heavy focus on the issue of sea turtle longline bycatch. The Leatherback International Survival Conference - Leatherback Taskforce issued a resolution in 2002 that called on the UN and countries "to institute a moratorium on pelagic longline, gillnet and other fisheries harmful to Pacific leatherback turtles until such activities can be conducted without harm to the species, and provide allocations of transitional aid to affected fishers and communities." The 2003 Second International Fisheries Forum, hosted by the US Western Pacific Regional Fisheries Management Council, involved all sectors of stakeholders and regulators concerned with the issues of sea bird and marine turtle longline bycatch. This was closely followed by the International Technical Expert Workshop on Marine Turtle Bycatch in Longline Fisheries, an international meeting of experts hosted by NMFS, and charged with finding a way forward in both technical and policy solutions to reduce incidental take of marine turtles in longline operations.

The US's efforts within these forums have been fairly consistent in terms of engaging the international community in longline sea turtle bycatch mitigation efforts. Even if they did not wish to take sanction action these efforts by the US, this meant that any prospective action, should it come before the WTO, would be much more likely to be found GATT compliant.

The current state of USA willingness to use sanctions to impose its policies on other countries will depend on not only the international activity of the US. The US decision on whether or not to take embargo measures will depend also upon the level of hardship faced by US industries due to the imposition of high environmental standards, the size and value of the USA fishery concerned, the political situation (such as the relationship between state and federal government, and role of Congress vis-à-vis the Administration), domestic court activities, high level public campaigns by environmental non-government organizations, and the development and availability of scientific and technical solutions such as bycatch reduction devices.

Should the issue progress and if any embargoed States were to take the US to the WTO dispute settlement body, this last issue of available technical mitigation measures would be of considerable influence in any subsequent determination.

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STATUS AND CONSERVATION OF SEA TURTLES IN SARAWAK

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Green turtles (*Chelonia mydas*), hawksbills (*Eretmochelys imbricata*), olive ridleys (*Lepidochelys olivacea*) and leatherbacks (*Dermochelys coriacea*) are the four species of sea turtles reported to nest in Sarawak. Sarawak's Turtle Islands (Talang-Satang National Park) are the major nesting beaches and host 99% of annual sea turtle nests. From the 1940s until the late 1980s, the population of sea turtles in Sarawak has declined drastically, but since 1990 the population is quite stable. As the government agency responsible for wildlife matters in Sarawak, the Forest Department has initiated a number of conservation efforts in the past few years to ensure the current population will increase in the future. This includes working closely with other relevant

agencies, amending the laws and regulations, conducting an intensive conservation-related research programme, protecting the nesting beaches and feeding grounds, improving the hatchery management techniques, initiating a reef ball project and enhancing enforcement activities.

CAN HEADSTARTING WORK? DETAILED RESULTS FROM THE CAYMAN TURTLE FARM *

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Headstarting as a conservation measure has attracted sustained and vigorous, yet unresolved, debate. One of the best-known projects that continues to draw international debate is carried out in the Cayman Islands. Here we describe the results of a 22-year headstarting programme. Since 1980, the Cayman Turtle Farm has released 16,424 hatchling and 14,345 yearling green turtles (*Chelonia mydas*). Over 80% of released turtles have been subjected to some form of tagging, either notching, flipper tagging, or live tagging. There have been 393 recaptures of headstarted animals since 1980, from Belize (n=2), Cayman (n=161), Cuba (n=176), Honduras (n=8), Mexico (n=1), Nicaragua (n=38), Panama (n=2), United States (n=4), and Venezuela (n=1). Mean tag return rate is 4.2% (2.5% foreign and 1.7% local) though this rate has varied from year to year. Recapture intervals between Cayman, Cuba and Nicaragua are significantly different from one another ($p=0.001$) and patterns of dispersal may offer insight into migration and settlement patterns in juvenile and adult green turtles. Seven living tagged animals have been recaptured as adults since 1998, four of these were observed to be reproductively active. These discoveries are likely to generate further discussion as to the acceptable definition of what constitutes success regarding a captive-breeding facility releasing headstarted turtles.

**GTTMNE WEBSITE: A INFORMATION STRATEGY OF THE ACTIVITIES OF THE NUEVA ESPARTA STATE
SEA TURTLE WORKGROUP ON MARGARITA ISLAND, VENEZUELA**

Angel Bonive and Pedro Vernet

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The Nueva Esparta State Sea Turtles Workgroup is a civil association made up of specialists and volunteers in wildlife conservation. The GTTM-NE is located in Margarita island, Nueva Esparta State, Venezuela. On Margarita island, 36 sea turtles nesting beaches have been identified, the most common species being the leatherback *Dermochelys coriacea*. Since 1998, the GTTM-NE developed multiple conservation activities including beach monitoring, environmental education and community integration. These activities conform with the different projects this institution manages among different populations of Margarita island.

Due to advances in technology and the use of internet which promote communication and information, the GTTM-NE developed and published a webpage titled GTTMNE WEBSITE approximately six months ago. At this site users have access to information about:

- Projects developed by the GTTM-NE including pictures and detailed information of these activities.
- Statistics of the last 2 nesting seasons on Margarita island.
- A contact lists of institutions and people who work on the sea turtles in Latin America and Venezuela.
- Links with other related pages.
- News articles and brief notes about the activities of different projects around the world.
- Electronic mail contact with our institution.

Our site has receives approximate 200 visits a month and we have received favorable comments from several countries including Argentina, Spain, United States, Brazil, Uruguay, Costa Rica, and Mexico.

THE USE OF SEA SURFACE TEMPERATURE IMAGERY AND THE MANAGEMENT OF SEA TURTLE INTERACTIONS IN THE MID ATLANTIC BIGHT *

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Large-mesh gill nets used in the goosefish (monkfish, *Lophius* sp.) fishery have been found to capture and drown sea turtles along the Mid Atlantic coast of the U.S. (NEFSC, unpubl. data), and significant stranding events have been associated with the operation of this fishery in its southern range (SEFSC, unpubl. data). The National Marine Fisheries Service, one of two federal agencies with responsibility for protecting and recovering listed sea turtles, evaluated the risk of sea turtles interacting with this and other fisheries by analyzing sea surface temperature (SST) imagery from Cape Hatteras, North Carolina to Cape Sable, Nova Scotia, for the months of March to June, 1993-2002. Weekly SST imagery acquired by the Advanced Very High Resolution Radiometer (AVHRR) sensor onboard NOAA polar orbiting satellites were divided into 18 zones with north/south boundaries spaced at 30 minute intervals; western and eastern boundaries were the coastline and the 20m and 200m depth contour, respectively. SST data from each zone were extracted and analyzed to determine the percentage of SSTs greater than 11 °C, and thus the likelihood for sea turtles to be present.

COMMUNITY-BASED MONITORING OF SEA TURTLE POPULATIONS IN THE BAJA CALIFORNIA, MEXICO REGION: A REPORT ON THE FIRST YEAR

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Long term, community-based monitoring of sea turtle population abundance and status was initiated at multiple sites in Baja California and Baja California Sur, Mexico. This report provides the first year of standardized data from sites on the Gulf of California and Pacific coasts. A total of 268 sea turtles were captured with a mean standard length (SCL) of 57.7 cm (\pm 10.8 SD, range 36.2 cm to 90.2 cm). East Pacific green turtles (*Chelonia mydas*) were the most abundant species encountered, while hawksbill (*Eretmochelys imbricata*) and loggerhead (*Caretta caretta*) turtles were also captured. Turtles were captured at all sites and in all months of the year. Effort per unit capture (EPUC) was 10 h/turtle (range 2 to 120 h/turtle). Data indicate a predominantly juvenile, year-round population at all sites, with Pacific sites possessing a higher abundance than Gulf of California sites. Long term monitoring is critical to assessing the viability of conservation efforts underway to recover populations of these endangered species.

USING TURTLE CONSERVATION AS A VOLUNTEER EXPERIENCE: ASSESSING VOLUNTEER PROGRAMS IN TORTUGUERO NATIONAL PARK AND GANDOCA MANZANILLO WILDLIFE REFUGE, COSTA RICA *

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Conservation programs in many places rely on volunteer labor. In some locales, notably in (exotic) developing country destinations, volunteers play an additional role in conservation, by paying for their experience. This specialized form of ecotourism, or non-consumptive use, can generate funds for conservation and local development. Due to the control conservation organizations exercise over their volunteers, some of the negative social, economic and cultural impacts on local communities associated with mainstream ecotourism may be minimized, and the use-value generated by non-consumptive use can be directed to specific stakeholders and objectives. This paper contrasts two very different volunteer programs operating in Costa Rica, at Tortuguero National Park by the Caribbean Conservation Corporation, and at Gandoca Manzanillo Wildlife Refuge by Association ANAI. Differences in the programs include numbers of volunteers and their spatial distribution, costs of participation, use of local labor, and level of supervision in the field. Based on field work at both sites, and on documents supplied by the CCC and ANAI, the paper highlights the strengths and weaknesses of the volunteer programs in terms of their economic benefits to, and social impacts on, local communities. While volunteer programs will be shaped to some extent by the local context, the general strengths and weaknesses identified here may inform other organizations wishing to develop such programs.

LOW PRESENCE OF THE LEATHERBACK TURTLE (*DERMOCHELYS CORIACEA*) AND HAWKSBILL TURTLE (*ERETMOCHELYS IMBRICATA*) IN THE JALISCO COAST, MEXICAN PACIFIC (2000-2002)

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Introduction

The biological diversity of the coastal region of Jalisco on the Mexican Pacific is threatened by the fragmentation of forests as well as destruction of habitats caused by the expansion of agricultural activities, cattle raising, forest exploitation and tourist activities, as well as by overexploitation and illegal capture of many species of fauna and flora. The Government is not able to embrace an adequate form of a sustainable use of the natural resources. In the coast of State of Jalisco, on the Mexican Pacific, the presence and nesting of four sea turtles species has been reported: olive Ridleys (*Lepidochelys olivacea*), greens (*Chelonia agassizii* or *C. mydas agassizii*), leatherbacks (*Dermochelys coriacea*) and hawksbills (*Eretmochelys imbricata*), and foraging of loggerheads (*Caretta caretta*) (García & Ceballos, 1994). The extensive legal and illegal exploitation over the last 40 years have had critical consequences on the populations of this species in these beaches and their populations have diminished dramatically (Cliffon et al, 1995; Márquez, 2000).

The Mexican Government approved laws for the total protection of all sea turtles in the littoral zone in 1990, and in this region 69 kilometres of beaches were decreed as protected zones for nesting and five nautical miles at sea as breeding in 1986 (Márquez, 2000). However, excessive predation continues on these beaches, many eggs are plundered, and many organisms are killed to obtain primarily skin and meat (Castellanos et al, 2001). All species are captured on the beaches, but are more frequently caught with nets in the sea when breeding. The University of Guadalajara, Foundation Selva Negra and other social and public organizations have been carrying out activities directed at mitigating predation and contributing to the recovery of the populations that still nest in the region, although at the sea we do not have the means to protect the sea turtles. In this presentation we outline of observations and our records since 1999 for two endangered: the leatherback and hawksbill turtles, as the first report about their status in this region.

Methods

The work is conducted along the Oriental Pacific, on the west coast of Mexico in the State of Jalisco (Fig. 1). We counted tracks and individuals found between January 1999 and December 2002 on the following beaches: Chalacatepec, Majahuas, Mismaloya and Villa del Mar (Tehuamixtle), located between 20°14'N, 105°36'W and 19° 40'N, 105°15'W and encompassing some 70 km, in addition to other localities near these beaches (Chamela Bay, Talpichichi Cove and Maito beach). We patrolled these beaches between July and December intensively, two to three rounds daily in Chalacatepec, Majahuas and Mismaloya. In Villa del Mar and other places we only sampled infrequently (one time per month). We recorded information such as date, hour, curved carapace length (LCC), curved carapace width (WCC), and when possible straight length and width (LSC & WSC); clutch size, nesting activity zone on the beach. Measurements were based on techniques suggested by Pritchard et al (1983) and Bolten A. B. (2000). Identification of specimens was made with help various field guides (Pritchard et al 1983; Marquez, 1990 and 1996-2000; Pritchard & Mortimer, 2000).

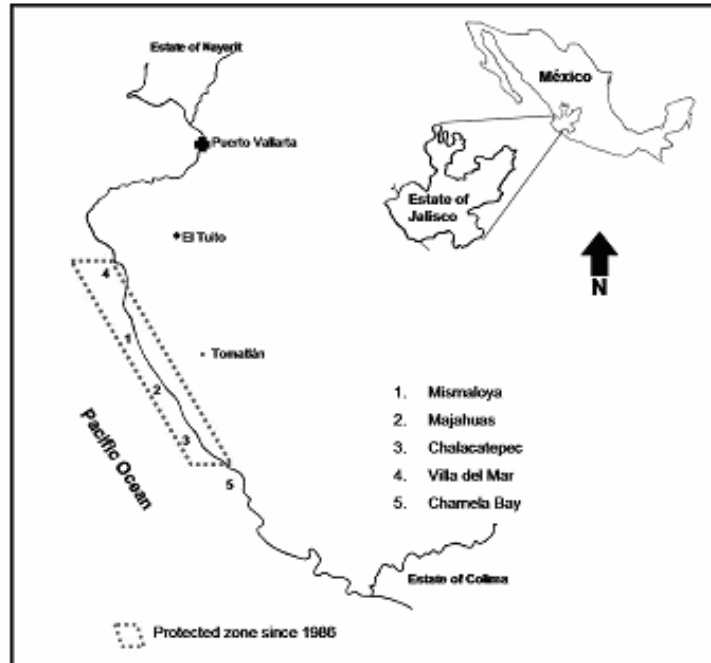


Figure 1: Study sites on the west coast of Mexico in the State of Jalisco

Results

Leatherbacks and hawksbills are found in very low numbers. For leatherbacks, we were found remains of five dead turtles, and tracks of nineteen turtles nesting on the beaches (Table 1). Average LCC was 144.5 cm (min 135, max 151) and average clutch size was 66 (min 45, max 82). Most turtles were encountered in November and December. For hawksbills, we found the remains of seven dead turtles, and we recorded four juveniles in the sea, near the coast; and found one female nesting (Table 2).

Conclusions

Leatherback turtles are present mainly in November and December on these beaches, although more surveys are needed and to expand the temporal and spatial coverage. Hawksbill turtles are infrequent as nesters, but many juveniles are seen in this region. There is a need to increase control on human predators, and the Mexican government should act to reduce their impact. The local people in this region are the principal predators of these species, even though it is illegal and they can be penalised. The vigilance of Government institutions is very low in the region, and the need for action is urgent to protect and to study this little group of hawksbill and leatherback turtles, as they play an important role in the struggle against extinction.

Table 1. LEATHERBACK (*Dermochelys coriacea*)

Season / date	Locality (beach)	specimen description
1 2002, Dec	Chalacatepec	Track on sand and nest, number of eggs unknown
2 2002, Nov	Majahuas	Track on sand and nest, number of eggs unknown
3 2002, July 25	Majahuas	Dead turtle LRC 150 cm
4 2002, April	Majahuas	Female Dead
5 2002, Feb	Majahuas	Track on sand and nest, number of eggs unknown
6 2002, Jan	Majahuas	Track on sand and nest, number of eggs unknown
7 2001, Dec 15	Majahuas	Track on sand and nest, 67 eggs
8 2001, Nov 27	Chalacatepec	Track on sand and nest, 55 eggs
9 2001, Nov 17	Chalacatepec	Nest plundered
10 2001, Nov	Majahuas	Female Dead
11 2000, Dec 29	Chalacatepec	Nest plundered
12 2000, Dec 12	Majahuas	Track on sand and nest, number of eggs unknown
13 2000, Jun 25	Chalacatepec	Female Nesting, 87 eggs, LCC: 142 cm, WCC: 112 cm
14 2000, Feb 14	Maito (near Villa del Mar)	Female Dead
15 1999, Dec 20	Chalacatepec	Nest: 60 eggs
16 1999, Dec 10	Majahuas	Track on sand and nest, number of eggs unknown
17 1999, Dec 06	Mismaloya	Female Nesting, 45 eggs, LCC: 135 cm, WCC: 105 cm
18 1999, Dec 05	Chalacatepec	Female Nesting, 68 eggs, LCC: 150 cm, WCC: 110 cm
19 1999, Dec 05	Chalacatepec	nest: 82 eggs
20 1999, Nov 29	Chalacatepec	Track on sand and nest, number of eggs unknown
21 1999, Nov 24	Chalacatepec	Female Nesting, 76 eggs, LCC: 151 cm, WCC: 104 cm
22 1999, Nov 20	Chalacatepec	Track on sand and nest, number of eggs unknown
23 1999, Nov 16	Majahuas	Track on sand and nest, number of eggs unknown

Table 2. HAWKSBILL (*Eretmochelys imbricata bissa*)

Season / date	Locality (beach)	specimen description
1 2002, Nov 28	Chalacatepec	Female Nesting, 140 eggs
2 2002, Oct 04	Talpichichi Cove	Carapace's scute
3 2002, July	Chamela's Bay	Juvenile diving
4 2002, April 01	Majahuas	Dead turtle, LCC 84 cm
5 2001, Dec 05	Chalacatepec	Dead adult female
6-8 2001, January	Majahuas	3 juvenile foraging and diving
9 2000, May 12	Villa del Mar	Juvenile dead, LCC 54 cm
10 2000, April 23	Talpichichi (near Villa del Mar)	Skull adult
11 1999, Sep, 19	Majahuas	Dead adult female
12 1999, August 30	Chalacatepec	Dead adult female

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NESTING BEACH AND SEA TURTLE DISTRIBUTION ALONG THE COLOMBIAN CARIBBEAN COASTLINE *

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Introduction

Four species of sea turtles nest or forage along the Caribbean coast of Colombia: loggerheads (*Caretta caretta*) hawksbills (*Eretmochelys imbricata*) leatherbacks (*Dermochelys coriacea*) and green turtles (*Chelonia mydas*) (Ministerio del Medio Ambiente de Colombia, 2002). In Colombia, the first three were recently classified as critically endangered and the last one as endangered (Castaño-Mora, 2002). Though sea turtles are protected through international and national laws, research and management activities are limited, focused on a few specific beaches, basic in nature and the results unpublished (around ~70% of work remains as grey literature; Álvarez-León, 2001). Based on these factors, in January 2002 INVEMAR initiated a short-term study to develop a comprehensive understanding of the conservation status of sea turtles in Colombia. Specifically, we wanted to locate and describe nesting beaches and aggregation sites in the sea locally known as “caladeros”. We also collected information on natural and anthropogenic threats, and use and trade of sea turtles and sea turtle products by local communities. Although the information regarding threats and trade is not included here, it is available from INVEMAR. This study was partially sponsored by the Ministry of Environment as one of the actions needed to implement the National Strategic Plan to Conserve and Recover Threatened Wildlife under the 1998-2002 National Development Plan.

Methods

This study was carried out along the 1,650 km of Colombia’s Caribbean coastline, including the continental and oceanic islands (Figure 1). All secondary data was compiled, analysed, and deposited in INVEMAR’s library, and is open to the general public. Five field data sheets were designed to gather information regarding the beach geomorphology and wildlife, sea turtle species presence on the beach or in the water in front of the beach, turtle activity (nesting, feeding, resting or passing-by) and their occurrence, relative abundance, threats, and the use and trade of sea turtle products. Since turtles were not tagged, abundance refers to the number of times that people noted a sea turtle on a beach in a year, on the following basis: rare = 1-100 turtles/beach/year, common = 10-100 turtles/beach/year, and abundant = >100 turtles/beach/year. Although these categories were assigned subjectively, and beach sizes were different, it allowed us to make comparisons among beaches and regions. Six field assistants were hired to cover different regions of the Caribbean seashore through short visits to all nesting beaches reported in the literature and those reported by the local communities.

Field data sheets were also annotated with personal observations and information from informal interviews to local communities, NGO’s, and environmental authorities. Once the information was organized in a Microsoft Excel database, data was exported to ArcGIS to create a point map. Each point represented a beach, and each of these was linked to its respective occurrence and species information. ArcMap was used to produce the final cartographic product in *.pdf format. These maps are available upon request from INVEMAR.

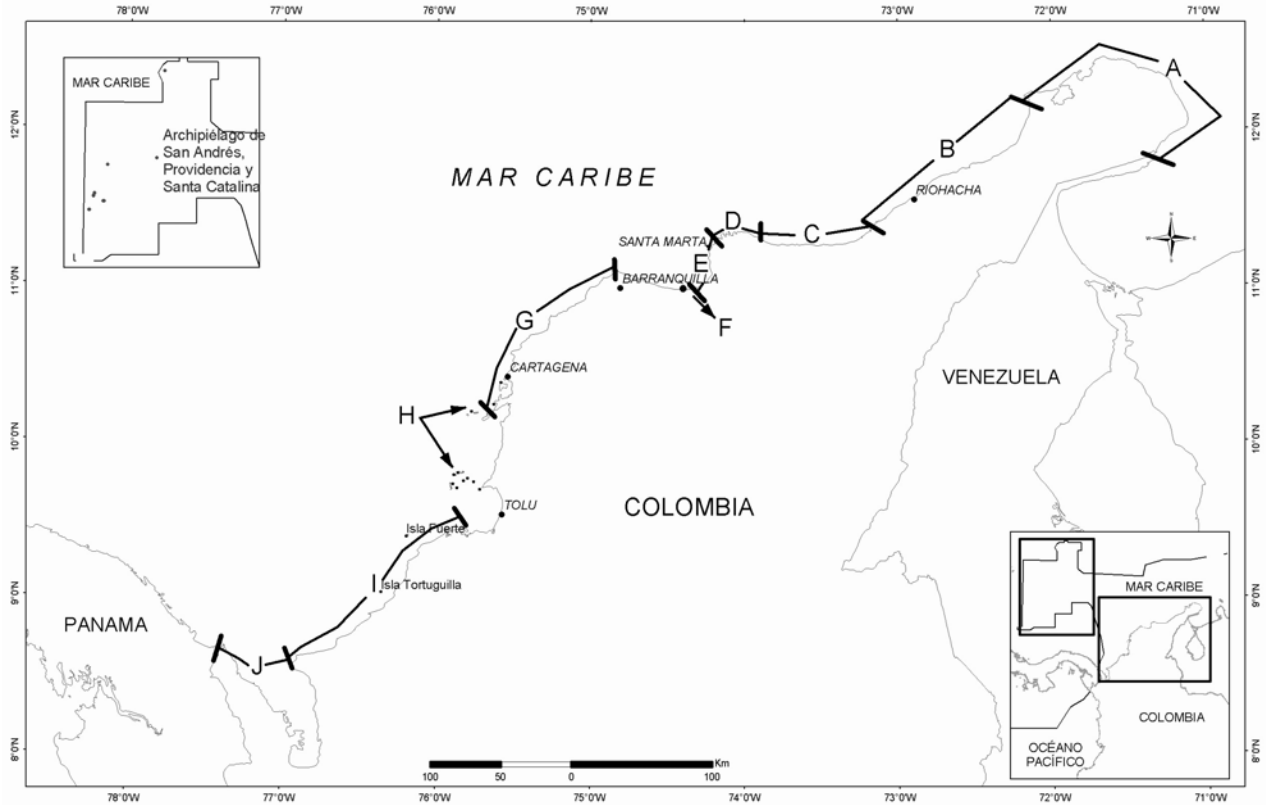


Figure 1. Map of the regions of the Caribbean Coast of Colombia: from northeast to southwest: Alta Guajira (A), Media Guajira (B), Baja Guajira (C), PNN Tayrona (D), Taganga – Tasajera (E), Vía Parque Isla de Salamanca VPIS (F), Barranquilla – Cartagena (G), Corales del Rosario and San Bernardo National Park (H), Cispatá – Damaquiel (I) and Urabá gulf (J) (Author: SIG lab, INVEMAR).

Results and Discussion

Nesting Beaches - A total of 181 beaches (729.66 km) were found to be important for present or past nesting or turtle aggregations in front of the beach. Of these, 127 beaches (535 km) are currently used by one or more species at different times of the year.

In the Alta Guajira, a total of 26 beaches (186 km) were used by hawksbills and green turtles, and to a lesser extent by loggerheads and leatherbacks, which were rare and scarcely distributed. In the Media Guajira sea turtles fed in front of 25 beaches (110.8 km of seashore), and although no nesting was reported, this might be a reflection of the low population levels in the area. On the 16 beaches of the Baja Guajira, all four species nested and fed, particularly the loggerhead. The Tayrona National Park's beaches are short, narrow and are difficult to access by turtles. All four species were reported nesting on these beaches, though in a very low numbers. The beaches Playa Brava and El Cinto were especially important for hawksbills although also in low numbers. Among the Santa Marta and Tasajera region (18 beaches with 39.4 km) and the Via Parque Isla de Salamanca VPIS (one long 70 km beach) loggerheads, hawksbills and leatherbacks still nest but numbers are very low. More information is needed especially in the VPIS. Between the cities of Barranquilla and Cartagena only 10 beaches were identified (43.8 km) where only hawksbills nest, although the four species reportedly nested in the past. A similar situation occurred in the seven beaches (1.8 km) of the Rosario and San Bernardo islands, where juveniles and green turtles were being captured in the water. Between Cartagena and the Gulf of Morrosquillo only 3 beaches were reported (37.7 km) and only hawksbills commonly nested there. Between Tinajones and Punta Arenas there are 11 beaches (83.1 km) where greens and hawksbills commonly nested, especially around Fuerte and Tortuguilla Islands. In the Uraba gulf, at the westernmost point of the Caribbean coast, a total of 27 beaches (50.9 km) were found to be important for sea turtles. The most important of these were Playona, Acandí, Los Chilingos and Amarilla, where more than ~300 females reportedly nest around the Holy week in April. Several beaches (23) were also found as sporadic nesting habitat for hawksbills, though its presence should be confirmed. Green turtles and loggerheads do not nest in this area, but their presence in the water was reported by local fishermen. In the San Andres islands there was no field work due to time and resources constraints, and so a relatively complete study regarding the general conservation status of sea turtles was not available. However, a total of 12 beaches (12.87 km) were important for sea turtles, especially for loggerheads, followed by hawksbills and greens.

Foraging Grounds and Species Abundance - INVEMAR has been monitoring the coral and seagrass beds of the Caribbean coast during the last 5 years. We found that the feeding grounds matched the regions / beaches where sea turtles were most abundant. Hawksbills were found to nest along 470 km of the Colombian Caribbean coast, and were categorized as rare along 330 km (70%) of this, and common along the remaining 141 km (30%). Counting nesting hawksbills and those observed in the water, this species is the most abundant among the continental islands (Rosario, San Bernardo, Fuerte and Tortuguilla). In Rosario and San Bernardo, a marine protected area, juveniles have also been observed among the 219.5 km² of coral reefs (Díaz et al., 2000). In this protected area the following sponges have been reported: *Aptos* spp., *Chondrilla nucula*, *Chondrosia collectrix*, *Geodia gibberosa*, *Geodia neptuni*, *Placospongia melobesiodes*, *Suberites aurantiaca* and *Tetrhya crypta* (Zea, 2002, non published data), which are known components of the hawksbill's diet (Bjorndal, 1997).

The green turtle was reported nesting along 400 km of the shoreline, including the Alta and Baja Guajira, Tayrona National Park, and the region between Cispatá and Damaquiel. This was the second most widespread species after the Hawksbill. It was rare along 339 km (84.6%), and common in only 61.6 km (15.3%). The region where it was most commonly reported fronted the Media Guajira beaches, from the Cabo de la Vela to the Camarones river mouth, also home to 33.174 Ha of seagrasses, or 76.7% of the total seagrass coverage in the Colombian Caribbean (Díaz et al., 2003), and whose main grass is *Thalassia testudinum*, the main food item of this species in the region (Bjorndal, 1995).

The third most common turtle was the loggerhead, along 360 km of nesting beaches, reported as rare along 181 km (50.3%) of this, and common along the remaining 179 km (49.6%). This species was most common in the Media Guajira, especially between the Dibulla and Mendiguaca rivers, and in the Serranilla cay, the most northward cay of the San Andrés islands. Its high abundance in the Media Guajira waters could be due to surge and convergence phenomena that makes it the richest region on fisheries production (Guerra, 1990), which complements its omnivorous diet (Bjorndal, 1997).

The species with the lowest nesting extension was the leatherback, along only 309 km. It was classified as rare along 292 km (94.8 %) in the Alta and Baja Guajira and the Tayrona National Park, common in 6 km (1.9 %) in the Chilingos, Acandí and Amarilla beaches in the Urabá gulf, and abundant in Playona (only 10 km long). These beaches are particularly open to the ocean, medium slope, and there are no reef areas in front of them. These conditions have been reported to be appropriate for this species that lacks a hard shell to protect his body, and that helps it to reduce the distance between the tide and the beach to nest (Mortimer, 1995).

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ASSESSMENT OF THE TRADE IN THE SEA TURTLES AND THEIR PRODUCTS IN THE CENTRAL AMERICAN ISTHMUS

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The present study was carried out in Central America during 2000-2002. Sea turtles are among the most economically and ecologically valuable shared natural resources in Central America. Because of their migratory habits and wide dispersal, the consumption of sea turtles and their products in one country has direct implications for management and conservation of these species in neighboring countries. The study included an analysis of the national and regional legal framework, an analysis of the status of the species in the isthmus and the regional assessment of the trade. It is clear from the results of these surveys that, CITES provisions notwithstanding, the recovery of Endangered or Critically Endangered sea turtles continues to be compromised by high levels of undocumented and unmitigated illegal product trade, especially meat, eggs and shell items. Over 100 individual surveys around the region showed that in all countries, legal and illegal trade of products from sea turtles could be found. Data on extra-regional illegal trade were also collect. Data about each item (eggs, meat, oil, and shell items) and their prices is presented including a comparison with data from other neighboring areas. The study concludes that illegal trade and international trafficking in sea turtle and their products is widespread, and that the threat posed by this illegal trade is serious. At a time when the economies of various nations, especially in coastal communities, increasingly depend on revenues from sea turtles eco-tourism, the serious implications of the ongoing illegal trade in sea turtle products cannot be ignored.

COSTA RICA'S NATIONAL STRATEGY TO REDUCE COASTAL LIGHT POLLUTION - YEAR TWO

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The control of artificial illumination in the coastal zone of Costa Rica forms a major part of the environmental effort coordinated by the Costa Rican Electrical Institution (ICE) in conjunction with the Douglas Robinson Marine Turtle Research Center. This is the second year of this national investigation. The project was initiated with a study to determine the best measures to apply to particular conditions at beaches determined as a priority for turtle conservation. These beaches present massive or intensive turtle nesting behaviour. The potential use of lens covers and obscuring paints has required intensive experimentation with materials and paint products to determine their resistance to temperature, solar radiation, precipitation and saline effects in tropical conditions. Other measures, which increase citizen participation and acceptance in the coastal zones, have been combined with alternative initiatives until such time as ICE decides on an adequate integral solution which may lead to the nationwide installation of Low Pressure Sodium lamps.

RECENT INITIATIVES TO PROTECT SEA TURTLE POPULATIONS IN THE SOCIALIST REPUBLIC OF VIET NAM

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Across the globe the actions of humans have placed the future of many marine species at risk of endangerment and habitats at risk of degradation. Sea turtles are no exception and in South East Asia many populations have declined by over 50 %, and some

have become nearly extinct during the last two decades. Sea turtle populations in South East Asia warrant conservation: they are economically, ecologically, nutritionally and philosophically important species. Although eight years of data have been collected on nesting green turtles in the Socialist Republic of Vietnam, little information existed that documented the distribution, abundance and threatening processes in this country. Our data, and information collected by WWF and TRAFFIC, indicate that two decades ago Vietnam may well have had large and regionally significant populations of hawksbills, green, leatherback and olive ridley sea turtles. Currently, most of the smaller nesting populations are extinct and nesting now only occurs in very low densities in most areas. Nesting populations of hawksbill and leatherbacks are on the brink of local extinction. Moreover, fishing pressure is immense along the entire coast and poses a massive threat to the survival of local and regional stocks. Over the last two years, the Vietnamese Government, together with local NGO groups (IUCN-Viet Nam, WWF and TRAFFIC) have embarked on a widespread campaign to initiate sea turtle protection strategies. Specifically;

- The Vietnamese Government has signed the IOSEA MoU for the protection of marine turtles and their habitats, and produced a Conservation Status Report at the meeting of parties.
- The Vietnamese Government, together with all stakeholder groups, have developed a draft National Action Plan for the protection of sea turtles in Viet Nam. It is envisaged that this plan will be approved by the end of 2003.
- Two baseline surveys have been completed. The first documenting the local and international trade of sea turtle products in Viet Nam, and the second, detailing the distribution, abundance and threats to sea turtles in Viet Nam.
- An education package, which aims to teach school age children about sea turtles has been developed and tested in pilot schools.
- Identification posters have been prepared in Vietnamese.
- Workshops have been held in key centres to encourage local support and participation.

A REVIEW OF SEA TURTLE CONSERVATION IN VIETNAM

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Five of the world's seven sea turtle species are found in Vietnam's waters. Turtles and turtle eggs have been traditionally harvested by fishers and local communities for consumption and traded for souvenirs. Very few sites remain in Vietnam where turtles still nest in significant numbers. WWF initiated the first marine turtle conservation activities in Vietnam in 1995, establishing a project to research and monitor nesting green turtles in Con Dao National Park. Since 1998, more than 1000 nesting green turtles have been tagged, and over 300,000 green turtle hatchlings released.

Since 2000, projects have been established in Ninh Thuan Province, on Vietnam's mainland and in Phu Quoc Island, in the Southern Province of Kien Giang. Ninh Thuan receives only a few nesters annually (<50/year) but the project is successfully protecting nesting beaches and is raising awareness among the local community. The waters around Phu Quoc Island appear to be very important and significant foraging grounds for green turtles in particular. Historically, hawksbill and green turtles once nested in significant numbers, but exploitation for trade, consumption of meat and egg collection has caused hawksbills to have declined dramatically and green turtles to nest only on remote outer islands.

TURTLE CONSERVATION AND FISHERY MANAGEMENT IN THE US WESTERN PACIFIC *

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The Western Pacific Regional Fishery Management Council has recently assumed a lead role in the conservation and recovery of Pacific sea turtles. The catching and consumption of turtles for subsistence and cultural purposes in the US-regulated Western

Pacific has been banned for two decades under the US Endangered Species Act (ESA), despite an extensive history of turtle exploitation by Pacific Islanders. More recently, management measures to minimize longline-turtle interactions in pelagic fisheries managed by this Council, and stemming from the ESA, greatly reduced turtle takes in the Hawaii-based longline fishery, but led to a 20% decline in production and a 40% loss in revenues. ESA provisions have also forced the State of Hawaii to seek federal permitting for the continuity of shore-based recreational rod and reel angling due to frequent turtle interactions in this fishery. During 2002, the Western Pacific Council convened the first workshop of its kind for the western and central Pacific, bringing together fishery and turtle conservation researchers and managers to formulate recovery strategies for Pacific turtles. The Council also co-hosted a global forum for fishers and other parties interested in mitigating turtle interactions with pelagic longlines. The Council is currently developing a range of conservation actions for Pacific turtles to be conducted in partnership with the National Marine Fisheries Service, Pacific regional bodies and non-government conservation organizations. These include collecting biological data on turtles, nesting beach identification and management, turtle tagging, recovering turtle tagging databases, and institutional strengthening.

PEYU PROJECT, SEA TURTLES OF ARGENTINA, ACTIVITIES 2002

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The Peyu Project deals with the conservation and research of sea turtles in Argentina. During 2002 the project carried out research trips to the province of Mendoza, and also to the shores in the province of Buenos Aires. The main objective of these trips was to get information about biology, feeding, and displacements for turtles that inhabit the Argentine Sea. In the first case, investigations were made on the loggerhead turtle (*Caretta caretta*) specimen that is located in the municipal Aquarium of Mendoza and additional information about carapaces and records of the species was obtained from museums and research institutes. In the second case, research trips included voyages for studies along the shore and at institutes and universities.

As a result of this research, a description of the patterns of behaviour (etogram) of sea turtles in captivity was elaborated; furthermore, information was obtained about variation of their abundance during the different seasons of the year, as well as about the incidence of fishery in their capture; Finally, uses of this information towards conservation were investigated.

MANAGEMENT OF TRADITIONAL HUNTING ON THE GREAT BARRIER REEF - MODELLING THE SOUTHERN GREAT BARRIER REEF GREEN TURTLE STOCK *

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Introduction

In the Great Barrier Reef Marine Park, there are two genetic breeding stocks of green turtles *Chelonia mydas* which are treated as separate management units (northern GBR, southern GBR) (Moritz et al. 1998). The southern GBR (sGBR) stock nests in an area including the mainland coast and islands from Townsville south to Southeast Queensland and east to the Swains Reefs. The major nesting aggregations occur at Northwest Island, Hoskyn Island, and Wreck Island. Foraging grounds, based on evidence from tag returns, principally encompass the waters from Cape Melville (latitude 14oS) to northern NSW and east to New Caledonia. Some individuals forage further afield in waters from western Arnhem Land through Torres Strait to Fiji.

Indigenous Culture and Turtles

Aboriginal and Torres Strait Islander people have lived along the Great Barrier Reef (GBR) for many thousands of years. The GBR is part of their culture and spirituality, and provides food for their customary lifestyle. The activities associated with the

hunting of turtles and preparing the meat has great significance and is an expression of the continuance of long cultural traditions. Aboriginal and Torres Strait Islander communities seek to be involved in the management of turtle stocks and the protection of their habitats in the World Heritage Area.

Current Management Approach to Traditional Hunting

Within the GBR, hunting turtles is restricted to Aboriginal peoples and Torres Strait Islanders. Current zoning plans for the GBR Marine Park require that a permit be obtained for traditional hunting. With the first successful Native Title determinations (per Brennan J. *Mabo vs. Queensland* (no. 2) (1992) 175 CLR1 at 58.61) handed down by the courts, much uncertainty has developed as to who requires permits and how the current zoning provisions applied to Aboriginal and Torres Strait Islander people.

In response to the need to better inform traditional hunting permit decision makers, and concerns about the sustainability of the southern GBR green turtle stocks, a stochastic simulation model for the southern GBR green turtle stock was commissioned by the Queensland (Queensland Environmental Protection Agency) and the Commonwealth (Great Barrier Reef Marine Park Authority, Environment Australia) governments.

The purpose of the model was to:

- Assist managing agencies to learn more about the population dynamics of the sGBR green turtle stock;
- Identify gaps in critical knowledge;
- Identify the most critical parameters for monitoring & research
- Assist decision making for conservation management;
- Assist interested users of the GBRMP in understanding stock dynamics of the sGBR green turtle population;
- Teach long-term population dynamics;
- Assist traditional owners in making decisions about turtle management and hunting in the southern GBR; and
- Provide insights on population response to harvest & management strategies.

The purpose of the model was not to be used for making determinations of the number of sGBR green turtles to be hunted by individual traditional owner groups along the coast. Rather, traditional owner groups were encouraged to work together to determine how they would like to allocate hunting levels amongst themselves.

Methods

The development of the model and its validation can be found in Chaloupka (2002a) and Chaloupka (in prep). The model used real measured values for most parameters such as:

- Eggs/clutch = 115.2;
- Clutches/yr = 5.2;
- Remigration interval = 5.8;
- Growth rates, Site fidelity, Recruitment - Hatchlings, Benthic juveniles, Benthic immatures, Subadults, Adults;
- Pelagic juveniles – least information available.

The model included the natural variability present in all parameters and the mathematical modelling was developed in collaboration with biologists and the biometrician. Model outputs were tested against measured stock reference behaviours. Age classes defined in the model (Chaloupka 2002a) were categorised to represent a particular size class (curved carapace length, cm), using growth curves published by Limpus and Chaloupka (1997, Figure 3C) (Table 1). It was assumed that all turtles of a particular size class had matured to the corresponding ageclass, even though it is widely recognised that not all turtles mature to an ageclass at the same size. However, for the purposes of this modelling exercise this assumption was followed.

A proportion of each human-related mortality factor was assigned to a particular age-class of the sGBR turtle stock, based on published information about the levels of annual mortality, and the size-class distribution of animals attributed to a particular mortality factor. Human-related mortality factors and levels were those listed for the sGBR green turtle stock in the Draft National Recovery Plan for Marine Turtles in Australia (Environment Australia 1998, Table 8, p.50). A percentage of each these human-related mortality factors was assigned to a particular ageclass of the sGBR turtle stock based on published information, where available, as to the size class distribution of animals known to occur. The Queensland Marine Wildlife Stranding and Mortality database and other published information were invaluable in providing size-class distributions. Examples of the types of data include Indigenous harvest (Figure 1), Queensland Shark Control Program (Figure 2), boat strike (Figure 3), disease – fibropapillomas (Figure 4). Pelagic juveniles were excluded, as there was no information for them.

Model Input Values

Start year: 2000. Any year could be used to start the human-related mortality factors. The year 2000 was chosen because this was when permits stopped being granted for traditional hunting in the GBRMP (note the permit regime recommenced in late 2002). Duration: 50 years. This is a biologically relevant time frame for the sGBR green turtles, which on average, mature at around 47 years of age. It was assumed that after 50 years, all human-related mortality would cease and only natural mortality would occur in the population. This is an unrealistic assumption as there is little chance of all human-related mortality ceasing at that time, but for the purposes of this modelling exercise, this assumption was followed.

Table 1. Definitions of age classes used in the model simulations.

Ageclass	Definition (Chaloupka in prep)	Sizeclass (cm)
Hatchling	recently hatched turtle and escaping to sea from nesting beach	N/A
Neonate	post-hatchling but still less than 1 year old (0 ageclass)	N/A
Pelagic juvenile	pelagic phase ageclasses (1-6 yrs of age)	N/A
Benthic juvenile	initial benthic phase ageclasses (ca 5-15 yrs)	35.0-60.0
Benthic immature	second benthic phase ageclasses (ca 15-29 yrs of age)	60.1-90.0
Subadult	third benthic phase ageclasses (ca 30-45 yrs of age)	90.1-99.9
Adult	fourth benthic phase ageclasses (≥ 46 yrs, 100% mature)	≥ 100.0

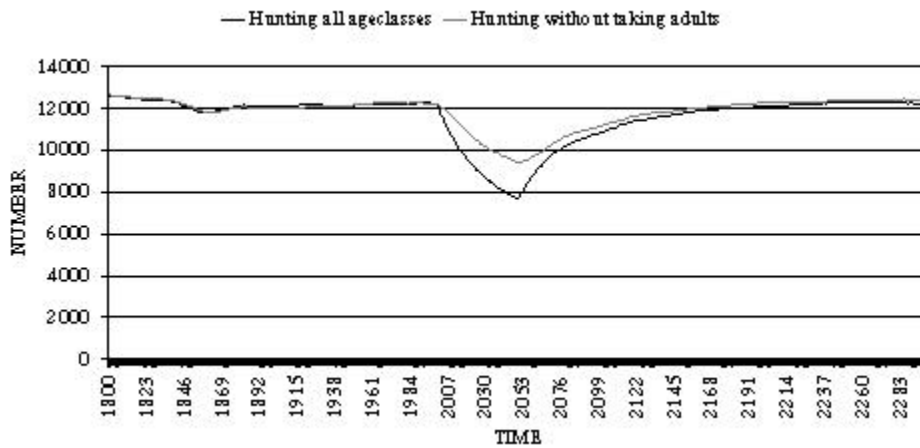


Figure 1 Size distribution of green turtles caught by Indigenous hunters (Smith 1987, and QPWS unpublished information).

Results

The adult female population declined by 36%, from ~12,000 to ~8,000, during the 50 years in which human-related mortality occurred (Figure 5). The adult population was able to recover to pre-mortality levels after 100-150 years, assuming there was no human-related mortality occurring during that time.

An option was considered whereby all turtles hunted by indigenous peoples were less than 100cm in CCL (e.g. only non-adults), but keeping the total number of turtles hunted the same. When the simulations were run and overlaid with the previous scenarios of the number of adults in the sGBR green turtle population (fewest, intermediate, most), there was a 40% reduction in the impact on the sGBR adult female population (Figure 5).

Discussion

A new framework for management of traditional hunting within the GBR is underway. The aim of these initiatives is to facilitate an active role for indigenous traditional owners in monitoring a sustainable level of take whilst maintaining their living maritime culture. These initiatives also propose to recognise that traditional owners have cultural authority over who is allowed to hunt in their sea country. Integral in these discussions is the need to ensure the sustainable use of green turtles.

Chaloupka (2002b) states that ‘extensive harvesting of either eggs or turtles is probably not a prudent management policy, if the long-term viability of the sGBR green sea turtle stock is the primary conservation objective’. Given this, some of the management options available include the following:

- Minimise the total number of turtles (all age-classes) killed by all human-related causes;
- Research the incidence of fibropapillomas in Moreton Bay;
- Make TEDs/BRDs mandatory in Eastern Queensland trawl fishery (2001);

- Minimise the number of adults killed;
- Implement 'Go Slow' campaigns to reduce boat strike impacts;
- Facilitate an active role for indigenous traditional owners in monitoring a sustainable level of take whilst maintaining their living maritime culture;
- Review Zoning Plans including options for traditional hunting;
- Encourage traditional owners to develop hunting management plans;
- Use modelling to test for likely outcomes; and
- Monitor ongoing key demographic parameters.

There is a need for a more accurate quantification of the levels of all sources of anthropogenic mortality to better inform simulation runs in the model. There is also a need to develop key demographic indicators that a population is declining so that management strategies can be evaluated more efficiently.

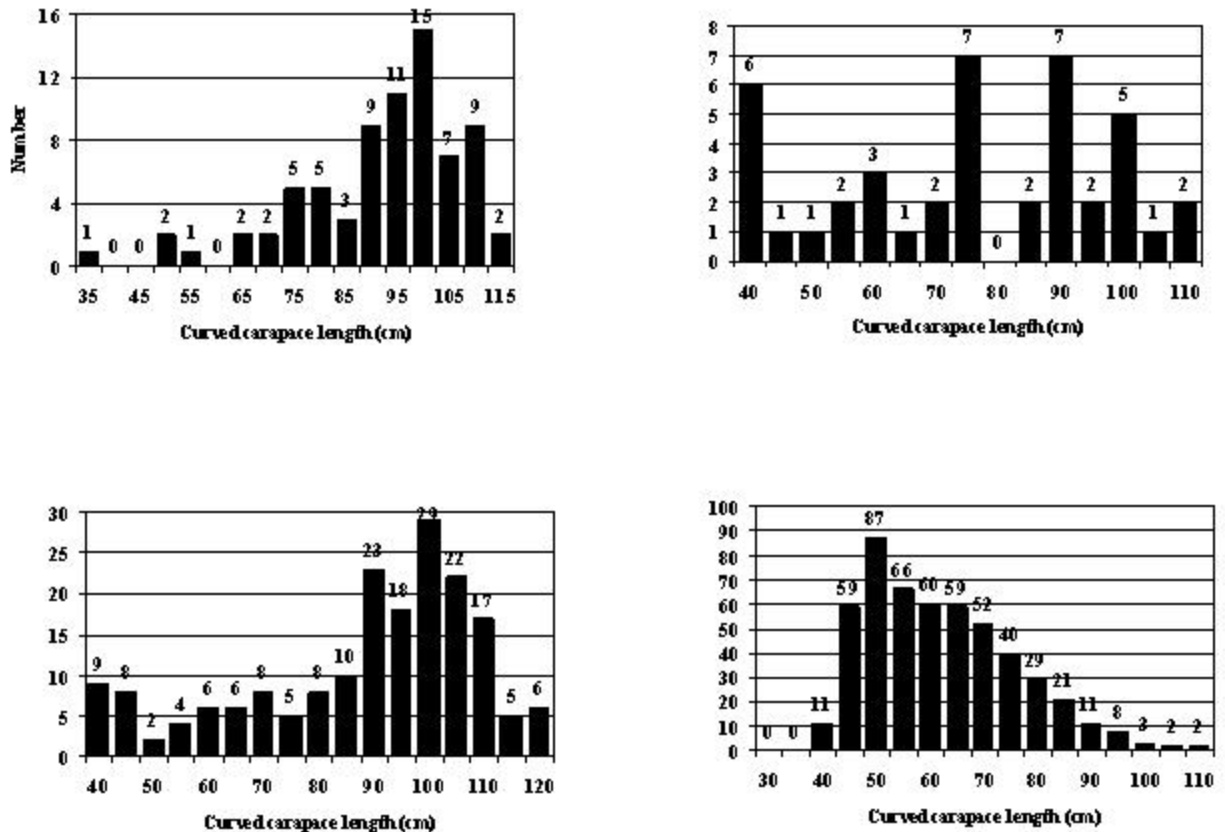


Figure 2. A. Size distribution of green turtles caught in the Queensland Shark Control Program (n=38), (QEPA Marine Turtle Tagging Database). B. Size distribution of green turtles struck by boats/propellers (n=186): QEPA Marine Wildlife Stranding and Mortality Database. C. Size distribution of green turtles recorded with fibropapillomas (n=510): QEPA Marine Turtle Capture Database. D. Number of female green turtles during the first simulation which included harvest of adult turtles (black line). Number of adults where hunting does not target adults (those animals with a CCL >100cm) (grey line).

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SEA TURTLE CONSERVATION PROGRAM IN BENIN: LOCAL COMMUNITIES PARTICIPATION

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Introduction

The Beninese government signed the Convention on Biological Diversity (CBD) and the Convention on Migratory Species (CMS) and actively implements its obligations. One of these obligations is the protection of all sea turtle species found in Benin.

Since 1998, the NGO "Musée Nature Tropicale" has been engaged in the conservation of sea turtles. Many activities developed since this time have motivated political authorities to elaborate a strategic action plan for the conservation of sea turtles. The development of this plan, which involves the contribution of local communities, is supported by the Benin Agency for Environment (ABE) and others local institutions.

Benin covers approximately 114 763 km² and is situated along the Gulf of Guinea. It is bordered to the west by Togo, to the north by Burkina Faso and Niger and to the east by Nigeria. The population is estimated at 6 million with a growth rate of 3.5 % per annum. The administrative capital is Porto-Novo (300,000 inhabitants), but the most important city is Cotonou, the economic capital, with approximately 850,000 residents. More than half of this population is under 20 years old. Benin is a poor, underdeveloped country. Some 60% to 70% of the population is illiterate. Wetland areas in the south of Benin represent the most important habitats of the country, and more than 60% of Benin's population lives in this area.

The Beninese coast stretches between 6° to 6°30N, and 1° to 2°44E over approximately 121 km between the Togolese border to the west and the Nigerian border to the east (Figure 1). The coast is sandy and of low elevation, covered by vast coconut plantations. It is interrupted in the west by the "Mouth of the King", the joint outlet of the Mono river and Aheme Lake, and by the Cotonou channel to the east.

The Northern stretch of the coast is made up of a series of interconnected lagoons and lakes: Lake Aheme, Ouidah lagoon, the Coastal lagoon, Grand-Popo lagoon, the Ancient lagoons, Cotonou lagoon, Lake Nokoué and Porto-Novo lagoon. Because of its sandy nature, all of the Beninese coast is inherently suitable for nesting turtles. Despite a low level of organic matter (0.5-1%) there is a diversity of coastal vegetation including coconut trees (*Coconuts nucifera*), filao (*Casuarina equisetifolia*) and occasional cactaceae (*Opuntia linguiformis*).

Objectives

The primary objective of our work is the sustainable conservation of sea turtles as well as the ecosystems upon which they depend in Benin, through a program that is a part of a regional strategy. Within this, our goal is to pursue sea turtle conservation against threats and captures within Ramsar sites 1017 and 1018, with the collaboration of local communities. The specific objectives are:

- Reinforcing of the national capacity for a better knowledge and conservation of sea turtles;
- Promotion of preservation initiatives for sea turtles, supported by the development of alternative income generating activities for the local communities whose livelihoods depend on these resources;
- Inducing the participation of the public at large and the making the local communities (Survival Committees) responsible for the preservation of migratory species;
- Setting-up a system for the valuation and sustainable management of sea turtle through eco-tourism;
- Setting-up of protected areas along the coast and on the high seas;

- Drawing up IEC (Information, Education and Communication) Program at the National level;
- Developing permanent monitoring studies on the migratory species; and
- Promoting regional and international co-operation for the protection of sea turtles.

Study Area

The following zones were covered in this study: Seme zone (from Krake beach to PK 10, 24 Km long); Cotonou zone (from Ambassadors zone to Togbin, 22,8 Km long); Ouidah zone (from Agbehonou beach to Agonsodji beach, 28,2 Km long); and Grand-Popo zone (from Houakpe beach to Hilla-Condji beach, 46 Km long).

Sea Turtle Species in Benin

Four species of sea turtles are known in Benin coast: the Olive ridley *Lepidochelys olivacea* (Eschscholtz, 1829), the leatherback *Dermochelys coriacea* (Vandelli, 1761), the green *Chelonia mydas* (Linné, 1758), and the hawksbill *Eretmochelys imbricata* (Linné, 1766). The two first nest on the Benin coast, while the two last are only caught by fishermen (Table 1).

Table 1: Species of marine turtles known in Benin

Common Name	Scientific Name	Local Names	Present in Benin	Nesting in Benin
Olive ridley	<i>Lepidochelys olivacea</i>	klo, eklo	Yes	Yes
Hawksbill	<i>Eretmochelys imbricata</i>	-	Yes	No
Green turtle	<i>Chelonia mydas</i>	klo, eklo	Yes	?
Loggerhead	<i>Caretta caretta</i>	-	?	No
Leatherback	<i>Dermochelys coriacea</i>	klo, hu agbossegbe	Yes	Yes

Threats to Sea Turtles in Benin

Sea turtles in Benin are caught in a spiral of massacres by the local communities thus in danger and measures need to be taken to protect them (Dossou-Bodjrenou et al., 2001). Among these threats, the main threats to the survival of the turtles and other marine resources in Benin include:

- bycatch - fishing with destructive machines and the less of nets at sea (traditional, trawlers);
- the collection of eggs and hatchlings;
- the capture of females on the beach by the coastal communities;
- the degradation of the vegetation along the coast because of increasing demographic pressure;
- houses and tourist infrastructure buildings on beaches, particularly along "Route des Pêches" after Fidjrossè;
- coastal erosion;
- plastic bags and the other household wastes on beaches;
- sand mining (Grand-Popo, Ouidah, Ekpè and Djèffa beach);
- organic pollution; and
- construction of the industrial free zone at Sèmè.

Others threats include the presence dogs, cats, crabs ghosts (*Ocypode quadrata*) and reptiles, all predators known on other beaches in the sub-region such as in Ghana. These predators are responsible for destroying nests and of killing hatchlings. A detailed scientific study on this subject would offer an appreciation of the impact of these natural predators on the survival of sea turtles on Beninese coast.

Alternatives activities for the local communities

Through the discussion with the Ecoguards at the different project sites, we collected many ideas about alternatives activities, which can bring economic success in those areas. All of the local Committee was interested in the mini-livestock projects especially the breeding of grasscutters. The activities, which are proposed by Ecoguards, after their trip to Ghana have been, analyses and are:

- Urban agriculture and ecotourism;
- Pigs and goat breeding;
- Fish breeding;
- Management of zoos and an eco-museum;
- Fish processing; and
- Management of telephone cabins.

Conclusions

This program has had considerable and quantifiable impact on the people of Benin in the sense that they now are much more aware of the need for protecting sea turtles. However, further reinforcing of national laws is necessary. The empowerment of the

local populations through a system of joint management will allow the long-term management of coastal resources. Regional cooperation is needed for the complete protection of sea turtles in the Atlantic Ocean and on the African coasts, and this must be included in all national plans based on the migratory status of the species in question.

Local participation has been acknowledged as a key to the success of sea turtle conservation program in Benin. Participation is being realized through the creation of sea turtle conservation committees and environmental youth-clubs in schools along the coast. With the support of local eco-guards, the Musée Nature Tropicale developed a monitoring program for the various species as well as for their nesting sites. Although it is still too early to cry victory, it already can be stated that sea turtles are much safer on the beaches of Benin.

Today, the national strategy and action plan for the conservation of the biological diversity in Benin takes into account the concerns for the protection by all the means of the migratory species among which are sea turtles. A National Action Plan and program for the conservation of sea turtles and other marine resources in Benin is being developed among stakeholders and takes into account the following:

- information sessions with the communities along the coast and schools, particularly the development of environmental clubs;
- integration of environmental issues in elementary school programs;
- development of monitoring and protection committees for sea turtles in all coastal villages;
- ongoing follow-up of sea turtle conservation issues;
- support for revenue-generating activities beneficial for the program;
- training in conservation and identification of sea turtles;
- scientific research;
- establishment of a database and information and education materials;
- the establishment of partnerships for exchanges of experiences on the conservation of turtles within the framework of a regional program of protection of the turtles of the Bay of Guinea.

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CURRENT SITUATION OF MARINE TURTLE CONSERVATION IN THE GAMBIA

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The Gambia is a small West African country lying at 15°N at equal distances from the Tropic of Cancer and the Equator. It is bordered on three sides by its much larger neighbour, Senegal, while the West side is bound by the Atlantic Ocean along 80 km of coastline. Four species of sea turtle have been recorded in the Gambia: Greens, hawksbills, leatherbacks and Olive ridleys. No evidence exists on the presence of the loggerhead. However, there is evidence of breeding for the green turtle in the Gambia.

Most of the fishing is artisanal, employing gill nets, hook and lines, traps and seine nets. These are operated either from pirogues (small local boat) or from the shore. There are also a number of large foreign vessels, licensed by the Gambia Government that trawl in deeper waters offshore. The green turtle appears to be the most common species in the Gambia as the majority of sightings, nests, recovered carapaces and strandings are from this species.

The potential for large numbers of breeding turtles is large, as 75% of the coastline is considered suitable for nesting, much of it fairly undeveloped.

USE OF POP-OFF SATELLITE TAGS TO STUDY THE POST-HOOKING SURVIVAL OF JUVENILE, OCEANIC LOGGERHEAD TURTLES IN THE NORTH ATLANTIC

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During September-October 2001, 19 pop-off satellite tags were deployed on loggerhead turtles captured in the North Atlantic to determine the feasibility of using this technology to estimate the post-hooking survival of oceanic turtles caught on pelagic longlines. Turtles lightly impacted (entangled, hooked externally, or lightly hooked in the mouth) were telemetered, as were greatly impacted turtles (swallowed hook); an additional 4 PAT tags were deployed as passive drifters in the area. All tags were programmed to pop-off by August, 2002. We review the attachment techniques, tag settings, and the results for both the tag performance and turtle movements and behavior.

THE EFFECTS OF SEA TURTLE RELOCATION TRAWLING DURING SELECTED COASTAL DREDGING PROJECTS

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All species of U.S. sea turtles are now endangered or threatened, and are so listed and protected under the Endangered Species Act (ESA) of 1973. The loggerhead (*Caretta caretta*), green (*Chelonia mydas*), Kemp's ridley (*Lepidochelys kempii*), hawksbill (*Eretmochelys imbricata*), and leatherback (*Dermochelys coriacea*) are the five species listed in the Eastern U.S. coastal waters of the Atlantic Ocean and the Gulf of Mexico.

The migratory patterns and populations of sea turtles are widely distributed throughout the world's oceans. Sea turtles generally migrate from northern climates to the warmer southern climates during the fall and winter (Dickerson et al, 1990), they are cold-blooded creatures and adapt to their warmer surroundings. Our coastal and open ocean environments are where much adult and sub adult sea turtle activity such as, breeding, nesting, foraging and resting typically occur.

By 1980, it was determined that hopper dredging was having a negative impact on sea turtle populations. In areas of Army Corp of Engineers (ACOE) dredging projects, sea turtles were being accidentally killed by equipment used to maintain depths in federally authorized navigation channels, inlets and waterways. The NMFS Southeast Region, as well as Jacksonville District and the Waterways Experiment Station of the ACOE were the first to take action to reduce the problem by assisting in the development of improved techniques and equipment modifications. Some of these improved techniques and equipment included:

1. Dredging "time windows". This suggests dredging projects should be scheduled for the colder months when turtles are less active.
2. Using turtle deflectors on the dragheads of hopper dredges. The draghead is the part of dredging equipment in contact with the channel bottom. The turtle deflector attachments function much the same as "cowcatchers" on railroad locomotives of the last century. As the draghead moves forward on the channel bottom, turtles that are encountered are pushed aside rather than being sucked under the draghead and into the intake pipe.
3. Employing NMFS-certified protected species observers aboard hopper dredges when operating within the special dates published for various dredging areas.
4. Conducting abundance/relocation trawling in dredging project areas. Abundance surveys are conducted prior to the commencement of dredging to generate an estimate of the turtle population to be encountered.

REMSA, Inc.

REMSA, Inc. applies the techniques previously developed by the ACOE in the conduct of turtle relocation trawling during dredging projects. REMSA also supports and trains Marine Endangered Species Observers (MESOs) who work closely with dredging contractors to monitor the impact on sea turtles and to achieve a successful balance between environmental requirements and dredging needs. MESOs are trained and certified in species identification and knowledge of state and federal laws and regulations pertaining to sea turtles and dredging. REMSA's relocation trawling program has quickly developed into one of the most successful in the country. Since September 2001, REMSA personnel have captured and relocated 114 sea turtles, allowing a total of only six takes by dredges working these projects after trawling was initiated.

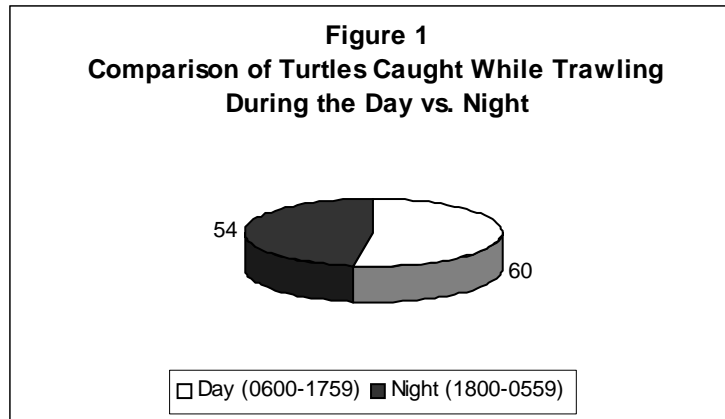
U.S. Army Corp of Engineers (ACOE)

ACOE is the Federal agency responsible for maintaining the depths of navigable channels. To accomplish this, the Corps employs a variety of dredges ranging from anchored cutterhead dredges used in inland channels to ocean-going hopper dredges which operate at a speed of two to three knots while dredging ocean bar and inlet channels. Specialists were put aboard ACOE hopper-dredge vessels in the early 1970's by National Marine Fisheries Service to observe the impact they were having upon sea turtles. The results led to the further monitoring of sea turtle species under the ESP Act of 1973. The NMFS and ACOE had a major issue to resolve with the understandings that if the dredging operation killed turtles, the Corps would have to produce a plan to modify their dredging equipment, operational procedures, and management practices in order to significantly reduce the number of sea turtle mortalities.

Observations of accidental sea turtle deaths by hopper dredges led to several actions. The first of which was the creation of turtle deflectors fitted to dragheads. To understand the effects of this technique, a turtle deflector model was attached to a scale model draghead and tested under laboratory conditions. Both with model studies at the ACOEs Waterways Experiment Station and during actual dredging operations, underwater video cameras were installed to observe its effectiveness in deflection of concrete mock turtles (USACE WES 1997). The deflectors proved promising. Accidental sea turtle deaths were reduced, but not enough, leading to continued experimentation with different dredge designs which have been used in key navigation channels during continuous, ongoing projects. Comparisons of dragheads alone cannot be validly used without evaluations of the methods and procedures used to operate each draghead. These procedures differ among ships and personnel (Dickerson et al, 1990). This has led ACOE managers to continue to rely on the described turtle relocation process.

Objective

The goal of the relocation trawling process is to capture and relocate as many turtles as possible to reduce or eliminate any accidental "takes" from dredging projects. In addition, REMSA wants to improve techniques to help prevent sea turtle losses. Fewer sea turtle deaths support population levels and turtle survival, and also avoid premature termination of the waterway channel dredging projects.



Methods / Problems of Trawling Efficiency

The first method is to trawl directly in front of the dredge. It is not necessarily the most effective and not always possible. The distance of the channel being dredged, the time it takes the dredge to acquire a load of material, and the dredge operating techniques all play important roles in determining the most successful method. The second method is to continuously trawl the area of the channel being dredged, staying in the vicinity of the dredge, but not directly in front of it. This allows the most “bottom time” and may be the most effective.

Today’s trawling methods and net design were all developed by the ACOE (Dickerson et al. 1995). Pre-trawling is done prior to all projects where turtles have been historically present, normally five days prior to the dredge. A stern or otter trawler is used to conduct trawling with 18.3 meter nets specially designed by Bill Fonferek. All segments are trawled with repetitive 25-42 minute tows. Trawling speed is a constant rate of approximately 2.5-3.0 knots. When the nets are hauled back, they are checked for turtles and any other endangered species. Once the pre-trawling is completed, the results are evaluated. If the trawl has indicated a significant sea turtle population, trawling is continued, with the trawler aggressively dragging its nets in the area of the working dredge whenever possible. This requires continuous radio contact between the two vessels. Methods are standard to all ACOE projects including data sheets, nets, trawling speed and direction to tide, length of segment, length of tow, and numbers of tows per segment.

Nets

The cost of a single, specially designed “sea turtle net” ranges from \$1,000 to \$1,400. This limits the number of nets available on any given project. A suggested minimum number of six nets are needed to conduct relocation trawling on most ACOE projects. Channels with excessive debris, mud, or rock can wreak havoc on nets. Once a supply of nets is exhausted, trawling operations are forced to stop and take time to make repairs or acquire replacements. Dredging too must be discontinued or turtle deaths are likely to occur if dredging continues (Figure 2).

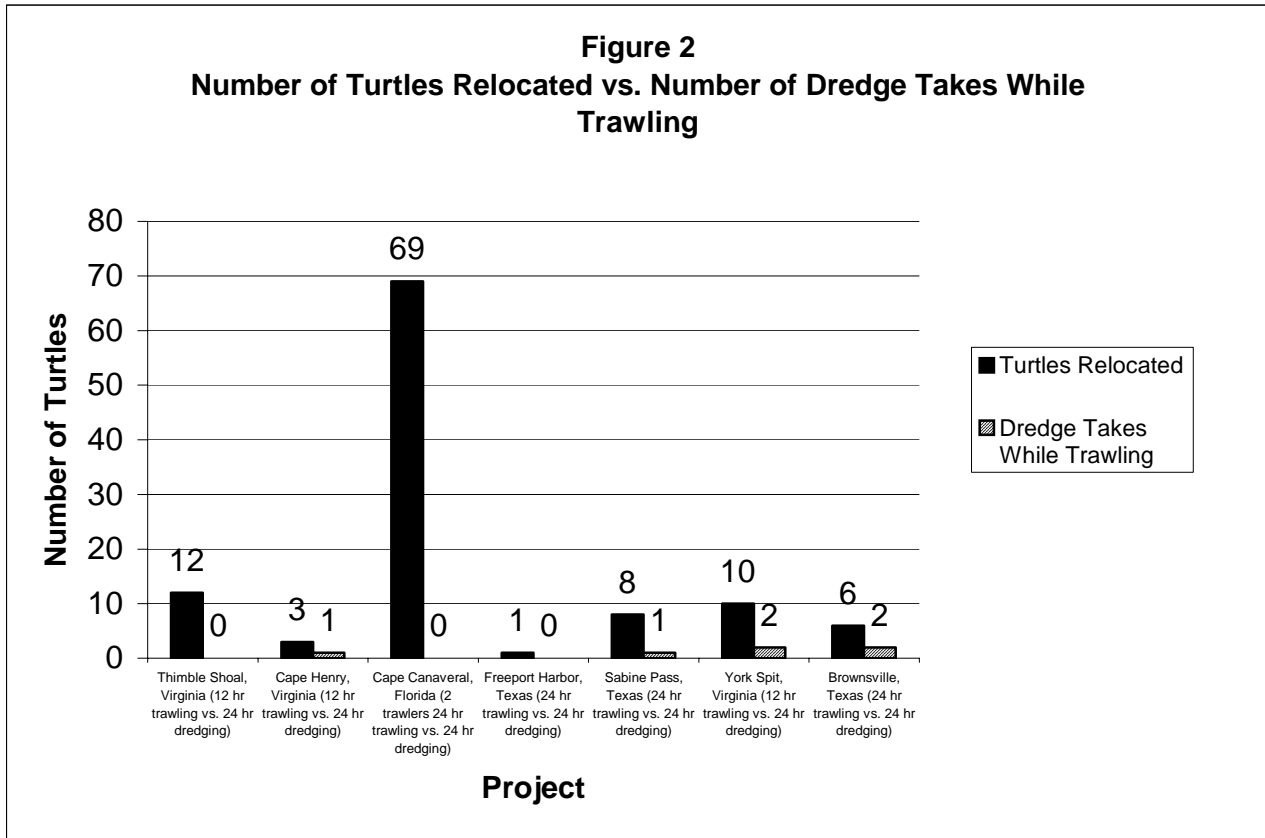
Once dredging begins, the bottom conditions of the channel can also create serious problems for trawling effectiveness. When hopper dredges work in muddy or clay filled channels, the dragheads create “grooves” which can damage and destroy trawling equipment and nets. The ideal operation for the trawler is to avoid “bogging down” or destroying equipment which in turn creates an ineffective operation. REMSA recently recommended increasing the thickness of the webbing used to decrease the possibility of destroying expensive nets.

Weather and Operations

Dredging and trawling inefficiency during rough seas often forces the operation to stop. Following a weather delay however, trawling should be reinitiated before dredging continues. A trawler should cover the specific project area where dredging is scheduled to resume, thus clearing the area of all turtles. Utilizing two trawlers simultaneously has been proven to be most effective. Both ACOE and the dredge companies should consider this for future projects, especially in areas where sea turtles are known to be abundant (ie: Cape Canaveral, Figure 2) and in open waterways.

Dangers of Trawling

The potential exists, although rare, that trawling may itself harm or even kill a turtle. The gear required to spread the nets underwater, the trawl doors or “boards”, are heavy and move through the water with tremendous force. Of the 114 turtles REMSA has relocated on various projects, one turtle (York Spit) is believed to have been killed by a direct blow from the trawling gear (door). This is an important factor the ACOE should consider when debating “when” to initiate trawling as take limits are being approached.



Results

Cape Canaveral, Florida, is a populated area where turtles are found in great numbers year-round. Because of concern for excessive turtle takes, hopper dredging was banned in the Cape Canaveral channel in 1992. An exception to the ban occurred in March 2002, when REMSA was assigned to trawl the Canaveral Entrance Channel during an emergency dredging maintenance project. The duration of the project was six continuous days, two trawlers working 24 hours a day, resulting in the successful relocation of 69 sea turtles, with no recaptures and no accidental turtle deaths (Figure 2). Specifics of each turtle captured during this project, as well as all trawling projects are well documented in the projects final report, which is submitted to both ACOE and NMFS.

Conclusion

Since 1980, significant modifications in dredging management and operational practices introduced by the ACOE have greatly reduced accidental deaths of threatened and endangered sea turtles. Most important improvements have been trawling relocation techniques, turtle behavior studies and draghead deflector designs. These practices have become and should continue to be an essential part of coastal and waterway ship channel dredging. REMSA strives to continue to contribute and be a part of this needed interagency partnership. With each project we seek to continue improving our methods, learning lessons from each project for the betterment of future trawling projects.

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MARINE TURTLES IN WEST AFRICA: THE ABIDJAN PROCESS

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In May 1999, CMS organized an international conference for the conservation of marine turtles of West Africa in Abidjan, Ivory Coast, with France, IUCN-France, and WWF. An agreement, known as the Memorandum of Abidjan, was proposed to the States in order to politically seal this decision of regional co-operation. In May 2002, at UNEP in Nairobi, the First Conference of the Memorandum of Abidjan took place and a regional conservation plan for marine turtles was developed. This conservation plan applies to all the countries ranging from the Straits of Gibraltar to the Cape of Good-Hope, including the islands of Macaronesia, Saint-Helena, Ascension, and the Spanish territory of Ceuta. To date, 17 States have signed the Memorandum, and several others, including European countries, are preparing to do so. This vast program, initiated by the CMS, is superimposed on the southeastern Atlantic region of the IUCN-MTSG.

We now call the process Programme Kudu, as Kudu is the vernacular name for marine turtles in several African languages. A regional office and a data base were created in Gabon, with assistance from the French Co-operation and the European program ECOFAC. The Kudu area is divided into 2 networks: PROTOMAC for Central Africa, and WAMER for West Africa. Numerous national projects are carried out by universities or NGOs. Conservation projects still remain to be organized in Mauritania and Angola. It is important that the Kudu Program and national projects are given continuity by long-term funding. If not, the regional Action Plan will only be a beautiful wish on paper.

REVIEW OF SEA TURTLE STATUS IN THE PORTLAND BIGHT, JAMAICA

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Four species of sea turtles nest on the beaches of Jamaica: hawksbill, loggerhead, leatherback and green turtles. Historically, sea turtles formed the basis of an important national fishery. This contributed to a decline in populations, which continued despite total protection by law in 1982.

Several attempts to survey turtles in Jamaica have employed a variety of methods, and produced large quantities of data most of which has never been analysed, or applied to conservation. We reviewed the available data to determine their usefulness for monitoring and managing sea turtles and their habitats in Portland Bight Protected Area. We identified severe limitations due to bad planning, lack of standardisation of methods, long gaps between surveys, incomplete data recording, inadequate analysis and problems with data storage. This meant that data sets could not be combined or compared. The data can be used to assess the relative importance of nesting areas and historical preferences but not to assess population status or nesting success or current nesting patterns.

The analysis indicates the relative importance of Portland Bight for sea turtle nesting and suggests where in Portland Bight new turtle conservation efforts might be most effective. The surveys showed that five of the fifteen small cays of the Portland Bight

Protected Area support a large proportion of Jamaica's total nesting population. In 2001, these five cays contained 71% of the nests in Portland Bight.

Based on these findings, recommendations for cost-effective methods for future monitoring and management of the sea turtle populations are made.

MARINE TURTLE EXPLOITATION AT ASCENSION ISLAND, SOUTH ATLANTIC *

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Ascension Island, (7°57S 14°22W) is one of the largest rookeries for the green turtle (*Chelonia mydas*) in the Atlantic and has been subject to varying levels of exploitation over the last 300 years. To contribute to the special session, "Measuring use and its impacts: beyond the poaching paradigm" we review the magnitude of past episodes of exploitation of green turtles at Ascension Island as recorded in historical archives. In concert, using results of detailed monitoring efforts over the last three decades, we look at how the status of this population appears to have responded to changes in patterns of use.

TEN YEARS OF SEA TURTLE COURSES IN VENEZUELA AND THEIR IMPACT IN THE CAPACITY BUILDING FOR RESEARCH AND CONSERVATION

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Introduction

After having participated in a Sea Turtle Course organized by the Caribbean Conservation Corporation in Tortuguero (Costa Rica, 1990), it was thought that this kind of training could be a good strategy to build the capacity for the sea turtle research and conservation in Venezuela. With this goal, a short course for Park rangers of the National Parks Service (DGSPN-INPARQUES) was held at Laguna de Tacarigua National Park in 1991. Since 1992, the course has been more a formal "Sea Turtle Biology and Conservation Course" and we have continued running the course each year to date, along with additional courses, seminars and workshop conducted by ourselves or in cooperation with other organizations in Venezuela and Latin America. This presentation focuses on the "Sea Turtle Biology and Conservation" courses and a workshop organized to provide insights on some of the course topics.

Our main goal has been to promote the survival of sea turtles in Venezuela by imparting scientific information, promoting national capacity-building regarding the conservation of sea turtles, and offering training for a new generation of competitive scientists and informed policy-makers.

Methods

Course Structure - Initially the "Sea Turtle Biology and Conservation" courses lasted 5 days, but the last five courses have lasted seven days. In 2001, the course was taught in Spanish and English. The courses include theoretical, practical (field) and video sessions for a total of 56 hours of training. The theoretical sessions comprise biology and ecology, monitoring techniques, conservation strategies, threats and solutions, sea turtle diseases and necropsies, current projects in Venezuela, national and international laws, and current projects in Range States, economic value of the sea turtles, raising funds and networking. In the taxonomic sessions the participants work with preserved materials (carapaces, skulls and other bones, hatchlings) and when available, dissections are performed. The Field sessions include diurnal and nocturnal beach surveys in order to evaluate sea turtle tracks and nests, the characteristics of nesting activities, and field work methods. The video sessions show advanced research techniques and foreign conservation programs (Brazilian "TAMAR Project", Costa Rican "Tortuguero Project" and "ANAI project", TEDs, hawksbill turtle use in Japan, fibropapillomas disease, feeding by hawksbill turtles, sea turtle necropsies, sea turtle work in Venezuela, and others).

In the first training courses, we did not conduct exams, but adopted these starting in the 1994. The “Sea Turtle Biology and Conservation” courses requirements include several reports (e.g., identification and measurement sessions, day surveys) and a final exam on which participants must get a score of 80 from 100 points to pass.

Results and Discussion

Numbers of Participants and Countries of Origin - We have had more than 200 participants and these have been mainly from Venezuela. However, since 1996, we have had an increase in foreign participants from Argentina, Uruguay, Peru, Ecuador, Colombia, Guatemala, Mexico, Cuba, Dominican Republic, USA, France, Italy, The Netherlands, Switzerland, and Equatorial Guinea.

Profile and Expectation of the Participants - The majority of the participants have been undergraduates or professionals in the following fields: biology, marine biology, oceanography and veterinary medicine. We have also had personnel from the National Guard, journalists, biology and economics professors, and forest engineers. The undergraduates usually listed marine environments and fauna and conservation as key fields of interest, while professionals usually have taken the course because it is close relation to their functions (protection, administration, others) or because sea turtles are a part of their projects. Very few participants indicated that their interest was mainly focused on sea turtles, though it is not possible to establish what number because old registration materials are no longer available. However, a significant number have been involved in some kind of activity in sea turtle research or conservation. In general, the participants have expressed satisfaction with the course, the quality of the instructors and of the materials received.

Foreign Instructors – The Venezuelan instructors have been scientists or personnel from GOs and NGOs related to sea turtle research or conservation. Guest instructors have been sea turtle scientists and conservationists from the Wider Caribbean region and have promoted an important exchange of training and research opportunities for participants. We have had instructors from Colombia, Brazil, Costa Rica, Mexico, Puerto Rico and Cuba.

Support - The courses have been supported through the years by governmental as well non-governmental organizations. The contributions have been in cash or “in kind” (lodging, food, coffee-breaks, photocopying, materials, classrooms, ground and aerial transportation, important discounts in the services, between others).

Focus - The main focus has been to create capacity for the work on the nesting beaches, although in 1998 we invited a foreign specialist in foraging areas research. After 10 years of the standard courses, some specific topics are beginning to be developed and presented in workshops. In March 2003, we organized with the support of other NGOs, a workshop addressed to standardize the methods of work in the nesting beaches at the beginning of the nesting season. This is currently being produced as a training manual. It is planned that future courses may focus more on in-water research and we are evaluating some changes in the course contents, in order to include more discussion sessions, for example.

Materials - The participants receive a package of materials on sea turtles. This package includes the most current sea turtle manuals (e.g. the MTSG Techniques Manual), scientific papers, and chapters of selected books (as “Biology and Conservation of Sea Turtles” and “Biology of Sea Turtles”). In addition, they receive stickers, leaflets, and other environmental education materials (manuals, brochures, posters, coloring books) when are available.

Course Impact - The Venezuelan “Sea Turtle Biology and Conservation” course has promoted sea turtle research and conservation efforts in Venezuela. Described below some of the principal achievements in Venezuela:

- Several course graduates have provided different levels of input to the Sea Turtle Working Group of Venezuela (GTTM).
- A poster about sea turtles was printed by the Ministry of the Environment and Natural Resources (MARN) and in 1995, the Nueva Esparta Division of MARN printed a sea turtle calendar.
- Law regulations in nesting beaches have been produced on Margarita Island (Nueva Esparta State).
- A regional sea turtle group was created in Margarita Island.
- Diego Amorochó began to organize similar courses in Colombia, after being Guest Instructor in 1993.
- Several scientists in the region have solicited the course content for similar activities in Costa Rica, Barbados, Suriname and others.
- Several Venezuelans have participated in different sea turtle projects in Venezuela at Aves Island Wildlife Refuge, Miranda and Nueva Esparta States and in addition, several of them have participated in projects or training activities in Costa Rica, Mexico, French Guiana, Puerto Rico and Bermuda.
- Graduates of the courses in 1997 and 1999 have participated in foreign projects in Puerto Rico, Mexico and Costa Rica. After obtaining their biology degrees they have been involved in the “Sea Turtle Conservation and Research Project” executed by WIDECAS-T-CICTMAR since 2000 and 2003.
- Between 2000 and 2002, five Venezuelan course graduates finished their thesis about sea turtles. One more student is writing his thesis and will present it during 2003.

- A participant of the 2002 course was one of the organizers of a course including topics about sea turtles in Venezuela and sea turtle diseases and necropsies, with the participation of Dr. Thierry Work (NWC-USGS).

Conclusions

- The “Sea Turtle Biology and Conservation” courses held in Venezuela since 1992 have increased the in-country capacity for the sea turtle research and conservation.
- That this kind of training provides a basis of technical capacity and networking enough strong to promote the efforts toward the recovery of the sea turtles.

Acknowledgements

The “Sea Turtle Biology and Conservation” courses have received extraordinary input from Dr. Karen L. Eckert (WIDECAST, Wider Caribbean Sea Turtle Conservation Network). Since 1992 she has been involved providing recommendations, contacts and raising funds in order to guarantee their organization each year.

Training course sponsors have included Universidad de Oriente, Universidad del Zulia, Universidad Simón Bolívar, Universidad Central de Venezuela, Fauna General Direction-Ministry of the Environment and Natural Resources, National Parks Institute (DGSPN-INPARQUES), Fisheries Service (currently National Institute of Fisheries and Aquaculture, INAPESCA), the Wider Caribbean Sea Turtle Conservation Network (WIDECAST), Conservation International (CI), the United States Fish and Wildlife Service (USFWS), the BP Conservation Programme, the Columbus Zoo (USA), the Tulsa Zoo (USA), the BP Conservation Programme, the Australian Embassy, the New Zealand Embassy, The Rufford Foundation, National Marine Fisheries Service (NMFS), Fundacion Thomas Merle, Fundacion Proyecto Paria, Corpomedina, ProVita, ProMargarita, EDIMAR-FLASA, and Avior, among others.

ESTABLISHING A ‘LEARNING NETWORK’ FOR COMMUNITY-BASED MARINE TURTLE MANAGEMENT AND CONSERVATION

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Practitioners of community-based sea turtle management and conservation have suggested the creation of a ‘learning network’ that could help promote learning and capacity building within communities and projects that are actively engaged (or hope to engage) in the management of sea turtles. Such a learning network would support the development of skills, best practices, and capacity related to data collection, project monitoring, evaluation, and communication elements that seem crucially important and could be improved among many existing and nascent turtle projects. In collaboration with turtle researchers, conservation practitioners and existing projects and networks, such an association of projects will support the collection and exchange of data, as many networks do, while promoting project evaluation and adaptive management principles to effectively learn how to do conservation better over time, as occurred in the Biodiversity Conservation Network (www.bcnet.org) and is occurring in the Locally Managed Marine Area Network (www.lmmanetwork.org). This paper will focus on the development of such a learning network. Preliminary discussions have occurred over the previous year with prominent sea turtle researchers, coordinators, and practitioners concerning the creation and value of such a network, potential important elements and criteria involved, and supportive activities that could be undertaken. Included is a discussion of progress to date and next-steps planned for the future. A summary of results of meetings and key ideas among all interested groups are presented and discussed.

**A PROPOSED MANAGEMENT PROGRAM FOR MARINE TURTLE POPULATION IN LIBYAN ARAB
JAMAHIRIYA ***

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Introduction

Three species of sea turtles are recorded living in Libyan waters: Loggerheads *Caretta caretta*, Greens *Chelonia mydas* and Leatherbacks *Dermochyles coriacea*. The last two species have only been found feeding and passing through Libyan waters, while the first *Caretta caretta* has been recorded nesting on many beaches of the country, especially after the discovery of large population nesting activity in late 1990's. The present status of sea turtles in the Mediterranean as well in Libya as endangered species makes it necessary to develop a management program to preserve this population and conserve their habitats from various threats. This paper presents some highlights of this management prospective in a form of an Action Plan, as well as summarizing available knowledge on sea turtles in Libya.

Program Outline

This program is based on six main actions:

1. Developing and enforcing existing regulations - Existing legislation that concerns the conservation of marine turtles are in urgent need of revision and development. The only direct legal text in this regard is the Decree of the Secretariat of Agriculture No.453/1993 concerning banning of hunting and/or selling turtles and tortoises and their eggs or other products. This decree is insufficient as a protection and legal tool, but it could be used for developing a new comprehensive law concerning turtles and other endangered animal species.
2. Establishment of a national management and research program - There is an urgent need to establish a special program for marine turtles aimed at setting-up national strategy for conservation of marine turtles; building-up national capacity to execute the fieldwork; declaring some nesting sites as specially protected areas (SPA) for marine turtles, and developing the needed regulations and the management plans for these sites (all national relevant institutes and NGO's should follow participatory approach in planning and implementing this program), and allocation technical and financial support on national, regional and international levels.
3. Establishment of marine turtles protected areas - Past surveys have indicated the presence of high nesting activity on some beaches, and high depredation by carnivores, and the following are proposed as protected areas: The Eastern beach of Ain Al-Ghazala, Abualfrais, Kouf National Park (KNP), Shut El Badin, East and West Sirte, and the Northern coast of Farwa Island.
4. Promoting Education and Capacity-building - The development of qualified personnel to work on turtle research and conservation is one of the key elements for success in this field. Special training sessions should be designed and conducted, in collaboration with EGA, MBRC with help of RAC/SPA, and dedicated for capacity building of selected personnel, which emphasize education and communication with the fishing community.
5. Information and Public awareness program – This includes producing leaflets, posters, and video films as an information dissemination activity of EGA, MBRC and NGO's, and educating fishermen by organizing meetings, discussions and training sessions with fishermen, fishery officers of Shabiyate (municipalities), fishing companies and cooperatives, fish market officers and civil guards.
6. Strengthening regional and international cooperation – Contacts with regional organizations working in turtle research and conservation should be continued and strengthened.

CONSERVATION STRATEGIES FOR LEATHERBACK TURTLE NESTING POPULATIONS ON THE NORTH COAST OF BIRDHEAD PENINSULA, WEST PAPUA, INDONESIA *

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The north Vogelkop coast of Papua (Indonesia) is one of the world's major nesting areas for leatherback turtles. Given the drastic declines of nesting populations globally, this Indonesian rookery is among the last remaining large leatherback population in Indo-Pacific (recent WWF's estimation is 1,500-2,000 annually).

WWF Indonesia (Sahul Bioregional program) has been involved for more than a decade in developing and implementing conservation actions in Jamursba Medi Beach where the largest nesting density occurs. Preliminary work has involved intensive population surveys in 1984-1985 (by Bathis Bhaskar) and was followed by a conservation project, including intensive beach patrol (conducted by local communities) in close collaboration with the Nature Conservation Agency, Sorong in 1993.

The existing data compels the argument that there has been a population decline over the years, especially during the mid-1980s to mid 1990s. In addition, several critical management issues are identified such as :

- Feral Depredation
- Nest Loss due to seasonal beach erosion and tidal inundation
- Hatching Failure/ Low Hatching Success
- Incidental Take by Fisheries

This presentation contains conservation achievements, lessons learned, current socio-political context and future strategies for sustainable conservation actions in the region, including expanding conservation action to the adjacent nesting habitats. Understanding the biological and ecological requirements of the species and its habitat becomes a priority especially to determine the best management measures.

COMMUNITY PARTICIPATION TOWARD THE ESTABLISHMENT OF A COMMUNITY-BASED MARINE TURTLE INFORMATION CENTRE ON THE SOUTH COAST OF TASIKMALAYA, WEST JAVA, INDONESIA

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There are two areas in West Java, which have important marine turtle nesting beaches, Pangumbahan beach in Sindangkerta and Sukabumi beach in Cipatujah, Tasikmalaya. A concessionaire has had exclusive rights to harvest eggs on Pangumbahan beach since the 1980s, whilst nesting beaches in Tasikmalaya are managed by the local authorities of the Fishery and Forestry Departments in cooperation with the local community. The south coast is 43 km long from west to east, and is used by four species of marine turtles. Other than green turtle, the area is also a nesting ground for leatherbacks (*Dermodochelys coriacea*), hawksbills (*Eretmodochelys imbricata*), and olive ridleys (*Lepidochelys olivacea*). These species are protected by law in Indonesia. Tasikmalayan already has a good understanding of the existence of marine turtles along the south coast of Tasikmalaya, based on a workshop conducted in October 2001 by ALAMI Foundation and supported by The Whitley Laing Foundation - UK (through the Rufford Small Grants 2001). This workshop identified that community needs included a better awareness and understanding on the conservation and management of marine turtles in their villages and beaches. ALAMI has helped building the capacity of local communities for the establishment of a community-based information centre for marine turtle conservation program, and the communities, with the support of local NGOs, have sustainably used marine turtles as a tourism attraction for years. Based on this, the southern coast of Tasikmalaya could become a successful model for community-based marine turtle and habitat management.

WORKING TOWARD ALTERNATIVES TO THE COMMERCIAL CONCESSION OF GREEN TURTLE EGGS IN PANGUMBAHAN BEACH SUKABUMI, WEST JAVA, INDONESIA *

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In January 1999, the Indonesian Government issued regulation (Peraturan Pemerintah/PP) No. 7/1999 concerning plant and animal preservation. The green turtle (of six species existed in Indonesian waters) was finally protected by this regulation. All types of commercial utilization are prohibited, including egg collection for commercial purposes. However, in Indonesia regulations related to marine turtle conservation and management outside protected areas are not clearly defined. In addition, with more autonomy at district level (with the issuance of Law (UU) No. 22/1999 and Government Regulation (PP) No. 25/2000), marine turtles in Indonesia are facing a different-type of challenge – a political one. District areas have greater authority over coastal and marine area management within its jurisdiction than does the central government. Another challenge is that they are of low priority and there is an uneven proportion of community participation in the management of local resources.

In August 1999, WWF Indonesia Wallacea Bioregion Program conducted a workshop in Bali. One important recommendation was a campaign program for marine turtles in West Java (with a focus on the green turtle). The campaign was aimed at the creation of multi-stakeholder management of beaches outside protected areas and the reduction of green turtles egg consumption in West Java.

From there, in October 2000, ALAMI arranged a workshop in Cimande – West Java. The workshop gathered marine turtle related stakeholders from West Java, and the results were two management strategies:

1. Community-based marine turtle conservation and management in Cipatujah, Tasikmalaya, West Java.
2. Private sector-based marine turtle conservation and management in Sukabumi, West Java.

The first goal of this process was sustainable utilization of green turtles eggs in Pangumbahan, while the second was to increase awareness and capacity of the key stakeholders on sustainable marine turtle management. The key stakeholders are local district authorities and the turtle egg concessionaires.

Pangumbahan Beach is located in West Java, the same province as the south coast of Tasikmalaya, but in a different district, and can be reached from Jakarta by a five-hour drive. The beach is 2.3 km long, and up to 500m wide from the highest tide line. Pangumbahan has been known as one of main nesting beaches for green turtles in Indonesia. A local businessman has been contracted to collect eggs from Pangumbahan since 1980. In spite of some attempts at a quota system, close seasons, hatchling releases, habitat protection and rehabilitation, and community participation, the number of marine turtles has decreased sharply (possibly up to 70% or more) over the past decades, when up to 100% of the eggs have been collected. The exclusive management and lack of transparency have narrowed the chances of obtaining long-term reliable data on green turtle population dynamics in Pangumbahan. Eggs production data are biased as they are derived only from the Concessionaire's notes. Positive aspects of this management are the need to maintain undisturbed nesting environments (not necessarily undisturbed an nesting process); 100% protection of nesting females and the requirement of the concessionaire to purchase turtles trapped in fishing nets from the fishermen, and to release these back to nature.

In 2002, the contract was renewed for another 15 years. Marine turtle enthusiasts in Indonesia have been greatly concerned over the Pangumbahan turtle management practices in the past, and now, with the PP issuance, where there should be no egg concessions, the concern has reached a critical stage. However, with more autonomy at the district level, and justification of a need for local revenue to promote development, the Sukabumi district authorized the new 15-year contract (with recommendations from its Environmental Body service). The lack of human resources and funding have made it difficult for the district authority to supervise and monitor the implementation of the new contract, and there is absolutely no law enforcement on egg collection in Pangumbahan. The new contract also lacks of control mechanism and is still exclusive. It will be devastating for the genetically distinct green turtles in the area if new alternatives are not introduced and applied by the key stakeholders soon.

The methods used to introduce alternatives resulted from the 2000 Cimande Workshop included a Peripheral Strategy and a Core Strategy. The peripheral strategy contains actions that directly targeted the general public in Sukabumi and adjacent cities (including Jakarta). Indirect targets were the key stakeholders. The information and results of actions in the Peripheral Strategy were distributed to related stakeholders, including the key stakeholders. Whilst the Core strategy (which is through direct contact with the two key stakeholders), are in the form of collaboration in conservation and education program. The core strategy is currently being implemented.

The following are activities conducted during the process of developing alternatives:

Education: Conservation education was conducted in April 2001 in the form of a Drawing Contest for Elementary school children in Sukabumi city supported by WWF Indonesia Wallacea Bioregion Program, and the Rio Tinto Indonesia Foundation. The activity prompted the Environmental Body of Sukabumi District to carry out similar activities, and they requested assistance from the ALAMI Foundation for materials and technical assistance. While ALAMI was never really involved when the drawing took place, the approach made by the Environmental Body was a positive indication that the local district authority was paying attention to actions developed in the peripheral strategy.

Chain of Custody of Turtle Eggs: This took place between March 2001 – 2002 and targeted Pangumbahan Beach, Sukabumi, Jakarta, and Bogor (a city between Sukabumi and Jakarta). The findings indicated beaches in western Sukabumi (including Pangumbahan Beach) were the main source of eggs, and the price of one egg was Rp. 2500 – Rp. 3000 (USD 25 cents).

Public Awareness: A program was conducted in December 2002 and included the regular publication of a spot called ‘turtles eggs’ (with a main message to stop marine turtles egg consumption), talk shows with various topics (from general information about marine turtles, children’s participation in marine turtle conservation education programs as shown in the pictures, to Muslim-related environmental and marine turtle issues). The talk shows took place on private radio (in Sukabumi city) and state Radio (Radio Republik Indonesia) in Bogor. Response from the public was positive, in terms of their eagerness to know why marine turtles were protected, and why eggs were not for consumption anymore. This activity was coincident with the Muslim holy celebration of Ied-Al-Fitr. ALAMI recorded Ied-Al-Fitr greetings by various stakeholders, including the Environmental Body in Sukabumi District and added an egg conservation message. We are continuing the radio talk show programs.

These three activities were the preconditioning activities as part of the Peripheral Strategy. Public Awareness was the essential entry point for the next activity, the signing of Memorandum of Agreement for conducting marine turtle conservation education programs in Sukabumi District. This last activity is part of the Core Strategy. In January 2003, the Environmental Body service of Sukabumi District agreed to sign a Memorandum of Agreement with ALAMI Foundation for a collaborative programme of public awareness and a conservation education program in the Sukabumi district. A positive outcome of this Agreement was an offer by the concessionaire to ALAMI Foundation in mid-February, whereby they would like to have a Memorandum of Agreement also for conservation education programs in Pangumbahan Beach. The offer is being carefully considered.

Finally, we plan to alternatives to the local key stakeholders. With the assistance of WWF Indonesia Wallacea Bioregion Program, an Adopt-a-Nest Program is planned. Ecotourism will also be introduced to the Concessionaire, and we will conduct school visits to the nesting beach. Research is badly needed to establish a basis for good management by the private concessionaire. These alternatives were outcomes of the Workshop in Cimande 2000. The idea of green turtle research center in Java (established in Pangumbahan Beach) was another idea from the process, which we see as a good opportunity to replace the egg concession.

The approaches we are using may appear too slow while egg collections in Pangumbahan continue rapidly. However, we also recognize the rules of the game ALAMI or other concerned parties must follow to be able to stay in the “circle”, or the door to enter the “the circle” would close for good. The decentralization system gives more power to the district authority in making policies, including the natural resources management. We hope that by approaching the local key stakeholders, the results would be more effective in the long run. There are strengths and weaknesses on how and what we have been doing to replace the egg concession in Pangumbahan, and we look forward to getting input, ideas or lessons learned from other places with similar cases.

Acknowledgements

The Western Pacific Fishery Council and the 2003 Symposium Organizer for the travel grant WWF Indonesia Wallacea Bioregion Program, friends and volunteers at ALAMI Foundation for the good teamwork. “Leave my eggs hatch in the wild freely”

THE CHALLENGES FOR SEA TURTLE CONSERVATION: LESSONS FROM THE DERAWAN ISLANDS-INDONESIA

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Background

The Derawan islands in East Kalimantan are one of the marine biodiversity hotspots, particularly regarding their complex ecosystems, high diversity of corals and coral reef species. A survey carried out by the Indonesian Centre of Science in 1994 identified 347 species of coral reef fishes, 222 species of mollusk, 7 species of sea grass, and a number of protected and rare species including the green turtle (*Chelonia mydas*), hawksbill turtle (*Eretmochelys imbricata*), dugong (*Dugong dugon*), Napoleon wrasse (*Cheilinus undulatus*), manta ray (*Manta birostris*), giant clam (*Tridacna* sp.), and coconut crab (*Birgus latro*). The condition of the reefs is of high regional importance, since they represent the only extensive reef system along the coastline of East-Kalimantan, and have been classified by IUCN and WWF as areas of global ecological importance.

There are seven small uninhabited islands harbouring the heavily exploited, but largest green turtle nesting population in Southeast Asia. As a migrating species, turtles nesting on the Derawan islands are found on feeding grounds in Malaysia and the Philippines. Sangalaki island is the major nesting site of this green turtles rookery. Turtles nest all year round, but the peak nesting period is between August and October. A conservative calculation estimates that there are around 16,000 - 20,000 nests per year, laid by 4,000 to 5,000 female turtles. This area is also a feeding ground for hawksbill turtles.

The History of Green Turtle Exploitation

Turtle eggs from the Derawan Islands have been exploited for centuries. Between 1900-1945, a closed season system was applied, where turtle eggs were collected every two years. During 1950-2000, the local government gave concession rights for turtle eggs collection through an annual auction. In the 1970s, a local government decree was stipulated, regulating that 10% of the turtle eggs collected should be incubated, and the resulting hatchlings should be reared up to six months before being released into freedom to maintain the nesting population. Incentives were provided for local people that reared and released the hatchlings. Despite the good intentions, there was inadequate supervision provided, lack of knowledge of proper handling of the turtle eggs, and the use of giant clam meat to feed the hatchlings.

According to the data from the Berau District Fisheries Agency, during 1985-1990 period, on average some 2.1 millions turtle eggs were collected per year. In 1998, 1.7 millions eggs, 1999, 2.7 millions eggs, and in 2000, 1.5 millions eggs. Despite the increase in 2000, the data indicate a general declining number of turtle eggs collected. The pressures to the survival of the turtle population are also coming from the hunting of green turtles for the meat trade and the hawksbill turtle for the scutes trade, and habitat destruction from cyanide and blast fishing.

Gradual Cessation Initiative

In 1999, the green turtle finally was protected under the Government Regulation No. 7/1999, but implementing this regulation was difficult. The auctioning of the rights to collect turtle eggs has provided a significant income for the Berau District for the last 50 years and it was the beginning of the local autonomy era (in the year of 2000, the auction value was \$110,000). Local government perceived that conservation was mostly the task of NGOs and the central government, and unless all the nesting islands could be guarded, full protection of the islands from turtle egg collection could not be put in place. After intensive dialogues among stakeholders, it was agreed that a gradual cessation was a sensible solution.

In 2001, 20% of turtle eggs in Sangalaki island were conserved by NGOs. In 2002, Sangalaki and Derawan islands were fully excluded from egg collection, and accounted for 40% of the total nests in the area. It is still in question whether in 2003 full protection can be put in place. The local legislative body perceives that the conservation efforts fail, since the turtles are still hunted, their eggs are still poached, and no positive results can be seen from the existing conservation efforts. Also, the common opinion that it is still more successful to have 10% eggs to be reared and released after a few months rather than seeing turtles laying eggs and destroying earlier nests and watching newly-hatched turtles becoming prey to birds, fish, and lizards.

Conservation Efforts

Turtle conservation needs to be part of a bigger framework of the area's management. Thus, developing a collaborative integrated management regime is also important. Since 2000, facilitation has started for the development of multi stakeholder committee, the integration of programs from various stakeholders, and to help the Department of Marine Affairs & Fisheries in developing turtle management guidelines for Berau.

The results so far are the phasing out of turtle egg exploitation, a co-funded turtle monitoring station has been established (funds from Turtle Foundation, Germany, KEHATI, the German Embassy, and WWF), and collaboration and integration among stakeholders has slowly been formed. The committee development is progressing, but slowly.

KEHATI facilitated a volunteer program for six months in 2001. From the data collected during May-October, during which 230 females were tagged and 18,192 eggs from 259 nests have been excluded from exploitation and naturally hatched. On average, there were 85 eggs per nest. The average size of nesting females was 89-90 cm SCL and 95-96 cm CCL. Hatching success rates from 46 *in situ* nests was 72.1% and from 89 hatchery nests was 85.5%. Incubation periods averaged 49 days. KEHATI has developed a Turtle Monitoring Station, and appointed a station manager for six months to initiate the management of the station, build a database of turtle records, and develop information displays. It is expected that in the future this station can become an information centre, producing regular information (newsletter) and supporting the establishment of trust fund for turtle conservation in Berau. There has also been a conservation campaign in the form of translation and distribution of films on case studies on community turtle conservation, radio programs, for District and Village Information Centres.

At the moment, there are thoughts to re-open the rearing program among several households. The objectives are to use this as a educational and awareness tool, to increase the community engagement to the turtle conservation, and to increase social pressures towards reducing egg poaching. This idea still needs to be discussed with other stakeholders. To implement this idea, support from other stakeholders and improvement of the rearing techniques will be required.

Conservation Challenges

Direct economic benefits gained by local egg concession holders, local government, and a few households involved in the rearing program, meant that an abrupt cessation of eggs exploitation was strongly opposed. Moreover, no data, demand for instant impact of intervention, and weak law enforcement were used to argue for continuing egg exploitation. Currently, additional problems are faced due to an increase in egg poaching and turtle hunting and demand from the local community for a right to turtle management (income from rearing program).

It is a challenge when long-life-span species depend on a yearly basis decisions, and when conservation efforts take a long time (or even unsuccessful) in showing results that can benefit the local stakeholders. There is an urgent need to find an effective, affordable patrolling mechanism and monitoring mechanism, creating a sustainable financing mechanism, and an effective campaign to promote natural hatching, and alternative activities for local community with short-term tangible results.

PRESENT STATUS OF MARINE TURTLES IN SRI LANKA *

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Sri Lanka provides the aquatic and terrestrial habitats for the five species of sea turtles: the green (*Chelonia mydas*), Olive ridley (*Lepidochelys olivacea*), loggerhead (*Caretta caretta*), leatherback (*Dermochelys coriacea*) and hawksbill (*Eretmochelys imbricata*). Despite protection by government legislation since 1972, and amendments made in 1993, their future is in jeopardy, with many turtle populations declining to the point where they are no longer significant resources either materially or culturally. This is due mainly to the indiscriminate exploitation largely for their eggs and meat (Hewavisenthi, 1990). In addition, turtle nesting beaches are being disturbed by tourist industry development and feeding habitats, such as coral reefs and other coastal vegetation including mangrove habitats, are being destroyed by pollution and unsustainable harvesting. Many turtles are accidentally caught and drowned in fishing gear each year (Kapurusinghe, M.M. Saman, 2001).

The South and Southwest coastline of Sri Lanka comprises the largest marine turtle rookeries (Amarasooriya, 2000). One of the most widespread forms of marine turtle exploitation in Sri Lanka is the illegal poaching of turtle eggs for human consumption or for sale to unscientifically managed 'tourist attractions' turtle hatcheries (Richardson, 1995). Law enforcement and the implementation of community-based turtle conservation projects at important nesting beaches are not at satisfactory levels in Sri Lanka. Research work is adequate to understand the dynamics of local turtle populations. To increase the public awareness in turtle conservation, the TCP conducts various programmes for coastal communities each year.

CONSERVATION ASSESSMENT AND MANAGEMENT ACTION PLAN FOR MARINE TURTLES IN BANGLADESH *

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Bangladesh is located in a unique biogeographic setting as far as sea turtle migration is concerned. The Bay of Bangladesh is semi-encircled by the coasts of Myanmar in the east, Madras & Nicobar coasts of India in the west, and the Sri Lankan coast in the southwest. The funnel shaped bay at the footstep of Bengal offers a very favorable and safe feeding and breeding ground of five species of sea turtles: green, Olive ridley, loggerhead and hawksbill. The Leatherback turtles are vagrant in Bangladesh waters. All sea turtles visit the Bangladesh coast to nest during the winter, from November through to January. The east coast is the main breeding ground for turtles. The main issues pertaining to sea turtle conservation in Bangladesh are encroachment of nesting beaches and development intervention, egg poaching, and bycatch of turtles in marine fisheries (TED are not used at present).

Although several piecemeal initiatives have been taken by both government and NGOs, the country still lacks a far-reaching National Conservation Action Plan. Legally, sea turtles are not protected by the Bangladesh Wildlife Preservation Act, which results in non-continuity of action after completion of short rotation projects. Therefore, it is a priority to develop a National Conservation Action Plan. Within this, IUCN-Bangladesh will present an outline strategy and prepare a Conservation Assessment and Management Action Plan for sea turtles in Bangladesh.

THE ROLE OF SOME ENVIRONMENTAL FACTORS IN TURTLE CONSERVATION *

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This experimental study highlights certain environmental influences on the hatching success of Olive ridley turtles. The study was conducted in Karwar, (14°48N 74°07E) on the west coast of Karnataka state, India, a place where no earlier studies on turtles have been recorded so far. Turtle eggs were purchased from the local community and were reburied in lots ranging from 19-160, in an open beach hatchery (Devbag). The hatching rates obtained from the first lot of incubated eggs were very low (15% of 668 eggs). The probable reasons were identified to be fluctuating temperatures and low moisture content in the sand - conditions dissimilar to those we found in a natural nest. Movement induced mortality was also a possible reason for the low success rates, as eggs were brought from the market, and there was no record of their handling status.

Incubation temperatures were recorded with an alcohol thermometer for 4 months; November 2002 to February 2003; nest depth was measured with calibrated iron rod; nest shape was recorded by visual inspection; sand texture by inspection and sediment analysis; and sand moisture by comparative inspection of two places where wet sand could be obtained at different depths.

On burying a different batch of eggs (status of handling not known) under simulated conditions of a natural nest, hatching rates increased from the initial 15% to 50% (i.e. 50% of 307 eggs)

It was found that a constant temperature of 31°C in February 2003 irrespective of time, found at a depth of 60 cm; a nest shape like the urn which helped trap incubation heat, a distance closer to high tide line (15 m from high tide line and 5 m away from Casuarina plantations), provided enough moisture for eggs, and the fine sand texture with equal proportions of silt and clay also enabled fixing of moisture, improving the hatching rates.

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COMMUNITY BASED SEA TURTLE CONSERVATION IN GRENADA, WEST INDIES

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The year 2003 marks the fourth consecutive year of research conducted by Ocean Spirits into the last remaining significant population of Leatherback turtles found in Grenada. Numbering over 800 nests in the last 3 years, Grenada's population of nesting leatherbacks and other species of marine turtle are under extreme pressure from a legal (species dependant) turtle fishery and the illegal harvesting of sea turtle eggs.

Since 2001, Ocean Spirits has been collecting data on the local nesting population in order to draw up effective conservation strategies for the future of this species. From March to August, a saturation-tagging programme is operated to assess nesting frequency, beach fidelity and inter-nesting behaviour. More recently Ocean Spirits has partnered with the Marine Turtle Research Group of the University of Wales Swansea to address migratory and diving behaviour through the deployment of satellite telemetry equipment.

This year sees the implementation of a national environmental education tool developed by Ocean Spirits for students and teachers alike throughout the Grenadian education system. This PC based application is intended to provide teachers and students with a readily available source of environmental education information as well as complimenting Ocean Spirits' existing programme of school visits and structured field trips.

The creation of a locally operated turtle-watching venture is part of Ocean Spirits continuing efforts to illustrate alternative sustainable usage of sea turtles. In partnership with the Grenadian Fisheries department, Ocean Spirits has developed a turtle guide training programme to provide local communities with an alternative source of employment.

MANAGEMENT OF HAWKSBILL TURTLES IN CUBA: LESSONS LEARNED *

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Introduction

Like many other Caribbean nations, Cuba has a long history of utilizing marine turtles (ROC 1998). However, Cuba's approach to management of marine turtle resources has differed from that of its neighbours. Since the early 1960s, the turtle fishery has been part of a managed fisheries program regulated by the Ministry of Fishing Industries (Carrillo *et al.* 1998a,b). The historical harvest (1968-90), undertaken throughout Cuban waters, deliberately reduced the wild population to extract a sustainable harvest; in the case of hawksbill turtles (*Eretmochelys imbricata*) this equated to a harvest of about 5000 individuals per year (ROC 1998, 2000). The fishery was phased down between 1990 and 1995, largely for economic reasons, and harvesting of turtles was restricted to two traditional fishing sites (Isle of Youth and Nuevitas), with a maximum annual quota of 500 *E. imbricata* per year.

Sampling of turtles taken during the historical harvest allowed insights into the effects of the harvest (Carrillo *et al.* 1999). From 1995 onwards, monitoring of the harvest shifted to the level of individual turtles (ROC 1998). The mean number of *E. imbricata* harvested per year at both sites is 414.0 ± 23.1 (SE) (1995-2002).

Objectives of Management

Cuba's management program has one overriding objective - "to guarantee the sustainable use and long-term conservation and management of *E. imbricata*, to benefit the wild population". The program is comprised of a number of elements (eg fishing regulations, management of traditional wild harvest, monitoring, control of incidental and illegal catch, control of shell stocks,

experimental ranching, research, etc.; see ROC 1998, 2002), and is based on science and objectivity, rather than emotion and political expediency. The approach taken has been one of adaptive management, with the broad management question being whether the *E. imbricata* population is increasing, decreasing or stable. Clearly, within this broad question are secondary questions and points of biological interest, but the central monitoring issue must always be kept clear. Within a diverse region such as the Caribbean, these management questions can only be addressed at the national level first.

Monitoring Results

Monitoring at the traditional harvest sites of Nuevitas and the Isle of Youth has involved various indices:

Sex Ratios: Sex ratios (proportion of females) of *E. imbricata* harvested from the Isle of Youth [0.832 ± 0.010 (SE); 1996-2002] and Nuevitas [0.716 ± 0.018 (SE); 1997-2002] are different from each other, but have both been constant over time, indicating no sex-specific harvest impact at either site.

Densities: Densities around some coral reefs in southern Cuba, at Doce Leguas (122-280 per km²) and the Isle of Youth (59 per km²) (ROC 2000a), are high relative to other published values (eg Limpus 1992; Diez and Van Dam 2002), but have not been monitored over time.

Mean Size of Turtles: At both traditional harvest sites, the mean size of *E. imbricata* caught has been steadily increasing.

Abundance: At the Isle of Youth, catch per unit effort (CPUE; calculated as number of *E. imbricata* caught per 100 net days in the season), had remained relatively constant and at similar levels to that recorded in 1990-96 [1.7 ± 0.06 (SE)] (ROC 1998). From 1997 onward, CPUE increased sharply, to a mean of 14.3 in 2001-2002, equivalent to a mean rate of increase of 36.3% per year (1997-2002). This indicates a substantial increase in the numbers of *E. imbricata* moving through the same capture sites. The reason for this increase is unclear, but it could reflect increased movement from the main juvenile foraging areas in the south.

At Nuevitas, fishing effort has varied within and between sites and years. CPUE rates of increase (1997-2001) ranged between +0.002 and +0.372 with a mean of 0.18 ± 0.08 (SE): 20.3% per year. Fishermen there have not reported the same major increase in abundance that has occurred at the Isle of Youth. The harvest sites at Nuevitas are well distanced from the main juvenile foraging grounds in the south, and intercept larger animals moving from west to east along the coast, inshore of the Cuban shelf (ROC 2000).

Systematic monitoring of the nesting population has been undertaken at the main nesting area for *E. imbricata* in Cuba, the Doce Leguas Keys (Moncada *et al.* 1998b, 1999). Surveys have also been carried out in other parts of Cuba.

Nesting: Nesting trends provide an index of the status of the adult female *E. imbricata* population in the nations where females live - not necessarily where they nest. A problem with *E. imbricata* is that low-density nesting on isolated keys and beaches is common, and such areas are often logistically difficult to monitor. This is the case in Cuba, where most nesting is on many remote and isolated keys, and the logistics of conventional beach monitoring, with uniform effort from year to year, are formidable.

From 1988 to 1996, opportunistic surveys in Doce Leguas aimed to identify specific nesting areas and some biological variables (eg clutch size, hatching success) (ROC 1998). From 1997 onward, a more standardised approach was adopted (Moncada *et al.* 1999). Data from the same 9 beaches, surveyed between October and December (92 days), from 1997 to 2001, showed a mean increase of 20.2% per year. Mean density of nests found increased from 3.01 ± 0.10 per km (1997-98) to 5.68 ± 0.80 per km (1999-2001), with search effort reasonably stable at 45.9 ± 5.1 days (SE) per year. Surveys in 2002 were severely hampered by cyclones, and search effort was greatly reduced relative to previous years.

Clutch Size: Between 1988 and 1996, clutch size at Doce Leguas was constant [mean= 135.3 ± 0.75 (SE); N= 9 years] and small clutches (<90 eggs), indicating small females, were rare [$2.7 \pm 1.5\%$ (SE) of clutches per year]. Between 1997 and 2001, the percentage of clutches with less than 90 eggs has increased ($11.5 \pm 1.5\%$) causing mean clutch to decrease (132.6 ± 2.23 ; N= 5). This is consistent with increased recruitment of younger females into the nesting population.

Extent of Nesting: Moncada *et al.* (1999) suggested the real number of nests in Cuba was between 1700 and 3400, based on a series of corrections. With additional information available on the distribution of nests through the season, this estimate was revised to 2000-2500 nests (in 2001).

The population structure under the historical harvest stabilised in parts of Cuba but not in others (Carrillo *et al.* 1999). Following the >90% reduction in the harvest, the population was expected to increase and stabilise at a new level (ROC 1998, 2000). Monitoring results indicate the wild population is increasing, confirming that the traditional harvest is being sustained and is well within safe limits.

Research

A significant research effort has been expended within the *E. imbricata* program. Results of particular significance include:

Movement: Some *E. imbricata* tracked by satellite from Cuba are known to have disbursed to other parts of the Caribbean, and 5 of 7 nesting females remained in Cuban waters (Manolis *et al.* 1999; Carrillo *et al.* 1999; Prieto *et al.* 2001). None of the 28 adult nesting females and four males tracked from other countries (Antigua, Barbados, Belize, Jamaica, Costa Rica, Mexico, Nicaragua, Puerto Rico, US Virgin Islands) has ventured into Cuban waters (MTSG 2002; C. Diez, pers. comm.). Only one of over 1000 *E. imbricata* tagged (with flipper tags) in Cuba has been recovered in another country (Colombia, in 2002; Moncada *et al.* 2003).

Growth: Results from an ongoing mark-recapture program confirmed that *E. imbricata* in Cuban and Mexican waters grow faster on average than *E. imbricata* elsewhere. Forty-nine growth intervals from 43 individual *E. imbricata* from Cuba [mean time interval between captures = 571 days (range 92-3085 d)] are currently available. Data for adults were collected from nesting females. Predicted mean growth rates for juveniles of different size (SCL) classes, derived from regression analysis, are: 20-30 cm, 9.38 cm/y; 30-40 cm, 7.89 cm/y; 40-50 cm, 6.41 cm/y, 50-60 cm, 4.92 cm/y. The extensive, shallow inner waters off the south coast of Cuba are warm, and provide abundant food for juveniles and adult *E. imbricata*. High growth rates, and subsequent early attainment of maturity (eg Prieto *et al.* 2000), may explain why Cuba was able to sustain high levels of harvest (about 5000 *E. imbricata* per year) for such a long period of time.

Genetics: Cuba has published considerable information on *E. imbricata* mtDNA (eg Moncada *et al.* 1998a; Diaz-Fernandez *et al.* 1999), and all indications from all studies to date are that the majority of *E. imbricata* caught in Cuban waters are of Cuban origin. The recent finding of nesting haplotypes in Cuba, previously only identified from nests in Mexico (G. Espinosa, pers. comm.), strengthens this case. However, caution should still be exercised when interpreting mtDNA data, due to the limitations of the analytical methods used (maximum likelihood analysis) and the limited sample sizes and areas examined to date.

Conclusions

Cuba's monitoring, indicating that the *E. imbricata* population is still increasing, provides confirmation that the rate of increase in the population is much greater than the rate of harvest. Rates of increase since the historical harvest was phased down are similar to those predicted from simple population models. Should monitoring results indicate a detrimental impact as a result of the traditional harvest, management will be altered accordingly (ROC 1998, 2002).

Experience with the management of other wildlife species (eg Webb 2003) indicates that consumptive use can occur whilst a population is recovering – there is no need to wait until complete recovery before initiating use programs. Indeed, management may not be able to wait for complete population recovery.

Cuba's program clearly confirms that National management programs are the building blocks for regional management. Difficulties at the first Conference of Parties to the InterAmerican Convention for the Protection and Conservation of Sea Turtles (C. Padilla, pers. comm.) exemplify the problem of a "top-down" approach to regional management. The importance of harvest data for monitoring is often overlooked (eg nest monitoring protocols discussed prior to 2nd CITES Regional Dialogue Meeting). In countries with a legal harvest, or significant legal by-catch, harvest data are an important source of monitoring data. Cuba's historical harvest data are a good example of this, and have provided important insights into the population dynamics of *E. imbricata* (ROC 1998; Carrillo *et al.* 1999). Legal and illegal use is occurring in many Caribbean nations (Fleming 2001; TRAFFIC 2002), and a similar approach to harvest data could be adopted for other areas.

Acknowledgements

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PROJECT TAMAR-IBAMA – RESULTS OF THE CONSERVATION AND MANAGEMENT ACTIVITIES OF SEA TURTLES DURING THE 2001/2002 REPRODUCTIVE SEASON

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Introduction

The initial objectives of TAMAR (the Brazilian Sea Turtle Conservation Program) are to quantify the number of species, distribution and abundance of sea turtles, the seasonality and geographic range of nesting, and the primary threats to turtle survival. A comprehensive two-year survey of the coastline was carried out between 1980 and 1981 (Marcovaldi & Marcovaldi, 1999).

At present, Projeto TAMAR operates 20 research and conservation stations in Brazil in sea turtle feeding and nesting grounds. Two of them are located in areas that are exclusively feeding areas for the turtles and will not be dealt with in this article. The other eighteen stations are located in areas where foraging activities are recorded, but nesting is the main activity. They are distributed along the coast and in oceanic islands as follows: 1 in Rio de Janeiro State, 5 in Espírito Santo State, 5 in Bahia State, 3 in Sergipe State, 1 in the Archipelago of Fernando de Noronha, 1 at Atol das Rocas and 1 in Archipelago of Trindade.

Methods

Despite more than two decades of conservation work, it has not been possible to extend equal efforts to all areas of the Brazilian coastline, even within the TAMAR stations. Therefore, an intensive study area (ISA) and a conservation area (CA) are associated

with each of the stations that deal with nesting populations. Each ISA is coincident with a major concentration of nesting. The ISA is patrolled each night during the nesting season. An ISA can extend from 5 to 50 km, and vehicles are used to patrol larger areas. Nesting turtles are measured [curved carapace length (CCL) and width], and flipper-tagged with monel or inconel tags (#681, National Band Company, Kentucky, U.S.A.; following Pritchard et al., 1983; Limpus, 1992). All information is coreported on a standard data sheet used by all stations.

In situ nests are those maintained at their original places. They must be within an ISA with permanent monitoring, easy access, and with minimal risk due to human activities and beach erosion. Beaches are patrolled every morning to locate and mark new nests. All nests left *in situ* are marked with a unique number. In areas where predators are a serious threat, nests are protected with a wire mesh buried just below the surface of the sand, above the eggs. The mesh size is large enough to allow hatchlings to escape from the nest. Monitoring is constant and after the 45th incubation day nests are checked daily to record the exact hatch date (Marcovaldi & Marcovaldi, 1999).

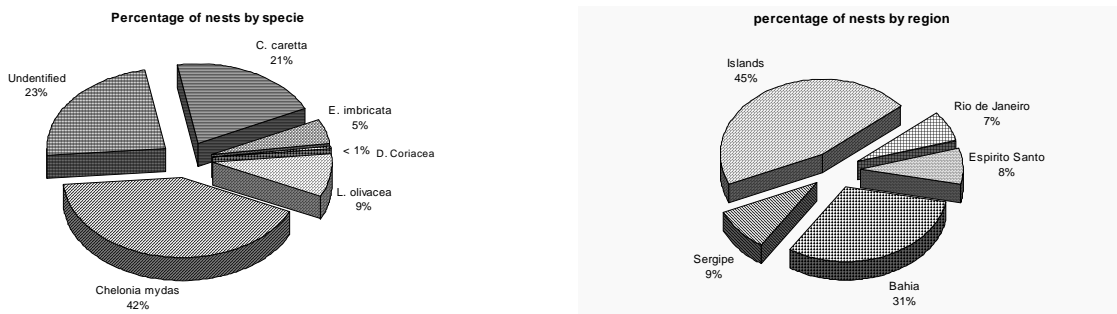
Each TAMAR station has an open-air-hatchery that normally receives eggs from the surrounding beaches in the CAs. The ISA, where nests are always monitored *in situ*, serves as a control, providing the necessary biological data to evaluate the incubation conditions and the success of the eggs in the hatchery. Unlike the ISAs, the CAs are monitored and protected by local fishermen. Nests are carefully transferred to a Styrofoam box, using sand to pack the eggs together. The eggs are then moved to hatcheries that are centrally located in natural nesting habitat, which normally reduces transport time to less than 12 h between laying and reburial. This strategy reduces the potential negative consequences for developing embryos associated with transport (Limpus et al., 1979, 1980; Parmenter, 1980; Blanck and Sawyer, 1981; Chan et al., 1985).

We carefully monitor a variety of incubation variables (incubation period, temperature, etc.) in order to keep the incubation conditions similar between the natural nests and those in the hatchery. Hatcheries are a necessary interim step; for now, nests that cannot otherwise be protected from poachers, predators, heavy beach traffic, or erosion, are moved to hatcheries for safe incubation. Where TAMAR has been working for several years, the level of involvement and price in the project on the part of the villagers is very high, and more nests are being left *in situ* over ever-expanding areas. The main goal of TAMAR in the near future is to keep as many nests as possible *in situ*. Nowadays, nearly 70% of all nests are left in original places.

Results

The most abundant species in the Brazilian coast is the green turtle, whose area of nesting is concentrated on oceanic islands with few nesting sites found on the continent. The second most abundant species is the loggerhead, followed by the Olive ridley and the hawksbill. These last two are known to nest mostly in Sergipe State and the north shore of Bahia State, respectively. The leatherback is the species with the least nests and for which the nesting area is restricted to Espirito Santo State. Some nests were not associated by species since as they were protected not monitored for data collection. (Fig. 1).

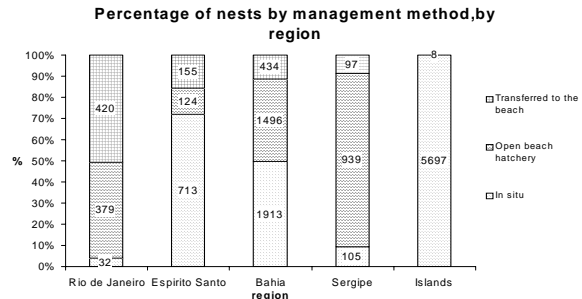
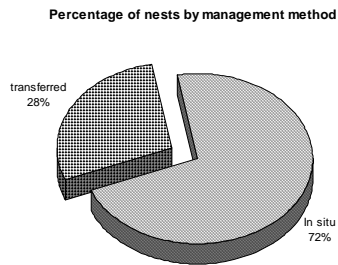
Taking the occurrence of nests by region, we see that the islands, especially the Island of Trindade (5.000 nests/ season), host the majority of nests found in the Brazilian sea coast (the main nesting sites for greens) along the Brazilian shore, and are one of the most important areas in the South Atlantic. On the continent, the State of Bahia presents the highest number of nests, followed by the States of SE, ES and RJ (Fig. 2).



Figures 1 & 2: Percentage of nests by species and by region.

During the 2001/2002 season, more than 70% of nests were protected by *in situ* protection, with no manipulation of the eggs. On the islands, due to total lack of human interference, nearly all nests were maintained *in situ* (Figs. 3 & 4). The majority of hatchlings from monitored nests were from greens, followed by Olive ridleys and then hawksbills. Taking into account the nests in non-monitored locations such as islands, greens likely produce the highest number of hatchlings. In the case of loggerheads and hawksbills, the *in situ* conservation strategy is the one that presents higher results in relation to other strategies where manipulation of eggs occurred, with the only exceptions linked to the size of the sample. The means of emergence of Olive ridleys is naturally higher than that obtained for other species, followed by loggerheads, leatherbacks and then hawksbills. The data for greens are from Fernando de Noronha island, the only island where severe human interference and for which monitoring

of the eggs until emergence was carried out. Here, the rate of emergence for the *in situ* strategy was superior to that obtained by transferring eggs to the beach. This difference is linked to the size of the sample and also to the late timing in moving of the eggs, 12 h after nesting. SE is the region with the best rate of emergence for the three most significant species: Olive ridleys, greens and hawksbills (Figs. 5, 6 & 7).



Figures 3 & 4: Overall percentage of nests by management method and regional breakdown of percentage of nests by management method.

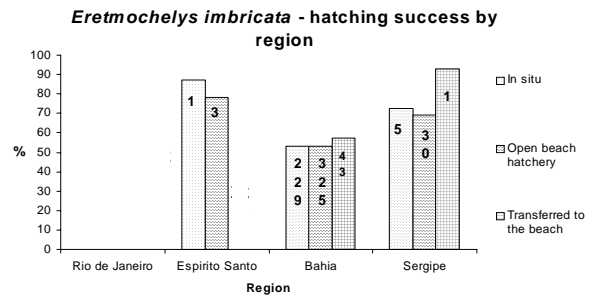
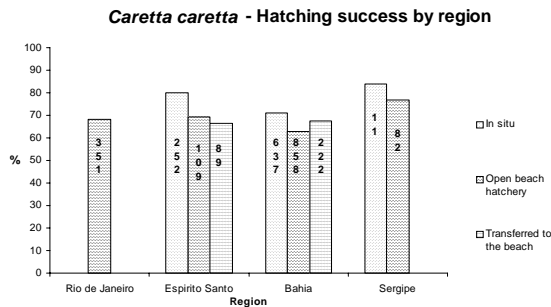
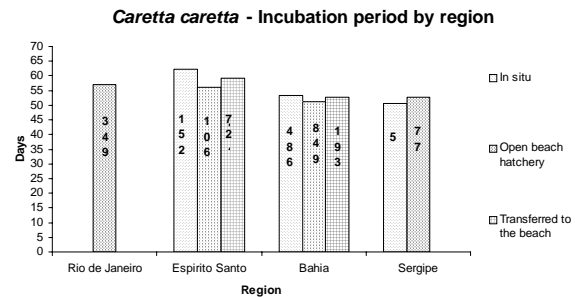
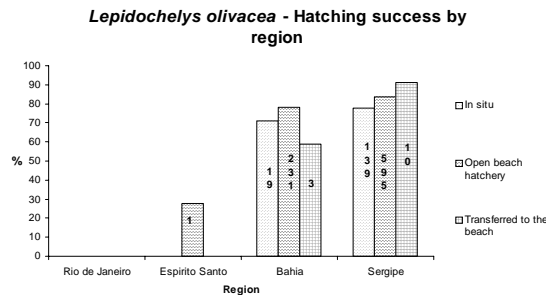
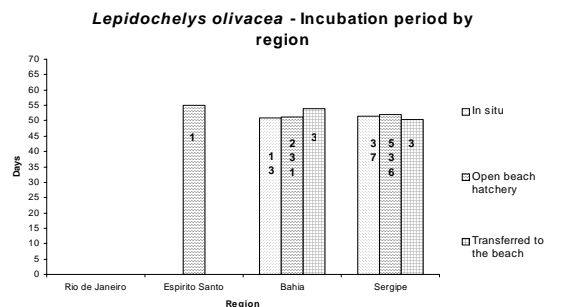
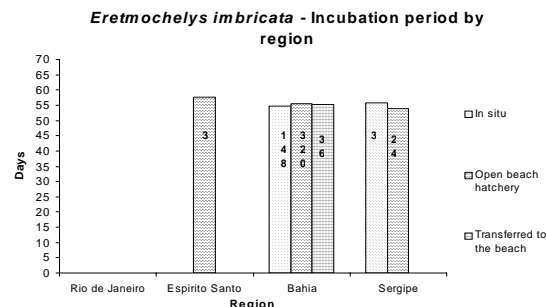


Figure 5 & 6: Hatching success by region for *Caretta caretta* and *Eretmochelys imbricata*.



Figures 7 & 8: *Lepidochelys olivacea* hatching success by region and *Caretta caretta* incubation period by region.



Figures 9 & 10: Incubation periods by region for *Eretmochelys imbricata* and *Lepidochelys olivacea*.

In relation to the mean incubation periods for loggerheads, we observed a decreasing gradient from north to south (RJ-SE). With the exception of the State of ES, there were no major differences in the mean incubation period in other regions, following our conservation strategy. Hawksbills showed little variation in incubation period among the different management regimes in this same region. The averages for this species were naturally higher to those observed for loggerheads and Olive ridleys for the three species when superimposed. We have not observed any significant difference in the mean incubation period for Olive ridleys with our conservation strategy. The leatherback was the species with the highest incubation periods in Brazil. Due to the small sample size however, we observed a difference in the mean incubation times among the different conservation strategies. However, when the analysis was made between pairs of nests, the incubation periods were similar. We did not observe significant differences for greens when using different conservation strategies. (Figs. 8, 9 & 10).

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NEST INUNDATION BY SEAWATER: A THREAT TO MITIGATE OR A NATURAL "MASCULINISING" FACTOR?

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Background

Southern Kyparissia Bay, western Greece, is a major nesting area for loggerhead turtles in the Mediterranean. On average, 425 clutches are deposited per season along 8 km of beach length (Margaritoulis and Rees, 2001). ARCHELON conducts a long-term monitoring and nest management programme in the area. Because of the prevailing winds during the nesting season, many nests are naturally inundated by seawater. This has prompted ARCHELON to include in its programme the routine relocation of clutches, laid within a certain distance from the sea, to sites higher up the beach. It is known that incubation duration is negatively correlated to nest temperature, which determines the sex ratio of hatchlings (Marcovaldi *et al.*, 1997). To test the impact of inundation to sex ratios, the incubation duration of inundated versus non-inundated nests was studied for the 8-year period 1994-2001.

Methods

For analysis, only "undisturbed" nests (i.e. *in situ* nests not disturbed by predation or human intervention after their location) were taken into account. Most of the clutches were, however, located by careful hand-excavation. This was done so that protective metal screens could be placed over the nests thus reducing predator success, as nest predation is a major problem in Kyparissia Bay (Margaritoulis, 1988; Rees *et al.*, 2002). Nests were then observed daily in the early morning during routine beach surveys to record, along with other data, inundation events and hatching.

A nest was classified as having been inundated when, from the daily beach survey, evidence was provided that waves had passed over the nest area. Thus inundated nests possibly varied from having suffered one or two waves passing over them to considerable periods of time spent submerged in the surf. Incubation duration (ID), for the purpose of this presentation, is defined as the elapsed time (in days) from egg laying until the first emergence of hatchlings. The Kruskal-Wallis test was used to identify significant differences in ID between years and between nest categories.

Results and Discussion

The overall average ID was 49.7 ± 4.1 days ($N=1,255$) for non-inundated nests and 53.2 ± 5.2 days ($N=505$) for inundated nests. Inundation thus appears to increase the overall average ID by 3.5 days and also to extend the spread of ID. Inter-seasonal variations of mean ID between non-inundated and inundated nests are shown in Fig. 1. Significantly more nests had IDs at or above the calculated pivotal ID of 56.6 days identified by Mrosovsky *et al.* (2002), from which it can be inferred that a higher proportion of male hatchlings were produced.

Results show that nest inundation, if not catastrophic, prompts longer ID and thus can have a “masculinising” effect on loggerhead clutches. It is known that at some beaches where hatching sex ratios have been studied a strong bias towards production of female hatchlings has been indicated (Mrosovsky and Provanca, 1989; Marcovaldi *et al.*, 1997; Godley *et al.*, 2001).

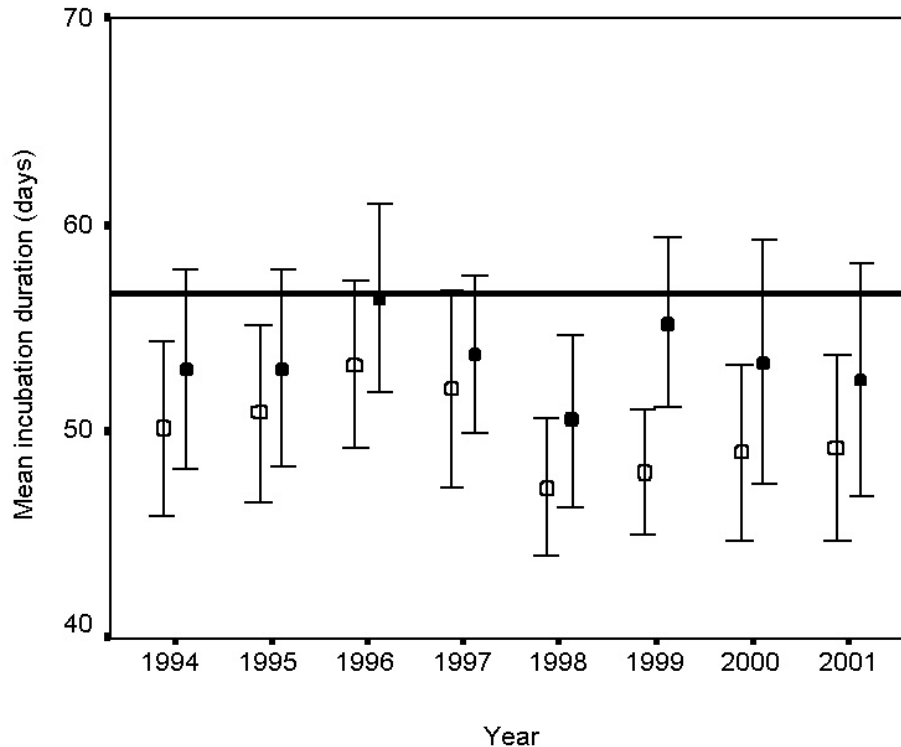


Figure 1. Comparison of yearly mean (± 1 SD) ID for inundated (filled circles) and non-inundated (open circles) nests. Thick line represents the pivotal ID (56.6 days, Mrosovsky *et al.*, 2002).

We hypothesise that the non-lethal effects of nest inundation (as shown here) may redress the balance towards a less female-skewed sex ratio and thus nests constructed closer to the sea in areas that, unpredictably, may be covered by sea water, contribute significantly to the overall sex ratio produced. If this is the case then management programmes involving nest relocation to avoid sea-inundation may be stopping production of an important percentage of male hatchlings that may have an as yet unknown effect on the overall population.

It is recommended that nest relocation as a conservation tool should be limited to those nests that are certain to be destroyed or have drastically reduced hatching success if left to remain *in situ*. Within the context of this paper, it means that nests on the border of high-tide or storm-wave zones should be left to incubate *in situ*, subsequently possibly suffering some inundation, rather than be relocated to a hatchery or further up the beach platform where conditions are more likely to favour a female-biased sex ratio.

These initial results with basic analysis urge further investigation into the masculinising effect of nest inundation. They are put forward as indicators so that further study can be made that takes into account the complete range of factors that are involved with sex-determination and ID.

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THE IMPACT FROM BEACH EROSION AND HEAT WAVE ON THE LOGGERHEAD TURTLE HATCHING SUCCESS RATE AT SAGARA COAST IN JAPAN

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Kamehameha Ohkoku was established for monitoring loggerheads and studying with school children at Sagara, in the Shizuoka prefecture, in 1997. Thereafter the activities were expanded into marine environmental conservation projects including sands and sea grass bed surveys. The Sagara coast faces several problems such as erosion of the sands, rocky shore denudation and rising sea temperatures. These environmental changes, when combined, intensify the impact on the loggerhead turtle hatching success rate.

Beach erosion results in high sand cliff and narrow beaches which interrupts sea turtle nesting activities, and relocation of eggs is performed when its necessary. Eight clutches out of 12 were relocated during 2002 to prevent nest flooding, however three of un-relocated clutches were washed away by unusual high tides (the typhoon season overlaps with nesting and emergence season). In addition, a heat wave that hit Japan affected the relocated clutches, and their hatching and emergence rates were dramatically reduced.

Heat Wave - The heat wave in Shizuoka prefecture recorded a 36 day long hot spell (above 30°C) with no rain. As a result, sand temperatures at 60 cm depth on the nesting beach were elevated above 30 °C from 25th June to 8th September (Fig. 1). This caused high mortality of the loggerhead turtle embryos.

Five relocated clutches were examined for hatching success rates and the embryonic stage determination of dead embryos in the shell (Table 1, Fig. 2). The hatching success rates of nest A-E were 50%, 15.9%, 0%, 6.6% and 8.3% respectively. Nest A (43.2%), nest B (59.1%) and C (98.4%) showed the highest mortality rate in the late stage (stage 29 to 30), and nest D (57.0%) and E (55.8%) were in the early stage (stage 6 to 10). The approximate dates of the stages were calculated on each clutch by using Miller (1985) as an index to compare the mortality rates (Fig. 3). The high mortality was concentrated in the first half of August during the period of highest sand temperatures. At this time 98.4% of embryos in the late stage died in nest C and this result suggests that increased metabolic heat from the embryos triggered this incidence.

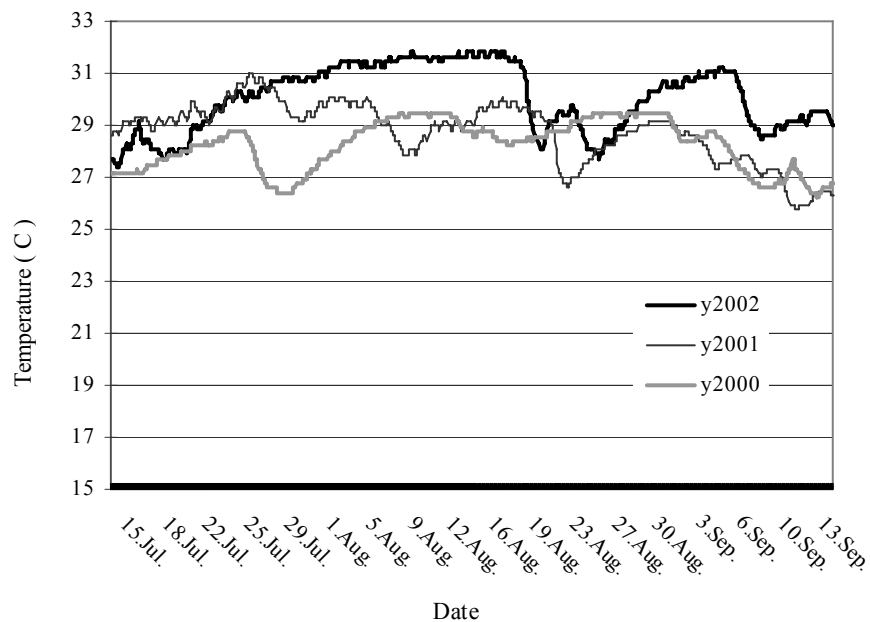
Table 1. The embryonic stages were determined on five clutches.

Nest A-C show high mortality rates on the late stage of embryo, and nest D and E showed the early stage of embryo.

Nest	A		B		C		D		E	
	Date of lay	30th May (%)	22nd June (%)	23rd June (%)	27th July (%)	29th July (%)				
Clutch size (eggs)	132	100	132	100	124	100	151	100	120	100
Embryo unidentified/stage 6-10	9	6.8	33	25.0	2	1.6	86	57.0	67	55.8
Embryonic stage 15-17	0	0.0	0	0.0	0	0.0	0	0.0	13	10.8
Embryonic stage 21-24	0	0.0	0	0.0	0	0.0	49	32.5	19	15.8
Embryonic stage 29-30	57	43.2	78	59.1	122	98.4	6	4.0	11	9.2
Death after hatched	10	7.6	2	1.5	0	0.0	1	0.7	2	1.7
Emergenced or missing*	50	37.9	16	12.1	0	0.0	7	4.6	8	6.7
Saved**	6	4.5	3	2.3	0	0.0	1	0.7	0	0.0
Incubation period	71 days		56 days		N/D		54 days		48 days	

*Some of individuals were devoured by insects in the sand

**Moved to the nursery

**Fig. 1. Sand temperatures at the 60cm depth at Sagara nesting beach in 2000 to 2002. The nesting beach was affected by the heat wave in the summer of 2002.**

Erosion of Nesting Beach - Due to changing of current flows by construction of seawalls at the International harbor nearby, Sagara nesting beaches have been eroded with net outflow of sand. Some beaches have lost all the sand completely, and relocation of eggs is necessary. Additionally, unusual high tides driven by typhoons removed sands from the nesting beaches and then left a 3m high sand cliff. A loggerhead did climb the cliff and laid eggs on the middle of the beach, however the nest was washed away by high tide (Fig. 4). The temperature reached 37.49 °C at 20 cm depth, as a result of receiving sunlight not only from the top but the side (Fig. 5). One of the causes of decreasing beach sands come from several dams on the big river nearby.



Fig.2. Sizes of the embryos measured to determine embryonic stage.

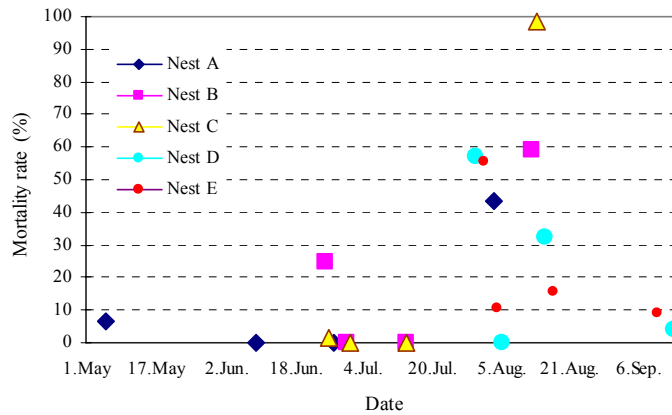


Fig. 3. The mortality rates were compared in five nests. The approximate dates of the stages were calculated by using of the Miller index.

Rocky Shore Alteration - The largest sea grass bed area (7,891 ha) in Japan where sea turtles rest during the nesting season has vanished because of rocky shore alterations. A rise in sea temperatures though global warming and changes in current patterns are the main factors behind shoreline alteration. In addition, covering rocks with sands and stagnation of water flow as a result of the construction of seawalls also causes shoreline changes. Rocky shore alteration has lead to a reduction in fisheries, which is positively correlated with the number of sea turtles landings.

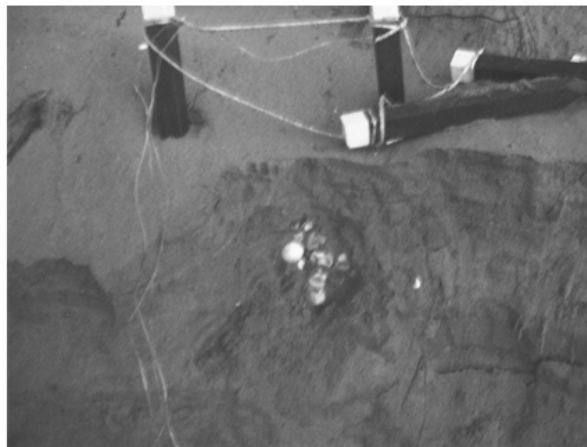


Fig. 4. Eggs are coming out from the middle of 3m sand cliff

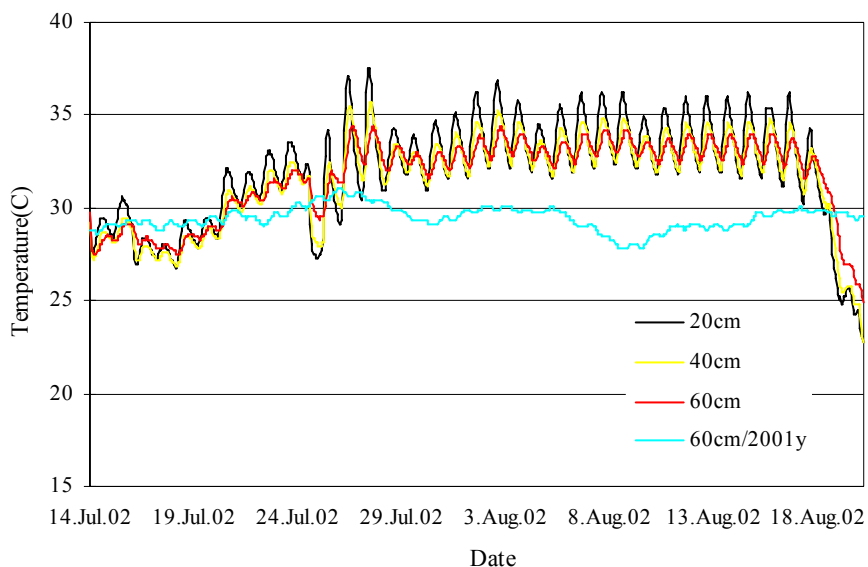


Fig 5. Sand temperatures of a nest at the sand cliff. Thermometer thrust vertically into the sand of the nest side 5 cm. The record shows 37.49C, 35.69C and 34.36C at 20cm, 40cm and 60cm depth respectively on 27th Jul.

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A TECHNICAL DESCRIPTION OF ENLARGED TED ESCAPE OPENINGS AND PRELIMINARY RESULTS FROM SHRIMP RETENTION STUDIES IN THE SOUTHEAST U.S. SHRIMP FISHERY

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Introduction

Federal regulations requiring the installation of turtle excluder devices (TEDs) in the shrimp trawls of vessels operating in the southeastern U.S. shrimp fishery were promulgated in 1987 (Federal Register, 1987). The required minimum escape opening dimensions for TEDs were based on stranding data and documented turtle captures aboard commercial shrimp trawlers. Since 1994, NOAA Fisheries has periodically enacted temporary emergency regulations requiring offshore shrimp fishers to use an enlarged TED escape opening during times of high leatherback (*Dermochelys coriacea*) concentrations. The required leatherback opening dimension measured 71 inches (180 cm) when stretched horizontally. The need for full-time offshore use of enlarged TED escape openings was determined through a comparison of the size of stranded sea turtles with the minimum required TED opening size (Epperly, et al., 2002). This comparison found that 33- 47% of stranded loggerheads (*Caretta caretta*) and a small proportion of stranded green sea turtles (*Chelonia mydas*) were too large to fit through the minimum-size required TED opening. Two methods for enlarging the TED opening have been developed and will be required in all TEDs used in offshore waters of the

southeast U.S. beginning August 15, 2003. These new openings are: a 71 inch (180 cm) TED opening, or a double cover opening (Federal Register, 2001). Additionally, the minimum TED frame size will increase to 32 inch (81 cm) in outside diameter.

Materials and Methods

Installation of the 71 inch (180 cm) opening requires the removal of a rectangular piece of TED extension webbing forward of the TED frame defined as the escape opening cut. The required minimum stretched mesh dimensions of the cut are 71 inches (180 cm) by 26 inches (66 cm). A cover or flap is installed over the exit hole cut by sewing a rectangular piece of webbing with minimum dimensions of 133 inches (338 cm) in width by 52 inches (132 cm) in length. The maximum allowed stretched mesh of the flap piece is 1 inches (4 cm). The forward edge of the flap is sewn to the leading edge of the cut using a ratio of approximately 2 meshes of the flap to one mesh of the cut. When compared to the original TED extension material which is initially removed, the installed flap piece is approximately double in size, providing more material to exclude large objects. The flap length may not exceed 24 inches (61cm) beyond the posterior edge of the TED frame. The double cover opening requires an escape opening cut of 56 inches (142 cm) by 20 inches (51 cm). Two rectangular flap sections are constructed from webbing which has a stretched mesh measurement no greater than 1 inches (4 cm). Each flap section must have a minimum measurement of 58 inches (147 cm) in width when stretched. The flap sections are sewn to the escape opening and overlap in the center of the cut. The overlapping sections of the flaps may not exceed 15 inches (38 cm) when stretched. The flap length may not exceed 6 inches (15 cm) beyond the posterior edge of the TED frame.

Comparative Testing : Double Cover Opening

Shrimpers participated in the study on a voluntary basis and were compensated \$300/day as incentive to take a NOAA Fisheries observer aboard during their fishing trips. Vessels were recruited with assistance from the Gulf of Mexico Sea Grant network and through direct contact by NOAA Fisheries gear specialists. Testing was conducted aboard 13 commercial shrimp trawlers in the Gulf Area, and one trawler in the Atlantic Area.

The double cover TED opening was tested in offshore areas (depth > 10 fm), nearshore areas (COLREGS demarcation line, seaward to 10 fm) and inshore areas (landward of COLREGS demarcation line). In the Gulf of Mexico, 9 vessels fished inshore and near shore areas (2 Texas, 4 Louisiana, 1 Mississippi, 1 Alabama and 1 Florida). Offshore testing was conducted along the southeast coast of Florida by 1 vessel, the pink shrimp grounds of southwest Florida by 2 vessels, and Texas by 2 vessels. Vessel captains determined the fishing location and duration of all trips.

Control TEDs used in the study were inspected by NOAA Fisheries gear specialists for opening size. All control TED openings were single flap designs which measured either the minimum Atlantic TED opening dimension of 35 inches by 12 inches (89 cm by 30 cm) or the Gulf of Mexico minimum TED opening dimension of 32 inches by 10 inches (81 cm by 25 cm).

NOAA Fisheries observers recorded the shrimp catch weights from control and experimental TED equipped trawls. Catches from control and experimental TED nets were kept separate from all other nets so that shrimp from each trawl could be weighed and recorded. Shrimp were separated from each sample and total weight of all species (*Penaeus* sp.) were combined and recorded for control and experimental TED nets. Observers recorded only the size-range of shrimp retained by the vessel for final weights. Shrimp weight was recorded in kilograms (kg). Catch was recorded as heads-on or heads-off. Heads-off weight = (0.63 x heads on weight, (Renaud et al., 1990). In order to minimize bias associated with a side of the vessel or the fishing efficiency of a particular trawl, the experimental and control TEDs were switched to opposite sides and trawls after approximately 10 tows. Switching TED position required removal of the TED extension piece only and re-installing it in the net on the opposite side of the vessel. Vessel captains were asked to conduct an equal number of tows for both experimental and control TEDs in each trawl/side position during a trip. In order to obtain statistically valid data, a minimum of 20 comparative tows were conducted during each trip. Inshore vessels typically made day trips only, thus multiple days were required to obtain the minimum 20 requisite tows. Paired t-tests were performed to test the hypothesis of equal shrimp catches by weight for experimental and control TED nets. Total shrimp catch weights were compared and analyzed by area fished (inshore/near shore and offshore) and for all areas and all tows. Confidence intervals (95%) on total shrimp catch weights were also calculated.

Results

A total of 182 paired tows were collected in inshore and near shore areas of Texas, Louisiana, Mississippi, Alabama and Florida (Table 1). Analysis of inshore and near shore data combined showed a 2.4% increase in total shrimp weight for the double cover opening TED when compared to a TED with a minimum Gulf of Mexico TED opening.

Table 1. Inshore and near shore shrimp catch summaries by area and statistical analysis for significance (paired *t* test) for control and double cover opening TED comparative tests.

Location	Control TED Total Shrimp (kg)	Double Cover Total Shrimp (kg)	% difference	(n) no. of tows
Texas	705.8	715.1	+1.3	40
Louisiana	1204.0	1252.2	+4.0	65
Mississippi	561.8	562.7	+0.2	30
Alabama	386.7	403.1	+4.2	27
NW Florida	214.1	212.6	-0.7	20
Totals	3072.4	3145.7	+2.4	182
<i>P</i> value (paired <i>t</i> test) = 0.17 , not statistically significant				
Ratio estimation on original scale, 95% confidence interval = -1.3% to +6%				

Table 2. Offshore shrimp catch summaries by area and statistical analysis for significance (paired *t* test) for control and double cover opening TED comparative tests.

Location	Control TED Total Shrimp (kg)	Double Cover Total Shrimp (kg)	% difference	(n) no. of tows
Texas	2424.3	2561.1	+5.6	88
SW Florida	1613.4	1567.7	-2.8	66
SE Florida	813.7	773.2	- 5.0	34
Totals	4851.4	4902	+1.0%	188
<i>P</i> value (paired <i>t</i> test) = 0.53 , not statistically significant				
Ratio estimation on original scale, 95% confidence interval = -2.5 to +4.6				

Table 3. Shrimp catch summaries for all areas and all tows and statistical analysis for significance (paired *t* test) for control and double cover opening TED comparative tests.

Location	Control TED Total Shrimp (kg)	Double Cover Total Shrimp (kg)	% difference	(n) no. of tows
All Areas	7923.8	8047.7	+1.6	370
<i>P</i> value (paired <i>t</i> test) = 0.20 , not statistically significant				
Ratio estimation on original scale, 95% confidence interval = + 4.2 to -1.0				

Offshore testing conducted in Florida and Texas resulted in the collection of 188 paired tows (Table 2). Analysis of the offshore data showed a 1.0 % increase in total shrimp weight for the double cover opening TED when compared to a TED with the minimum Atlantic and Gulf of Mexico TED openings. Combining the data for all tows over all areas resulted in 370 paired tows (Table 3). Analysis of the data showed an overall 1.6% increase in total shrimp weight for the double cover opening TED when compared to a TED with minimum Gulf of Mexico TED opening. None of the differences in total shrimp weight were statistically different from zero ($P < 0.05$).

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SEA TURTLE CONSERVATION BY PROJETO TAMAR-IBAMA AT ALMOFALA, STATE OF CEARÁ, BRAZIL

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Almofala, in the State of Ceará, northeastern Brazil, is a foraging area for juvenile and adult green turtles (*Chelonia mydas*). Other sea turtle species are also found there in relatively low numbers: the loggerhead turtle (*Caretta caretta*), the hawksbill (*Eretmochelys imbricata*), the olive ridley (*Lepidochelys olivacea*) and the leatherback (*Dermochelys coriacea*). Projeto TAMAR-IBAMA, the Brazilian sea turtle conservation program, has been conducting conservation and research activities at Almofala since 1991. A station has been maintained there since 1992, including a visitor center, display tanks and a small museum. Educational activities and the development of economic alternatives for the local community are key aspects of TAMAR's work in the area.

Artisanal fishing is a widespread way of living at Almofala, and an important problem faced by sea turtles as there is the incidental capture in fishing gear. TAMAR has tackled mainly the incidental capture in fish weirs, but the impact of other fishing methods on sea turtles is being assessed. Most of the captured turtles are found alive, and are tagged and released into the sea. This work describes TAMARs activities at Almofala, presents data gathered between 1993 and 2001 and points to directions for future conservation activities in that region.

TRENDS IN THE GREEN TURTLE (*CHELONIA MYDAS*) NESTING POPULATION AT ALDABRA ATOLL, SEYCHELLES (WESTERN INDIAN OCEAN) AND THEIR IMPLICATIONS FOR THE REGION

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Introduction

At the turn of the 19th century, the Aldabra green turtle (*Chelonia mydas*) nesting population is believed to have comprised some 6,000-8,000 females nesting annually (Mortimer 1985, 1988) and possibly as many as 12,000 (Spurs, 1892). Between 1904 and 1968, over-exploitation of green turtles in Seychelles to produce calipee for export to Europe reduced annual nesting numbers at Aldabra to well below 1,000 females nesting annually during the late 1960s (Frazier 1976, 1984; Hirth & Carr 1970) and mid-1970s (Gibson 1979). In 1968, Seychelles halted the export of green turtle products and began to manage Aldabra as a nature reserve. Since 1981, turtle nesting activity has been monitored at Aldabra using methodologies consistent from year to year, thus enabling an assessment of population trends between 1981 and the present.

The Study Site

Aldabra is the most remote atoll in the Republic of Seychelles, and a World Heritage Site managed by the Seychelles Islands Foundation (SIF), where green turtles have been completely protected for 35 years (since 1968). Green turtle nesting habitat comprises more than 50 beaches whose total length is ~ 3.5 km or 4% of Aldabra's total outer coastline.

Methods

Since December 1980, all 50 green turtle beaches at Aldabra have been monitored for sea turtle nesting activity, but with varying consistency. The most consistent survey effort has been on 17 index beaches i.e., the West Grand Terre beaches Nos. 1 to 17, located along the south west coast of the atoll in the vicinity of Anse Mais and within only a few km of the Research Station. Surveys entail early morning counts of all nesting emergences that occurred during the night in which they are categorised

according to whether or not digging occurred (Mortimer 1997). Tracks are defined as emergences in which digging occurred, while Half-moons (HM) or Emergences-stopped-by-obstacle (ESBO) are those in which it did not. An effort was made to survey beaches 1-17 at least 3 to 4 times each month (although the actual number of surveys ranged from 0 to 15 per month.) Previously, Mortimer (1988) determined that on beaches 1-17, turtles make an average of 1.5 for each egg clutch laid. Based on these figures, the track count data were used to estimate the average number of egg clutches laid daily per month. These data were further extrapolated to provide estimates of numbers of egg clutches laid per year.

Results

Track surveys were done on the index beaches 1-17 during 18 years (1981-1989, 1992, and 1995-2002). Preliminary analysis of the data indicates the following:

Nesting Seasonality - Green turtles nest year-round with a bi-modal peak in nesting activity during February to March and June to September. This pattern is typical of most green turtle rookeries in the western Indian Ocean (Rene & Roos, 1996). In most, but not all years (11 of 13, or 85%), the June to September peak predominated.

Population Trends - Figure 1a shows the estimated numbers of egg clutches laid annually on beaches 1-17 during those 13 years (1981-84, 1989, and 1995-2003) when data were collected consistently throughout the year. Because during the other 5 years (1985-88 and 1992) insufficient data were collected to provide estimates of annual egg clutch production, data from those years are not indicated in Figure 1.

Assessing trends in sea turtle nesting populations is complicated by the fact that individual green turtles do not nest during consecutive seasons, and also by inter-annual fluctuations in nesting activity (especially subsequent to the 1998 El Niño event) (Fig. 1a). To get a better indication of trends, means were calculated and graphed (Fig. 1b) for each period of four consecutive years for which data are available. Those graphs indicate a clear upward trend in nesting activity during the period 1981-2002, for the index beaches 1-17.

Discussion & Conclusions

Numbers of nesting turtles appear to have increased significantly during the past 35 years. Mortimer (1985, 1988) had previously reported that nesting activity at Aldabra during 1981-1985 was approximately double that reported during 1968-70 (Frazier 1976, 1984; Hirth & Carr 1970) and 1975-76 (Gibson, 1979). Preliminary data produced for the present study indicate that there has been an additional increase in nesting activity since the early 1980s with the average numbers of egg clutches produced during 1995 to 2002 being approximately 2 to 3 times the number produced during 1981-1984. Clearly, the Aldabra green turtle population has responded positively to the 35 years of complete protection afforded nesting turtles at the atoll.

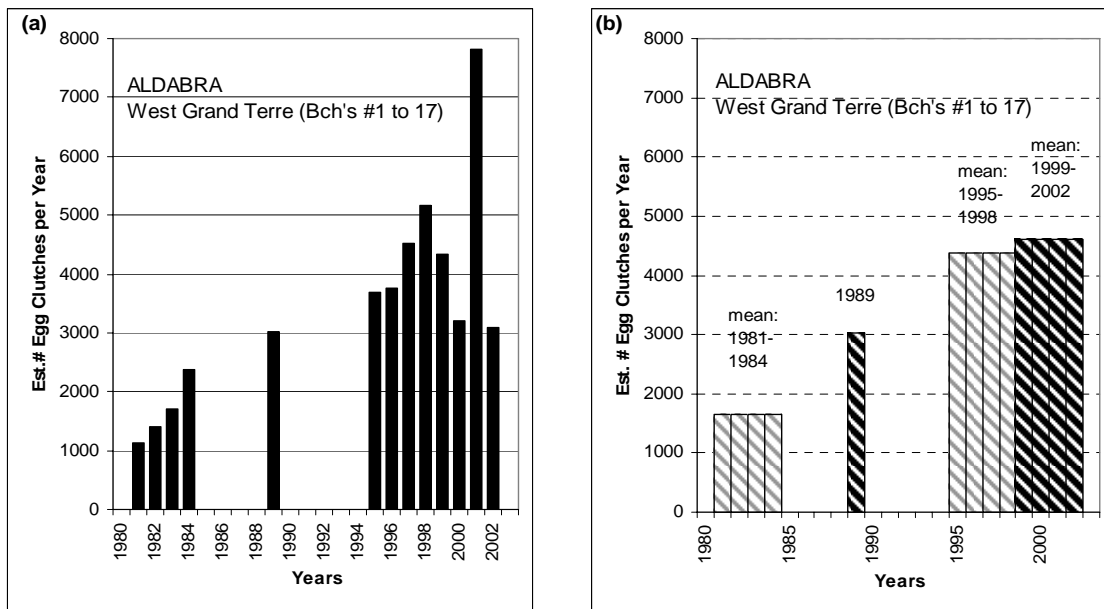


Figure 1. Estimated number of egg clutches laid at Aldabra index beaches #1-17 during those years adequately surveyed between 1981 and 2002. (a) shows numbers of egg clutches laid each year. (b) shows means for each period of four consecutive years (excepting 1989)

Because sea turtles are so vulnerable during reproduction, protection at the nesting beach is critical to the long term survival of any population. Nesting female green turtles show strong site fidelity in their choice of nesting beach (Miller, 1997), so we can expect the females to return consistently to nest at Aldabra (or an adjacent island) in years to come. But, green turtles are also highly migratory during other stages of their life cycle. Tagging studies show that adult green turtles migrate between their nesting grounds at Aldabra and feeding grounds located elsewhere in the western Indian Ocean (Mortimer, 2001). Meanwhile, genetic studies indicate that juvenile green turtles disperse to other parts of Seychelles and indeed throughout the region (Broderick et al., 1998; Mortimer 1998). It follows that protection of green turtles at Aldabra has positive implications for the entire region.

The Seychelles Government and SIF are to be congratulated on the success of their efforts to conserve the wildlife of Aldabra. But, the world also owes Seychelles a debt of gratitude for increasing the number of foraging green turtles in the region. Recent ecological studies indicate that the health of seagrass ecosystems and the prevention of such ecological catastrophes as seagrass wasting disease may depend on maintaining large populations of herbivores. These include green turtles, dugongs, & herbivorous fishes whose populations have been largely destroyed by past over-harvest (Jackson, et al., 2001). Enabling green turtles to increase in numbers to the point that the turtles can fulfill their ecological roles on their foraging pastures is likely to enhance the general productivity of the region's sea grass ecosystems, and in turn to have positive implications for fisheries as well as global biodiversity.

Acknowledgements

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BEACH RENOURISHMENT AND ITS IMPACT ON GAS CONCENTRATIONS IN LOGGERHEAD SEA TURTLE NESTS IN FLORIDA

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Beach renourishment projects pump foreign sand onto eroded beaches in order to supplement natural conditions. Obviously, this can have a deleterious impact on the incubation environment of sea turtle clutches.

For the past 3 years we compared gas concentrations of oxygen, carbon dioxide, hydrogen sulfide and methane in loggerhead sea turtle clutches deposited in native and nourished beaches in Florida. Our methods consisted of placing an air sampling tube and a temperature datalogger in the middle of the clutch, and in a control site one meter away. Weekly samples were pulled from each tube using a gas tight syringe and sampling bags.

CO₂ and O₂ analyses were completed with a gas chromatograph (GC) with thermal conductivity detector with and without a molecular sieve column, respectively. HS and CH₄ were analyzed on a portable GC with photoionization detector.

Data show that native beaches consistently tend to have higher CO₂, similar O₂ and HS, and lower CH₄ concentrations than nourished. These differences can be partially attributed to factors confounded by the renourishment process.

Physical characteristics such as compactness, temperature, humidity, and grain composition (among others), of each respective beach were measured. These parameters can have a substantial impact on the clutch gaseous microenvironment and their relative significance must be considered during beach nourishment projects. Physical properties of the native beach can influence higher CO₂ levels, while those of the nourished higher CH₄. Our future research will decipher the interactions existing between the physical properties of a beach and its incubating turtle clutches.

CONSERVATION AND MANAGEMENT OF SEA TURTLES IN KENYA

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This paper summarizes turtle conservation and management activities spanning a five-year period (1997-2002) characterized by increased reports of incidents of turtle mortality, poaching and illegal trade in turtle products (oil, meat and eggs) which constitute the major challenges to the realization of sustainable populations of marine turtles in Kenya. Within this period, the Kenya Sea Turtle Conservation Committee (KESCOM) has evolved from a committee to become the national body coordinating turtle conservation action in Kenya guided by three broad objectives (conducting research, awareness and monitoring activities, education and capacity building programs and enhancing community participation), which are designed to respond to the above challenges.

Data analysis results for 1997-2002 (nesting, tagging and mortality data), the progress made in the implementation of KESCOM's awareness programs will be presented in addition to the conservation efforts of eight Turtle Conservation Groups (TCGs) whose activities are spread over 31% of Kenya's 600KM coastline and adjacent waters and represents significant achievement in KESCOM's community involvement strategy. TCGs brief includes data collection, information dissemination, conducting education and awareness programs and enhancing community participation in the conservation and management of sea turtles in Kenya.

A number of parameters manifest in the nesting, tagging and mortality data collected by TCGs are compared for consistency and variability. These include clutch sizes, hatchling recruitment rates, carapace sizes (Curved Length and Width) and seasonal dynamics in nesting and hatching activity.

COMMUNITY-BASED CONSERVATION OF SEA TURTLES AT MAFIA ISLAND, TANZANIA *

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Tanzania's 800 km mainland coastline, together with Zanzibar and numerous smaller offshore islands, provides feeding, breeding and nesting habitats for all five species of turtle found in the Western Indian Ocean (green, hawksbill, loggerhead, leatherback and olive Ridley). Although officially protected, turtle populations nationally have been declining due to poaching of nesting females and eggs, captures in gillnets and prawn trawlers and disturbance of nesting beaches. Maziwe Island, for example, was an important nesting site for green, hawksbill and olive Ridley turtles until the early 1980s when the vegetation cover was destroyed and the island subsequently submerged. Natural causes however are much less significant than the unknown, but certainly very high, numbers of turtles killed by artisanal fishers, and from beach disturbance from hotel development, especially around Dar es Salaam and the main Zanzibar island, Unguja.

Mafia Island, located 120 km south of Dar es Salaam and 10 km offshore, is recognised as a key site for marine biodiversity protection and an important nesting site for green and hawksbill turtles. Roughly 50% of Mafia's 41,000 inhabitants rely mainly on marine resources for their livelihoods and in 1995 Tanzania's first marine park, 822 km² in size, was established at Mafia to manage these resources and to protect the rich mosaic of tropical coastal marine ecosystems including coral reefs, seagrass beds and mangrove forests.

The Mafia Island Turtle Conservation Programme was initiated in January 2001 in partnership with the Mafia Island Marine Park (MIMP), Mafia District Council, World Wide Fund for Nature (WWF) and local communities to ensure the long-term survival of turtles in the area. The aim was to achieve this through proactive community protection, research, monitoring and awareness raising.

Whilst Mafia is biologically rich, local communities on Mafia are economically poor. Tanzania is one of the poorest countries in Africa, and Mafia is probably one of the poorest five out of 120 districts in Tanzania. Average per capita cash income is about USD \$150 per year generated mostly from coconut farming and fishing. Education and health facilities are poor and infrastructure such as electricity and telephones is lacking in 90% of villages.

Within this economic climate, the concept of conservation and sustainable resource use is not a priority amongst local communities. For this reason, poaching of eggs and slaughter of nesting females as a source of income and protein has been a major threat to turtles on Mafia. Other threats include incidental captures in gillnets and disturbance of nesting beaches from fisher camps as growing numbers of migrant fishers are attracted to Mafia waters. Involvement of local communities in the Programme was therefore considered of high importance from the outset.

Nests are protected and monitored by a team of 8 locally elected Turtle Protection Officers who patrol the 14 main nesting beaches, covering approximately 50 km. They record data on nests, hatchlings and mortalities and are proficient in translocating nests and in tagging. Based on data gathered to date, it is estimated that Mafia has an annual nesting population of 60 - 100 turtles, mostly green with a small number of hawksbills. Turtle nesting frequency is shown in Figure 1.

In the first year of the programme (2001), an incentive scheme for nest protection was considered, based on similar initiatives in Kenya. However, concern was raised about the danger of setting a financial precedent which might prove hard to sustain especially as funding had only been secured for an initial two-year period. It was also considered worthwhile to determine first if it would be possible to establish turtle protection driven by a conservation ethic alone, without financial incentives. At the very least this would serve as a baseline if incentives were introduced at a later stage.

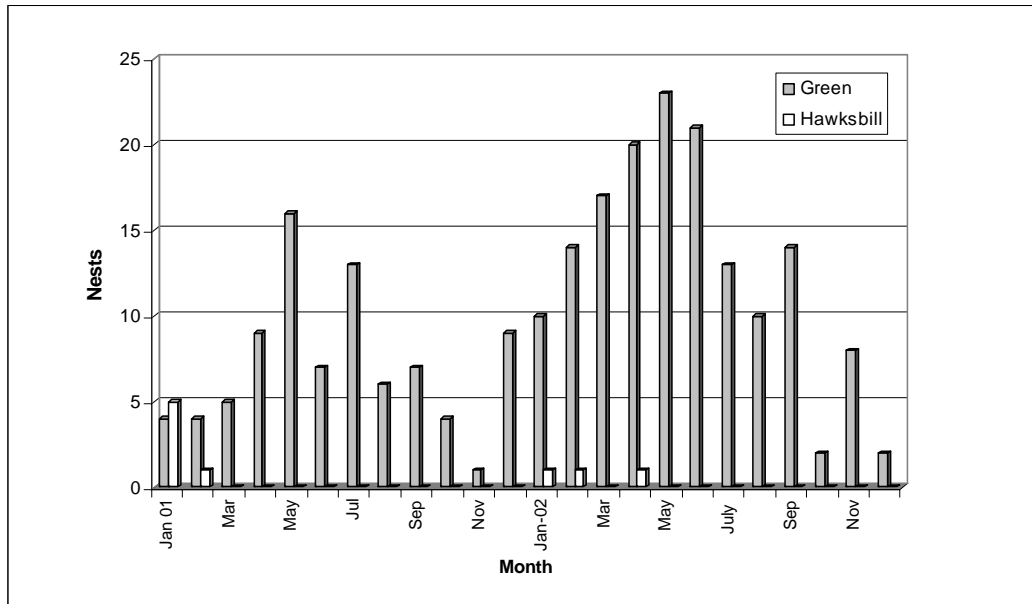


Figure 1. Nesting seasonality of Green and Hawksbill turtles on Mafia Island

In 2001, 68 nests were recorded (Table 1). Only 25% of these hatched whereas nearly 50% were poached. There were strong indications that nests were not being reported in certain locations, partly because of an unwillingness to cooperate amongst three communities and partly because of the inaccessibility of some of the more remote beaches. Discussions with fishers further indicated that awareness-raising alone was unlikely to change attitudes towards turtle protection, valued as they were as a food source.

Table 1. Fate of turtle nests at Mafia Island: 2001 & 2002

Nest data 2001/2	2001	2002
No. nests reported	68	164
No. nests hatched	17 (25%)	112 (68%)
No. successful hatchlings	1262	9163
No. nests poached	33 (49%)	8 (5%)

In view of the low hatching success and high poaching levels during the first year, a nest incentive scheme was introduced in January 2002. Under the scheme, individuals who report a nest received an initial reward of USD \$3 once the nest was verified. They then assisted the village Turtle Protection Officer in protecting the nest from human and non-human predators during the incubation period and are rewarded with a second payment of USD 0.40 for every successful hatchling and USD 0.20 for every rotten egg. During 2002, there was a dramatic increase in the number of nests reported from 68 in 2001 to 164 in 2002. The proportion of nests that hatched successfully increased even more dramatically mainly as a result of a substantial decline in poaching from 49% in 2001 to 5% in 2002 (Table 1). The average incentive per nest in 2002 was USD \$7, which equates to roughly 7 cents per live hatchling.

Notwithstanding the strong response to incentives, there has also been some evidence of voluntary community action, suggestive of early signs of changes in attitudes and perceptions. In August 2002, a gillnet fisher on Bwejuu Island voluntarily released a female green turtle that had nested and been tagged in the Comoros in 2001. This was the first officially recorded voluntary release of a captured turtle in Mafia. Since then fishers in two other villages, Chole and Bweni, have also voluntarily reported and released live turtles from nets. All these releases have been reliably witnessed. Gillnet fishers from Chole village are also now recording data on incidental turtle catches with no incentives attached, and are assisting with tagging.

Whilst encouraging, voluntary conservation actions are the exception rather than the rule. However, through the implementation of on-going awareness-raising campaigns it is hoped that voluntary actions will become more commonplace in the future. Awareness-raising activities include annual primary and secondary school marine conservation arts competitions; regular fisher meetings; distribution of educational materials such as locally designed posters, calendars and T-shirts; and the establishment of a District Environmental Education Committee.

The challenge ahead lies in developing long-term sustainability for the initiatives taken so far as well as extending the approach to other key sites on Tanzania's coastline. One means of securing financial sustainability is through turtle-based tourism and this is currently being tested and developed to gauge tourist interest in turtle-watching and in a nest adoption scheme. Another source of relatively sustainable funding is income generated from marine park visitor fees. Although tourist numbers to Mafia are relatively low compared to other destinations in Tanzania (such as Zanzibar) there is an upward trend and it is possible that in 4-5 years time a proportion of the fees could routinely support a turtle protection programme.

In conclusion, experiences on Mafia indicate that amongst poor, resource-dependent communities in Tanzania, at least in the short term, promoting a conservation ethic alone is insufficient to engage significant numbers of people in turtle conservation. The nesting and poaching figures show that even modest incentives of \$7 - 10 a nest can have a significantly beneficial impact from both a conservation and community aspect. In the longer term, it remains to be seen whether schools level education and awareness can achieve the same impact at a comparably low cost.

Acknowledgements

The authors wish to acknowledge the Sea Turtle Symposium and Western Pacific Fisheries Council for the generous travel grant and the Born Free Foundation for financial support. In addition, our thanks to Jason Rubens (WWF Mafia Technical Advisor), Louisa Muir, the village Turtle Protection Officers and the staff of the Mafia Island Marine Park and Mafia District Council for their continued support and cooperation.

SEA TURTLES ALONG TAMIL NADU COAST, SOUTHEAST COAST OF INDIA: STATUS AND CONSERVATION NEEDS

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Five species of sea turtles (*Lepidochelys olivacea*, *Chelonia mydas*, *Eretmochelys imbricata*, *Dermochelys coriacea* and *Caretta caretta*) occur along the Indian coast. The Andaman and Nicobar islands, the Lakshadweep islands and the Gulf of Mannar are important feeding grounds for the turtles. Gahirmatha beach in Orissa state is unique for sea turtle nesting wherein mass nesting of thousands of Olive Ridleys occur every year. Olive Ridleys also nests along Point Calimere Sanctuary in mid Tamil Nadu coast. But the predation rate is high threatening the population. In Gulf of Mannar and Palk Bay, turtle fishing was commonplace during the sixties and seventies and regular turtle trade existed between India and Sri Lanka. In order to protect turtles, all the five species have been brought under Schedule I of the Indian Wildlife (Protection) Act 1972 and listed in Appendix I of CITES. In spite of these measures, illegal turtle meat trade is still going on along Tuticorin coast of Gulf of Mannar. Turtle poisoning has been reported along this coast in earlier days. The incidental catches, mostly *Chelonia mydas*, are traded for meat. The turtle meat is highly priced as it is said to be having medicinal property. On an average three to five turtles are brought to the market every week. Based on the demand, the turtles are also said to be hunted illegally. Enforcing the use of TEDs, public awareness campaigns, and a participatory approach, among others, are considered as vital strategies to conserve the depleting turtle resources.

CONSERVING INDONESIAN SEA TURTLES 2001-2003 : FROM ISLANDS TO COUNTRIES

Putu Liza Kusuma Mustika, Ngurah Mahardika, and Windia Adnyana

Sea Turtle Campaign, WWF Indonesia Wallacea Program

Since the all-encompassing protection of all sea turtles by Indonesian law in 1999, there has been a lot of progresses in sea turtle conservation in the country. The prohibition of the trade of sea turtles and their by products has ignited pros and contra arguments from turtle traders and concessionaires in major trade places in Indonesia. Bali turtle traders launched the strongest protest against the new law, while some turtle egg concessionaires did not launch any protests, while in Derawan Islands (East

Kalimantan), the biggest concessionaire supported the law by upholding the Regent's Decree on turtle conservation in the islands by releasing two major turtle islands for conservation.

Life goes on, and efforts are made to up hold and endorse the turtle protection law. Together with its neighbour, West and East Nusa Tenggara, Bali has committed to help turtle conservation by establishing species task force to monitor trades of protected species and enforce the protection law in three provinces. Derawan Islands has progressed by running a training workshop among three countries (Indonesia, Malaysia, and the Philippines), held in Berau last March 2002.

This paper explains efforts made by the WWF Indonesia Wallacea Bioregion Program and partners to conserve sea turtles in two major ecoregions: the Sulu Sulawesi Marine Ecoregion (SSME : Derawan Islands) and the Flores Banda Sea Ecoregion (Bali, West Nusa Tenggara and East Nusa Tenggara). The paper will also review current status on turtle law enforcement in the regions.

THE PROTECTION OF SEA TURTLES HABITATS: INTERNATIONAL PERSPECTIVE AND A CASE STUDY

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This presentation analyses the problems surrounding protection and conservation of sea turtle habitats, caused mainly by the threats by tourism and coastal development. Beginning with the Interamerican Convention for the Protection and Conservation of Sea Turtles, which requires all parties to protect, conserve and if necessary restore sea turtle habitats and nesting areas, the presentation covers the main international instruments and mechanisms that have been developed at global and regional levels to enhance the protection of sea turtle habitats. The presentation also describes how these international mechanisms have been adopted and implemented at a local level within National environmental legislation and how these internal mechanisms have helped halt a large economic tourism development that has caused massive destruction in coastal habitats. As an example of the mechanisms available within the law to protect sea turtle habitats, the presentation exposes an important case that caused an enormous precedent in sea turtle conservation, not only in Mexico but among the international community: the case X'Acel – X'Acelito, in the Quintana Roo State Rivera Maya, and documents the use of the mechanisms mentioned above to halt the development of a large resort on the most important green and loggerhead sea turtle nesting grounds in the Caribbean and Atlantic.

CONSERVATION AND MANAGEMENT OF OLIVE RIDLEY SEA TURTLES AT GAHIRMATHA, ORISSA, INDIA

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Gahirmatha is located in the north-eastern part of Orissa, and is the world's largest known nesting ground for Olive Ridley turtles. It is estimated that about 50% of the world population of Olive Ridleys nests in India between January and May, and about 90% of these nest in Gahirmatha. The Gahirmatha Marine Sanctuary, declared in 1997, encompasses an area of 1435 sq. km. Olive Ridleys usually arrive at Gahirmatha during October/ November and remain untill April/May during which patrols are carried out by sanctuary staff. The entire beach is divided into segments, monitoring camps are set up and trained workers engaged to monitor mortality and sporadic nesting of sea turtles. Protection camps are also set up at vantage locations. Turtle monitoring committees are convened for coordination and joint patrols. Workshops and awareness camps are also organized in peripheral fishing villages. In-situ conservation efforts include protecting the nesting sites along the coast by engaging local youth as well as fencing off certain places to prevent entry of predators. Ex-situ conservation measures have been taken up in the last years through hatcheries at four places. Turtle tourism is being promoted involving children at accessible locations for awareness and education. Threats at Gahirmatha are due to the proliferation of mechanized fishing, beach erosion, northward shifting of nesting sites, light pollution from Outer Wheeler Island and Paradeep, loss of mangrove in the Mahanadi delta, predators and water pollution by industries at Paradeep.

SEA TURTLE CONSERVATION AND MANAGEMENT IN KENYA *

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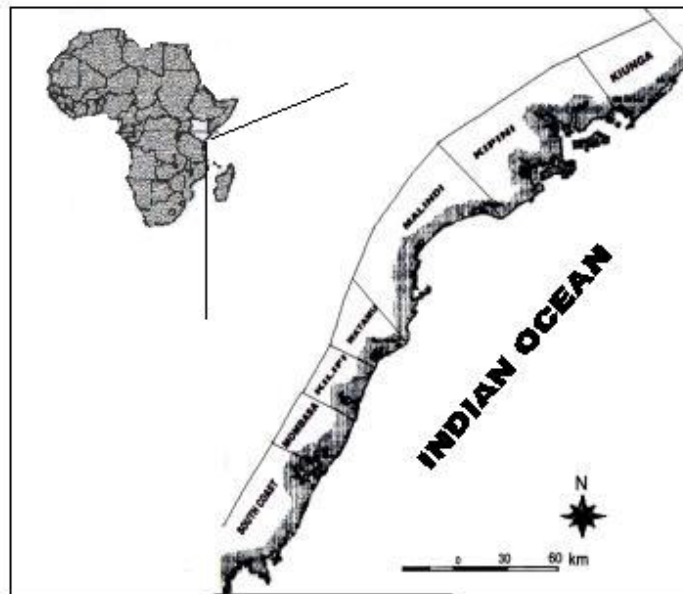
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Introduction

The Kenya Sea Turtle Conservation Committee (KESCOM) was established in 1993 out of a necessity to address the plight of five marine turtle species (green, hawksbill, olive ridley, loggerhead and the leatherback) occurring in Kenya, and represents a national integrated approach contributing towards global efforts in turtle conservation. This followed increased incidents of turtle mortality (Wamukoya, 1997) mainly occasioned by fishing activities and reportedly declining populations (Wamukoya, 1997, Frazier, 1975) within the Western Indian Ocean region as a whole. The committee sought to specifically address the problems of illegal poaching of turtle eggs and meat and a burgeoning list of threats posed by the growth of the tourism industry. There have also been attempts to institute measures, which can withstand gaps in national legislation (Cap 376 of the Wildlife Act and Cap 378 of the Fisheries Act) mainly through community and stakeholder involvement and participation in the conservation process. The guiding objectives relate to conservation and management driven research and monitoring, capacity building and awareness, community participation and building of networks and collaborative strategies (KESCOM, 1999).

Initial efforts to implement conservation and management objectives were limited within the Mombasa Marine National Park and Reserve (Fig. 1) with the support of the Kenya Wildlife Service and Baobab Trust. Over time, with increased support and cooperation from government institutions and NGOs as well as private interests and volunteers, KESCOM has to date established nine community-based Turtle Conservation Groups (TCGs) along the Kenyan Coast. The activities of TCGs involve collection of turtle data and information at the ground level and engaging local communities in the conservation process through education and awareness programs, beach patrols and surveillance-to protect turtle nests and nesting females, tagging of sea turtles, and fishermen-turtle-release programs. They also participate in beach-clean up events. The current group listing includes (from south to north-coast); Bodo Turtle Conservation Group, Funzi Turtle Club, Boabab Trust, Kilifi Community Conservation Group, Watamu Turtle Watch, Robinson Island Turtle Conservation Project, Kipini Community Conservation Group, Lamu Marine Conservation Project and WWF-Kiunga. Their activities cover 31% of the Kenyan Coast and have so far tagged over 500 turtles with no tag returns reported.



Map 1. The Kenyan Coast showing conservation areas covered by TCGs.

However, in spite of the above efforts local people are still exploiting sea turtles for their eggs, shells and meat. In addition, turtle nesting beaches (rookeries) are being modified and/or being lost gradually to unplanned coastal development, and foraging habitats such as coral reefs and seagrass beds are being destroyed by pollution, perennial sedimentation and unsustainable fishing activities (Frazier, 1980, Wamukoya, 1997, Okemwa, 2003). Many turtles are accidentally caught and drowned in fishing gear (mainly trawlers, seine and gill nets) each year (Wamukoya et. al. 1995, Okemwa, 2003). This problem is further compounded by the existence of a black market trade in turtle products and a lax implementation of the supporting legislation. Reports from Turtle Conservation Groups (TCGs) indicate that between 85%-89% of incidents leading to decline of turtle populations in Kenya are human-based (Nzuki, 2002, Okemwa, 2003). In response, KESCOM is currently conducting targeted research (scientific and social) to fill in specific gaps in information to further awareness and education campaigns and promote community participation.

Research Output -1997-2001

Nesting activity, hatching success and mortality reports - Although the KESCOM was established in the early 90's, marine turtle data and information was scarce and basically limited to areas around Mombasa. It was not until 1997 that data from several other areas along the Kenyan coast become available, in line with the establishment of more TCGs. From 1997 to 2001 a total of 695 nests containing a total of 64,877 eggs were reported, 60% of which were located in the North Coast. Of these, green turtle nests accounted for 94% of the total. Nine hawksbill nests were sighted with the highest number sighted in 2000 (four sighted in Mombasa and two in Kiunga). Olive ridleys were confirmed to nest in Kenya in 2000 when eight were sighted in Mombasa, four at Watamu and five at Kiunga. This is mainly attributed to improved surveillance and monitoring activities/and/or improved knowledge in species identification.

The major nesting sites include; Jumba Ruins, Kijipwa, and Nyali Beach along the Mombasa section; Chandani, Kongowale, Kiumwini, Mwanabule, Mtunumwe, Mongo Shariff and Mongoni at Kiunga and the Watamu beach stretch (Figure 1). There is however, gaps in knowledge especially between the Malindi and Watamu stretch. The seasonal patterns in nesting activity, which peaks in May and gradually decreases from June onwards but with spatial-temporal variations for different species are indicated in Figure 2.

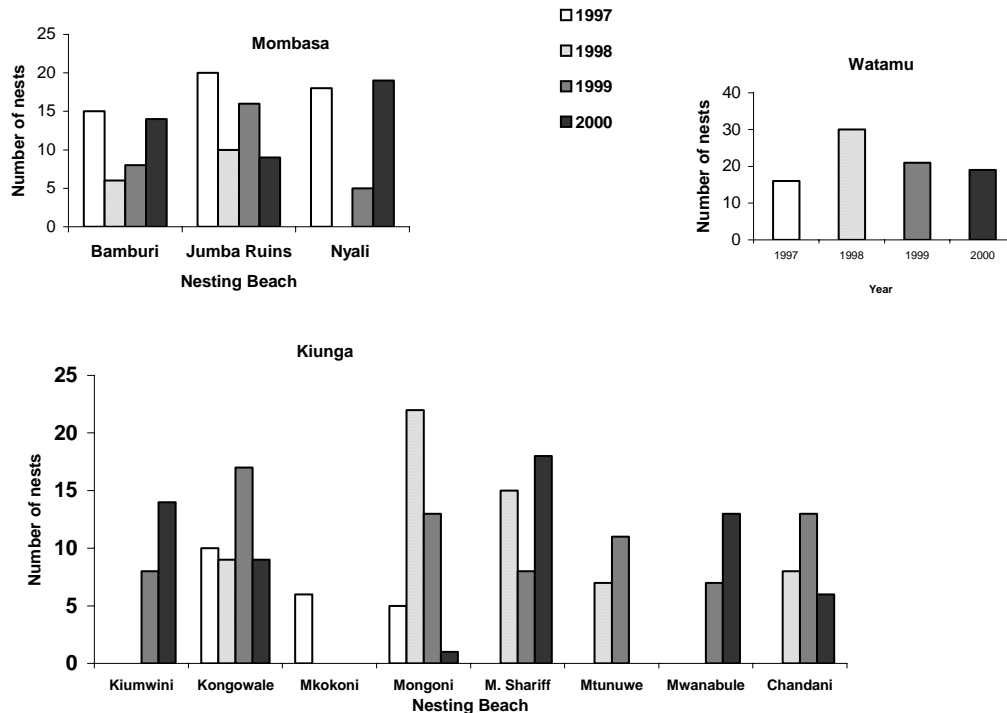


Figure 1. The number of nests sighted at some major nesting sites along the Kenyan coast from the years 1997 to 2000.

A total of 51,215 (79%) hatchlings were successfully released back to sea during the 1997-2000 period. There was a 5-10% increase in hatching success during the 1999-nesting season at all locations attributed to improved surveillance, proper management of natural hatcheries and increased public awareness efforts by KESCOM. Hatching success for green turtles at Watamu and Kiunga peaked during 1999 (92% and 83% respectively) but remained fairly constant at Mombasa (85%). The mean

clutch sizes for green turtles were relatively similar annually at Mombasa (114-122 eggs) and Watamu (118-138 eggs) but notably lower at Kiunga (104-107). The mean clutch size for olive turtles was 100, 102 and 134 eggs in Watamu, Kiunga and Mombasa respectively. Hawksbill clutches had a mean of 146 eggs in Mombasa and 92 for Kiunga. The mean incubation period ranged between 55-60 days for green turtles. Hawksbill and olive ridleys eggs incubated for an average of 54.5 and 43.3 days respectively with slight variations for different areas along the Kenyan coast.

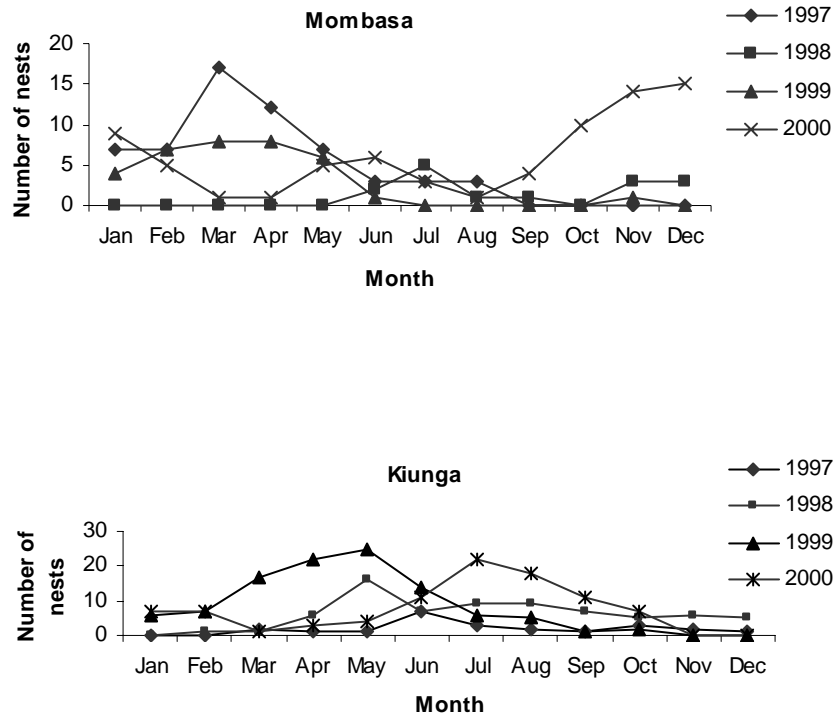


Figure 2. Seasonal patterns of sea turtle nesting activity at Kiunga and Mombasa during the 1997-2000 nesting period.

During 1997-2001, 171 mortalities were reported. There was an upsurge in mortality reports in 2000 and 2001 mainly attributed to increased surveillance by turtle groups. Of the mortalities 58% were slaughtered by fishermen, 36% were as a result of entrapment in fishing gear and spear guns while the rest were due to ingestion of plastics.

Awareness and Education Programmes

Implementing community-based activities requires awareness as well as capacity building activities to significantly influence the quality of local action/community participation in the conservation process. Conducting awareness and education programs has been core to the success of KESCOM’s objectives and has been key to the establishment of new TCGs in Kenya. Each year awareness and education activities account for over 50% of KESCOM’s budget. This is attributed to a global realization that including environmental concern in the consciousness of the average citizen is crucial to the sustained survival of both human residents and wildlife. Sea turtles are particularly good candidates for public education campaigns since they are a flagship species whose populations are affected by health of the coastal zone, both marine (coral reefs, seagrass) and terrestrial (sandy beaches, littoral forest).

KESCOM also recognizes that local leaders such as teachers, government administrative officers and community elders constitute an important audience for education and awareness and therefore works towards strengthening them to become aware of the wide range of co-management responsibilities that exist. Emphasis is placed on the need for greater awareness on the responsibilities they have or could have in controlling marine resource use and exploitation and general development of their communities. Currently KESCOM conducts regular awareness and education campaigns targeting mainly local communities, school and college students and the tourism industry. The package includes lectures, discussions, exchange programs, use of audiovisuals, brochures and newsletters.

Community Involvement

TCGs constitute an important avenue for the involvement of local people in the conservation and management of sea turtles in Kenya. Although there are inherent gaps in the information collected by TCGs (mainly due to limited resources) and the challenge of lack of conservation programs in neighboring areas, TCGs have remained steadfast in implementing Kenya's national sea turtle conservation agenda through their commitment in ground data provision, information sharing and a strong advocacy for sustainable utilization of our marine resources. The latter has helped to change the attitudes of local fisher folk towards conservation and many of them are now joining organized turtle conservation groups to collectively promote the survival of sea turtles. Success stories from other conservation groups have been instrumental in promoting local action in coastal areas hitherto with little or no conservation effort.

Conclusions

The current status of sea turtle exploitation in Kenya spells a major challenge to conservation and management efforts especially given that a large percentage of mortalities are human caused and mitigation measures partly involve major socio-cultural as well as socio-economic shifts. Furthermore the legislation, which protects sea turtles in Kenya i.e., the Wildlife Act (Cap 376) and the Fisheries Act (Cap 378) does not provide for the protection of habitats within which sea turtles occur except for nesting and foraging areas falling within the Marine Protected Areas (MPAs). And, the lack of adequate financial and human resources continues to considerably slow the pace of conservation action.

Among KESCOM's plan of action is to strengthen its institutional partnerships and stakeholder involvement in conservation. In addition there are plans to support TCGs to identify potential sources of alternative livelihoods and increase our spatial coverage to 75% of the Kenyan coast within the next five years through engagement of stakeholders in the tourism industry, local communities and donors. Eventually KESCOM intends to shift actual conservation and management responsibilities to the local people but through a gradual process and play more of a coordinating role.

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SEA TURTLE PROTECTION ACROSS FRONTIERS: SOUTH-SOUTH COOPERATION

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Introduction

Since 2000, organizations from the Netherlands, Benin and Costa Rica have been developing relationships to promote sea turtle protection. This was possible under bilateral international agreements between the Netherlands and the two other countries. The agreements aim to work towards sustainable development in the member countries through cooperation and the exchange of knowledge, and they promote cooperation between NGOs from the different countries.

International Agreement of KIT-NIPS and CBDD

NIPS - the Netherlands International Partnership for Sustainability - coordinates in the Netherlands the implementation of agreements on sustainable development. The principles of the agreements are: reciprocity, equality and participation, in order to promote the exploration of new horizons. NIPS' ambition is to contribute towards the development of new standards in North-South relations. NIPS wants to stimulate global sustainable development with the recognition of mutual dependency and responsibility, the necessity for equal sharing, for the benefit of future generations and the ability to learn from each other and each others organizations. The counterpart of NIPS in Benin is the CBDD, the Centre Beninois pour le Developpement Durable.

History

In 2000, representatives from Nature Tropicale (Benin) and Biotopic (The Netherlands) visited five different sea turtle conservation projects in Costa Rica. Mr. Randal Arauz of STRP Pretoma introduced them to several projects looking at management, ecotourism, working with the population and volunteers and the use of turtle excluder devices in fisheries. The next step was the organization of a technical workshop in Benin by Nature Tropicale, Biotopic and the IUCN. One of the results was the establishment of a regional sea turtle network in West Africa, Wastcon, and an evaluation of the status of sea turtle protection in Benin. The evaluation highlighted the importance of stakeholder participation in conservation issues along the coastal zone in Benin.

Participation in Conservation

In February 2003 several meetings were organized by Nature Tropicale, Coope Sol i Dar, Biotopic and IUCN in Benin, where information and discussion sessions with the different stakeholders took place. Comparisons were made with the situations in Suriname where ecotourisms play an important role in the conservation efforts and the local economy. Costa Rican practices on participatory methodologies were presented and explained. Together with the stakeholders, a first inventory of their problems was made. With the members of Nature Tropicale a session was organized on the methodology for the analysis, identification and how to prioritize the actions. Possible alternative socio-economical development can be discussed with the actors, for instance in ecotourism and aquaculture.

Conclusions

1. The participatory methodologies used in Costa Rican field projects appeared to be useful in the African context and in the work that Nature Tropicale does in Benin.
2. The practical application of these methodologies can be adapted to the African context using local animation, drawings and histories from the African Culture.
3. Nature Tropicale and Biotopic could benefit strongly from a training course on facilitation of meetings and participation tools.
4. The challenge in Benin is to look for alternative and sustainable socio-economical such as ecotourism and aquaculture.
5. North-South relations as well as South-South relations between NGOs or between villages can be used as a stimulus for new conservation developments.
6. It is urgent to develop ways to incorporate the different institutions, sectors and communities into the conservation and scientific work developed by Nature Tropicale in Benin.

SOUTH PACIFIC REGIONAL MARINE TURTLE CONSERVATION PROGRAMME: A VISION FOR EFFECTIVE CONSERVATION AND SUSTAINABLE USE OF OUR TURTLE RESOURCES

Job Opu

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The Regional Marine Turtle Programme was first developed by SPREP and the Australian National Parks and Wildlife Service (ANPWS) in 1989 and adopted by the Fourth South Pacific Conference on Nature Conservation and Protected Areas. Since then the RMTCP has been adopted by all the countries of the region as the focus for turtle conservation work in the South Pacific.

The programme includes population census, tagging and monitoring, other research, the creation of a regional information database, public education (posters, school education etc); staff training; legislation and regulation review; and other conservation work (protection of nesting areas etc.).

The RMTCP currently carry out three major activities:

- Networking with member countries,

- Support for in-country projects / programmes,
- Production and distribution of turtle conservation resource material

In networking, RMTCP maintains communication between and among member countries ensuring exchange of information. A regional database on marine turtles is housed in SPREP and information disseminated regionally according to country requests. RMTCP provides support to in-country programmes and projects aimed at turtle conservation and sustainable utilization. Project proposals from member are submitted to RMTCP for funding. Projects submitted to date have been designed to carry out turtle tagging programmes and carrying out awareness campaigns. Project proponents have mainly asked RMTCP to produce and distribute turtle conservation resource material to member countries and other interested parties to promote turtle conservation. Resource material includes turtle video re-run, turtle tags and applicator kits, posters and t-shirts. These materials are distributed according to country requests and as resources allow.

INVOLVING COMMUNITIES IN SEA TURTLE RESEARCH: EDUCATION MAKES A DIFFERENCE

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Illegal egg harvests from sea turtle nesting beaches continues to be a major threat to the long-term survival of sea turtle populations (Spotila et al, 1996). Many research programs desire local residents' participation in conservation efforts, but involving the public extends beyond the expertise and time of many scientists (Brewer et al, 2002). For three years, Ecology Project International has successfully integrated local residents in conservation research at a high-density nesting beach for leatherback sea turtles (*Dermochelys coriacea*) on the Caribbean coast of Costa Rica. In 2002, 17 student groups totaling 272 participants served as research assistants during 51 nights of the peak leatherback nesting season. Local high school students collected biometric data, augmented the frequency and duration of patrols, contributed to habitat restoration of the nesting beach, and provided energy and inspiration to resident researchers. In February, 2003, Ecology Project International applied this model of community involvement at a green turtle (*Chelonia mydas*) monitoring program in Galapagos National Park, Ecuador. In the first partnership of its kind on the islands, local Galapageño high school students patrolled critical nesting beaches alongside biologists from the Charles Darwin Research Station.

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PROTECTING SEA TURTLE NESTS FROM RACCOON DEPREDATION AT SEBASTIAN INLET STATE PARK

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Raccoons are the main predators of sea turtle nests at Sebastian Inlet State Park, the largest section of public owned land in the Archie Carr National Wildlife Refuge, located on the central East Coast of Florida (USA). The Archie Carr National Wildlife Refuge has the second largest nesting aggregation of Loggerhead sea turtles in the world. A raccoon reduction program has been implemented, in which we used three methods to decrease the raccoon population. One, we reduced access to human food sources, such as dumpsters and garbage cans; two, we used public education activities such as public interpretive programs and signage; and three we used a live trapping and euthanasia program. By reducing the raccoon population there has been a positive effect on reducing raccoon predation on sea turtle nests.

TOUR OPERATORS: A POTENTIAL ALLY IN THE PROTECTION OF SEA TURTLE NESTING HABITATS. THE CASE OF CRETE, GREECE *

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Introduction

Crete is the 5th largest island in the Mediterranean, situated in the Eastern Mediterranean basin. Three important nesting sites for loggerhead sea turtles were discovered on the island: Rethymno, the Bay of Chania and the Bay of Messara (Margaritoulis et al., 1992) and they have since been monitored by ARCHELON, the Sea Turtle Protection Society of Greece.

With more than 2.6 million visitors per year, Crete is also one of the most popular tourist destinations in the Mediterranean. The dominant type of tourism is package holidays, regulated by tour operator companies. Tourism on the island is concentrated on the coasts and has a strong seasonal character, since 92% of the total activity takes place between May and October, coinciding with the sea turtle nesting season (Data GNTO, 2003). All three nesting sites are under pressure due to intense tourist development (Panagopoulou & Dimopoulos, in press). With the completion in 1997 of a LIFE-Nature Project, co-funded by the European Union, a Management Plan was compiled aiming to:

1. Mitigate the effect of tourist development on the nesting sites, thus ensuring their viability for the future;
2. Ensure that all future development will have minimal impact on the nesting habitats; and
3. Achieve the above through cooperation with the local community, the local authorities and the tourism industry (Irvine et al., 1998).

This paper presents ARCHELON's cooperation with tour operator companies on Crete, analysing the strategy used to approach them and the major outcomes of this cooperation.

Methods

Why would a tour operator company wish to contribute to conservation? The environment is perceived as one of the main reasons why people choose an area for their holidays. Tour operator companies acknowledge the fact that tourism has a negative impact on the local environment, therefore by minimising that impact, they protect the quality of their tourist product and ensure that each destination will continue to appeal to their clients in the future. Moreover they gain a competitive advantage differentiating their product.

As a result, most of the tour operator companies have established Environmental Departments that promote environmentally friendly policies, support local conservation work, and urge their clients as well as the resorts they cooperate with to follow their example. According to the results derived by questionnaires filled in by the hotels as well as clients, tour operators such as Hotelplan, TUI and Kuoni reward hotels for their conservation achievements.

Tour operator companies have also formed partnerships to promote sustainable development, committing themselves to minimising the impact of tourism on the environment. Such partnerships include the Tour Operators Initiative for Sustainable Tourism Development, supported by UNEP, UNESCO and the World Tourism Organisation, as well as the "Declaration of Crete" signed in 1999 by the Swiss Federation of Travel Agencies.

Who to approach? Most European tour operators belong to larger, multi-national companies, even though they maintain some degree of independence. Environmental Departments are usually answerable directly to the Board of Directors of the parent company. Each of these companies has a head office in the tourist destination, and may have one or more local offices, responsible for the area's tourist businesses.

ARCHELON's cooperation with tour operators invariably starts with contacting the Head of the Environmental Department. Once an agreement is reached, the local offices and businesses implement it. In other cases, tour operators express interest following recommendation by businesses ARCHELON is already working with, as was the case with Grecotel and TUI. In most cases however, the first contact is made at the level of the local offices first, before moving on to the destination head office and from there to the Environmental Department.

How can tour operators support sea turtle conservation on Crete? Tour operators can act as intermediaries between ARCHELON and the tourists. By providing information about sea turtles in the brochures prepared for Crete, including information on their

web sites or printing leaflets, they play a key role in raising awareness among tourists about sea turtles. Tour operators can also inform their clients at welcome meetings held upon their arrival to Crete.

Tour operators can also use their influence to apply pressure for the protection of the sea turtle nesting habitats of Crete. This is usually done by writing letters to the authorities asking for ARCHELON's management proposals to be implemented, asking hotels to improve their policies for the benefit of sea turtles and intervening on any management issues that arise.

Tour operators can support ARCHELON financially either directly in the form of beach or hatchery sponsorships, or indirectly by recommending ARCHELON's work to their clients or other companies they work with.

Results

ARCHELON cooperates with the major tour operator companies that account for more than half the tourists that visit Crete (1.7 million people). These include TUI GROUP, TUI Nordic, TUI Netherlands, Finnmatkat, Hotelplan, Apollo, PURE CRETE and Kuoni. In the last five years, these cooperations have produced significant results:

1. Raising Awareness about Sea Turtles

- TUI, Hotelplan, PURE CRETE and Apollo include information about sea turtles in the brochures prepared for Crete. The total number of brochures exceeds 10,000,000 copies per year
- Hotelplan have issued 300,000 leaflets for distribution to their clients at welcome meetings
- TUI, Hotelplan and PURE CRETE include information about ARCHELON on their web sites
- Tour representatives trained by ARCHELON include information about sea turtles at their client's welcome meetings.

As a result of the above, the total number of people informed since 1998 exceeds 2.5 million people. It is estimated that one out of four visitors to Crete during 2003 (650,000 people) will have received information about sea turtles prior to or upon their arrival to the island.

2. Lobbying for the implementation of ARCHELON's management proposals - TUI, TUI Nordic and Apollo send letters to all hotels they cooperate with asking them to implement ARCHELON's management proposals. In 2000, TUI sent a letter to all the local authorities of Crete, as well as the Regional Office, the Greek National Tourism Office and the Ministry of Environment requiring information on the status of sea turtle conservation on Crete. All recipients contacted ARCHELON for advice on how to reply to this letter, and have since made more of an effort to cooperate.

Tour Operators have intervened on beach management issues in favour of ARCHELON. For example, in 2000 a hotel dug a 1,500m trench along the beach in order to connect its sewage system to that of a neighbouring hotel. ARCHELON's immediate reaction combined with an intervention by TUI resulted in the pipe being removed and the beach restored to its original condition at the expense of the hotel involved.

3. Supporting ARCHELON's work - In 1994, ARCHELON received TUI's Environmental Award for "ten years of persistent efforts in the areas of environmental education, public awareness, monitoring, rescue and rehabilitation of sea turtles at Greek coastal areas". ARCHELON's project of Crete covers 30% of its running costs through beach and hatchery sponsorships from tour operators. The Prince Bernhard Foundation supported ARCHELON's environmental education Programme for one year following a recommendation made by TUI Nordic Hotels that used to be skeptical towards ARCHELON are now models of cooperation thanks to the intervention of Tour Operators. A hotel in Chania rapidly changed their attitude towards ARCHELON when they were informed of its cooperation with two of their major clients, Hotelplan and TUI Nordic.

Conclusions

Tour Operators can be important allies for the conservation of sea turtle nesting habitats on Crete by helping to reduce the negative impact of tourism on the local environment and by acting as intermediaries between ARCHELON and the tourists.

Furthermore, ARCHELON's cooperation with tour operators has increased support among the local community who no longer perceive the existence of sea turtles as an obstacle to their prosperity.

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TURTLES IN THE CARIBBEAN OVERSEAS TERRITORIES (TCOT): A SUMMARY OF PROGRESS

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The exploitation of marine turtles in the Caribbean has generated an extraordinary level of international concern in recent years. Consequently, the CITES Hawksbill Turtle Range State Dialogue Process has led to a general agreement among Range States to work towards a regional management strategy for the hawksbill turtle in the Caribbean.

In line with recommendations made through the Dialogue process, the UK Government has commissioned a three-year project to address critical gaps in the knowledge of marine turtle populations found in the UK Overseas Territories. The project, known as TCOT (Turtles in the Caribbean Overseas Territories), was launched in November 2001 and aims to assess the status and exploitation of the marine turtle populations found in Anguilla, Bermuda, British Virgin Islands, Cayman Islands, Montserrat and Turks and Caicos Islands.

TCOT is coordinated by the Marine Turtle Research Group, University of Wales, Swansea and the Marine Conservation Society (MCS), in association with the Cayman Island Department of Environment, the Cayman Turtle Farm, University of Wales, Cardiff and the University of Western Ontario. TCOT relies heavily on a partnership approach and is conducting research in collaboration with project partners in each Territory. The research includes nesting beach and foraging site monitoring, genetic stock analysis, PIT and flipper tagging, socio-economic surveys, as well as volunteer programmes involving dive operators and tourists. These research methodologies were standardised between the Territories at a TCOT training workshop attended by the project partners and held in Grand Cayman in August 2002.

The data collected from the research programmes will be analysed to form the basis of a series of Territory-specific reports, which will provide an up to date status evaluation of marine turtle populations and will include recommendations for future marine turtle management and research in each Territory. These recommendations will be submitted to the Territory governments and the UK Government in October 2004 in order to inform their positions with respect to the CITES Hawksbill Turtle Range State Dialogue Process.

REPRODUCTIVE ASPECTS OF THE SEA TURTLES IN CIPARA, PENINSULA OF PARIA, SUCRE STATE, VENEZUELA DURING THE 2002 NESTING SEASON

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Introduction

The “Research and Conservation of the Sea Turtles of the Peninsula of Paria” project concluded its fourth year of activities on Cipara Beach (10°45' N, 62°42' W in Sucre State, northeastern Venezuela). This peninsula is the most important nesting area for leatherback turtles in the Venezuelan mainland (Guada, 2000). The project goals are to collect reproductive data and guarantee the protection of the gravid females and the nests, beside promoting a local and regional awareness about the endangered status of the sea turtles. In addition, the data of the incidental caught and mortality by unknown causes are also recorded.

Methods

During 2002, the beach was monitored from April 17th to September 15th. The beach patrolling was performed at night, although several females arrived during the day. The gravid females were double-tagged with metallic tags in the left fore-flipper and with PIT tags in the right shoulder. Pictures of the pink spot in the head (crown) of the turtles were taken. Carapace measurements (SCL and CCW) along with notes on the general condition and the presence of tag scars. The majority of nests were translocated to a protected hatchery and several more were relocated in the beach.

Daily surveys were made to estimate the total number of reproductive events and the nesting frequency, the interesting period and the nesting success (Alvarado and Murphy 2000; Hernández 2002). For nests we recorded the number of hatchlings and embryos (alive and dead), the presence of eggs without apparent development, and the number of hatchlings released. The hatching success and the recruitment success was then established (Sarti and García, 1999).

Environmental education activities were conducted between April and September and during November in Cipara and on other beaches of the northern Peninsula of Paria.

Results and Discussion

Turtle Tagging: Only 30 gravid females were tagged and 3 turtles were recaptured which had been tagged two years earlier. In addition, two loggerhead turtles (*Caretta caretta*) and one hawksbill turtle (*Eretmochelys imbricata*) were tagged (Guada and Rondón, 2003). During 2002 we encountered a lower number of turtles than we expected in Cipara (n = 37 in the 2000, and n = 51 in the 2001), and it appears to be the same trend observed in other nesting beaches in Venezuela and the Caribbean Sea (A. Gómez, pers. comm., Margarita Island, GTTM-NE; D. Chacón, ANAI, Costa Rica).

Nesting on Adjacent Beaches: A leatherback turtle tagged in Cipara was reported nesting in San Juan de Unare (to the west of Cipara). Another female tagged in Querepare (the second beach in the project) was sighted in Cipara, and a turtle from Cipara nested in Querepare (Guada and Rondón, 2003). Female *Dermochelys coriacea* have continued their exchange between the nesting beaches.

Nesting: The estimated number of nesting females was of 42 with 176 nesting events. The estimated number of females between 2000 and 2002 is approximately 159 females (Rondon and Guada, 2003). The observed nesting frequency was of 2.5 times per female and the interesting period was of 12.4 days. The inferred nesting frequency and interesting period are 2.7 times per female and 11.1 days, respectively. The nesting success was of 64.6%.

Nests and Hatchlings: Eighty-seven leatherback turtle nests were translocated to the hatchery and 11 nests were relocated on the beach. A total of 4,503 hatchlings were released to the sea. The hatching success and the recruitment success were 68.6% and 60.6%, respectively. For the loggerheads, two nests were transferred to the hatchery and three were relocated in the beach. A total of 341 loggerhead hatchling were released, and the hatching success and the recruitment success were 55.9% and 54.0%. Two hawksbill nests were translocated to the hatchery and one was relocated on the beach. A total of 361 hatchlings were released, and the hatching success and the recruitment success were 91.2% and 85.0%.

Incidental Capture in Artisanal Fisheries and Mortality by Unknown Causes: Four leatherback turtles were caught in gill nets but were released with the help of fishermen. A tagged *Dermochelys coriacea* was found drowned in a gill net off an adjacent beach (Boca de Cumaná). Carcasses of another two leatherbacks were found, but the cause of death could not be established. A dolphin (*Delphinus* sp.) drowned in a gill net also. The mortality caused in gill nets is one of the greatest problems for the sea turtles in the Peninsula of Paria, affecting the nesting females during the reproductive season.

Environmental Education Activities: During the nesting season the community children participated in several of the project activities, in addition to coloring contests. An exhibition was prepared concerning the problems of the litter in the sea, including fishing gear. Special sessions were conducted with women in order to show them how to prepare turtle cloth for sale. Given time constraints, these specific lectures only could be taught in November 2002. The lectures, coloring sessions and games were conducted in the schools of Santa Isabel, Boca de Cumana, Cipara, Guacuco, and Río Caribe. This facet of our work reinforces the need for education specialists during the nesting season.

Acknowledgements

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UNDERWATER NOISE AND ANTHROPOGENIC DISTURBANCE IN CRITICAL SEA TURTLE HABITATS *

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Underwater noise levels have increased dramatically in recent decades, and will continue rising with ever-increasing human activity. Anthropogenic noises that would most impact sea turtles are those found within the low end of the frequency spectrum, such as from shipping, recreational boating, and the U.S. Navy’s new LFA sonar program. To determine the noise levels to which sea turtles are exposed, we recorded underwater sound in one of the major foraging areas for juvenile sea turtles in northeastern U.S. coastal waters. Within the range of sea turtle hearing, noise intensity was very high during periods of high human activity, and diminished proportionally with decreasing human presence. Significant differences in intensity were accompanied by an increase in complexity of noises across the spectrum. Analyses of turtle behavior indicate that these anthropogenic noises have a significant effect on sea turtle behavior, especially on their submergence patterns. In complementary studies, we introduced low frequency sounds to captive turtles. In 100% of experimental trials, turtles responded to intensities well below those recorded in the natural environment, and showed apparent distress when exposed to LFA signals. Results imply that pervasive noise found in

vital sea turtle habitats could affect turtle behavior and ecology. The existing levels and additional increases, such as noise from Navy LFA sonar, could have more far-reaching effects on sea turtle orientation and health. With increasing human activity, it may be important to acknowledge potential impacts of underwater noise in future management strategies for sea turtle protection and species recovery.

RELOCATION OF GREEN SEA TURTLE EGGS TO BERMUDA

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Overexploitation of the adult green sea turtle (*Chelonia mydas*) has led to the extirpation of many nesting populations around the world. A massive reintroduction project, called Operation Green Turtle, began in 1959, aimed to reestablish the extirpated nesting populations throughout the Greater Caribbean, including Bermuda. The project is largely considered a failure; as of 2002, there was no conclusive evidence that new nesting populations exist. We propose to conduct a similar reintroduction project, using the wealth of knowledge that has accumulated since the previous project as a guide. We plan to relocate green turtle eggs from Costa Rica to Bermuda. If the hatchlings are imprinted on Bermuda, we believe they will return there to nest once they reach sexual maturity.

THE EFFECT ON NEW FISHERY REGULATIONS ON TRADITIONAL TURTLE FISHERMEN IN BELIZE

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In efforts to meet the requirements of the IAC, the Government of Belize passed revised fishery legislation on June 1, 2002, giving all sea turtles found in Belize waters full protection. Limited harvest is allowed only for cultural purposes by permit. Since the turtle fishermen are unable to supplement their incomes with the sale of turtle meat, what other product will they harvest, or will turtles be harvested illegally? How much did they make harvesting turtles? To answer these questions fisherman are being interviewed and the results were presented in a poster presented at the 23rd Sea Turtle Symposium.

STATUS OF SEA TURTLE CONSERVATION PROGRAM IN CAMBODIA

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Developing sustainable use practices for marine animals in Cambodia, along with research and monitoring of endangered species and Marine Protected Areas, are the best options for the future generation of Cambodian people. This will also benefit people in a greater regional context as the marine living resources play a vital role in national economy and also assist in balancing regional ecosystems. One of the target resources are sea turtles. The Department of Fisheries (DoF) of Cambodia has set up project to conserve sea turtles in cooperation with both government and non-government agencies and has also issued a Law and Declarations to minimize impacts to turtles.

In this respect, the DoF introduced community-based conservation programmes such as extension and public awareness activities and conducting a training workshop on sea turtles with funding from the World Wild Fund for Nature-Indochina Program. Furthermore, at that time SEASTAR 2000 also donated a satellite Platform Transmitter Terminal (PTT) for the aim of monitoring

sea turtle migration and also providing information to scientists about turtle movements in the Gulf of Thailand. The DoF also has been tagging all sea turtles caught accidentally in fisheries before releasing them to the sea. One of the main fishing gear threats to sea turtles is the stingray hook line that is now being banned by law. At present, the DoF has plans for a Phase Two of the project, focusing on sea turtle habitat surveys and raising public awareness with the use of posters, pamphlets, story books and working books.

A RE-ASSESSMENT OF THE OLIVE RIDLEY TURTLE (*LEPIDOCHELYS OLIVACEA*) NESTING POPULATION IN ORISSA, INDIA *

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Olive ridley mass nesting events or 'arribadas' have been documented in Orissa, India since 1974. However, since standardized techniques have not been used to census turtles, population trends are actually unknown. Here, we summarise information on nesting populations in Orissa, using data from multiple sources to arrive at consensus estimates and to derive trends. We also carried out a census during an arribada in March 1999, where nesting was estimated as 180,000 turtles using the strip transect method. Non-linear (quadratic) fits for arribada data from 1976-1999 and a decrease in the size of adults between 1996-1998 suggest a recent decline, which is consistent with fishery related mortality of at least 90,000 turtles since 1994. Though statistical support for the recent decline may be equivocal, the patterns suggest that efforts to reduce mortality and close monitoring of the population would be prudent. The absence of reliable data on which to base conservation action highlights an urgent need to train management personnel in estimation techniques and data collection for effective monitoring of status, threats and trends.

MARINE TURTLE STATUS IN SIERRA LEONE

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The most recent investigation on marine turtles in Sierra Leone (Aruna, 2000) recorded loggerhead, green, hawksbill, Olive ridley, and leatherback turtles along a 12 km stretch of a 402 km coastline. This was the first attempt by a Sierra Leonean to list all the species occurring in Sierra Leone and which are now recognised as among the most critical species for biodiversity conservation in Sierra Leone. The research also identified some of the main threats affecting marine turtles, including egg collection, capture by the numerous artisanal fisheries, sand mining of beaches and use of sea beaches for recreation and leisure. The report on marine turtle signals a new beginning for conserving and protecting priceless marine turtle diversity. Marine turtles in Sierra Leone are not under any legal protection or recognition in spite of the fact that they are a globally threatened species. Government legislation and decision makers in Sierra Leone are recently beginning to protect these species, so that the future of Sierra Leone's marine turtles will be more secure. One of CSSL's key strategies to protect Sierra Leone's marine turtles and other biodiversity is to raise awareness and help develop grassroots community groups committed to monitor, manage and sustain marine species and their habitats, nesting and foraging sites. Conservation activities are now in progress through education and sensitisation of local communities in radio programmes, surveys and education, and nature clubs. The CSSL intends to carry out this campaign throughout the entire coastline but funding is hindering the society.

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THE EFFECTS OF NEST RELOCATION ON HATCHING SUCCESS WITH ANALYSIS OF UNSUCCESSFUL EGGS (1999-2001) OF LOGGERHEAD SEA TURTLE (*CARETTA CARETTA*) NESTS IN BROWARD COUNTY, FLORIDA

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Introduction

There are three main conservation/management techniques that are used on sea turtle nests: leave the nest *in situ*, screen or cage the nest, and relocate the nest to a new location. The careful techniques of relocation, including the reburying of eggs within two hours of collection, decreases the number of hatchlings emerging from their nests by about 20% (Bustard, 1976). However, results of Wyneken, et al. (1988) have shown that if the eggs are not traumatized, are moved early, and placed in a "safe" area, then relocating nests may be an affective conservation method.

Broward County's beaches are 90% urbanized with highrises and in most places there is beach lighting. Sea turtle nests have to be relocated to either hatcheries or undisturbed beaches. This study was conducted to determine a cause of the observed lower hatching success in relocated nests.

Materials and Methods

Data collected for this study was done under the Broward County Sea Turtle Conservation Program during the 1999 through 2001 nesting seasons. The nesting season in SE Florida is from March 1 to September 15. Sea turtle specialists patrol Broward County Beaches each morning in search of nests that have been laid the night before. Nests that were on Pompano and Fort Lauderdale beaches were relocated to Hillsboro beach. The eggs were moved before 9 a.m. and kept in their original orientation when transported.

Each nest was evaluated after the nest was allowed to hatch naturally. The eggs were placed into seven groups: 1) emerged on their own, 2) live hatchlings in the nest (LIN), 3) live hatchlings partially emerged from their eggs (LPIP), 4) dead hatchlings in the nest (DIN), 5) dead hatchlings partially emerged from their eggs (DPIP), 6) unhatched eggs with visible embryo development (VD), and 7) unhatched eggs with no visible embryo development (NVD).

This study examined the effects of nest relocation on hatching success. The data being used were derived from Hillsboro Beach *in situ* nests and nests from Pompano and Fort Lauderdale Beaches relocated to Hillsboro Beach (HB1). Hatching success was compared between the two nest types over the three years. The percentage hatch success was used to compare the seasonal trends that may have occurred in each year and between the years. By comparing the two nest categories and the three years, it was hypothesized that differences may be found. The data was analyzed and compared using 1-way analysis of variance (ANOVA/MANOVA) and Tukey Honest Significant Difference Test, both at a 0.05% significance level.

Results

Seasonally, emergence success showed a downward slope in both relocated and *in situ* nests throughout the three years. There was higher emergence success at the beginning of the seasons.

The DPIP and VD categories showed upward sloping trends throughout the nesting season. For *in situ* nests, there were positive trends in DPIP and VD categories for all three years. For relocated nests from other beaches (HB1), there were increasing trends in the same two categories (DPIP and VD) for the year 1999, while the DPIP category showed similar trend in the relocated nests in 2001.

Over the three year study period, hatching success proved to be slightly lower in the relocated nests when the three years were combined. Hatching success in *in situ* nests was slightly higher than relocated nests in the year 1999 and 2001. Overall the hatching success averages for the three years (1999-2001) were 70.5% for *in situ* nests and 69.7% for relocated nests from other beaches.

Conclusion

In the study of Hillsboro Beach for the three years (1999-2001), the overall hatching success was higher in *in situ* nests by 0.8%. With this small difference between the *in situ* nests and the relocated nests, relocation may be a management technique that can and should be used in areas where other human conditions exist (coastal lighting and vehicle usage on the beach). As emergence success decreased over the season, other egg evaluation category(s) consistently increased. The dead pipped (DPIP) and the visible development (VD) categories consistently showed significant upward sloping trends through the season, which was similar in *in situ* and relocated nests. It can be stated that as the emergence success decreases over the season, the main two categories that show increasing trends were dead pipped (DPIP) and visible development (VD).

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HOW COUNTING DEAD TURTLES CAN HELP SAVE LIVE ONES

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Stranding and salvage networks can be utilized as a valuable tool in sea turtle population management in a multitude of ways. Temporal and spatial stranding patterns, when combined with water current information can help pinpoint locations of fisheries interactions or other potential threats to both individuals and populations. Thorough documentation of threats and associated mortality is necessary in order to effect positive changes in the shortest possible time to reduce or eliminate the mortality and provide lasting benefits to the overall population. Species composition and size class distribution information helps provide information on whether threats are specific to certain species or sizes of turtles. For example, stranding size distribution information was recently utilized to document that many turtles stranding in the United States were larger than the currently required TED opening sizes (Epperly and Teas, 2002). New regulations that increase the size of required TED openings in U.S. waters are being implemented as a result of this analysis. Necropsy of stranded turtles provides important information on sex composition and state of health of turtles utilizing nearshore locations. Specimen collection from stranded individuals provides valuable materials for researchers working on genetics, aging, gut content analysis, etc. and can help to establish areas of critical habitat which can be protected to benefit turtle species. Rehabilitation of live stranded individuals provides a valuable resource for educating the public on threats turtles face and how specific actions of individuals can help preserve and protect sea turtles for future generations.

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THE POSSIBILITY OF SEA TURTLE ECOTOURISM ON WAN-AN ISLAND, PENGHU ARCHIPELAGO, TAIWAN

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Conservation strategies without economic benefits to the host communities will not be realistic in underdeveloped areas. Wan-An Island fell into this category ten years ago when we started the sea turtle conservation programs. In order to solve this problem, a survey was made to interview the Wan-An residents and determine the possibility of developing sea turtle ecotourism on the island.

In 2002, 308 families on the island were interviewed to obtain their opinions toward ecotourism. Although 46% families had never heard the word ecotourism, they understood its importance. Some 74% families believed that a turtle-watch program could

increase both the number of visitors to the archipelago and household income. Up to 92% families understood the basic biology of sea turtles. Based on this survey; we tentatively concluded that sea turtle ecotourism was a good opportunity for Wan-An Island in the near future.

AVES ISLAND WILDLIFE REFUGE, VENEZUELA: RESULTS OF THE 2002 PEAK NESTING SEASON

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Introduction

In 2002 the project "Monitoring and conservation of the green sea turtle (*Chelonia mydas*) population from Aves Island Wildlife Refuge" (located 200 kilometers to the west from Dominica) entered its second year. This project is being carried out by the General Direction of Fauna (Ministry of Environment and Natural Resources), which is in charge of its administration and management. This protected area includes the most important sea turtle nesting site in Venezuela and in the Caribbean Sea it is the second most important place for nesting of green turtle.

The main objective of this project is monitor the female sea turtles on the nesting beach and to protect the nests from natural adverse factors. However, in the near future, this objective could grow to include new aspects related to the sea turtle conservation.

Materials and Methods

Beach patrols was carried out on Aves Island from 8 pm until 3 am, except on days in which the weather conditions did not allow access to the nesting beach. When a turtle was observed nesting, it was tagged in the fore left flipper (close to the second big scale on the posterior edge), with a Monel tag. The serial number of each tag was recorded. Standard curved carapace length (SCL) and curved carapace width (CCW) were measured with a flexible tape, and they were also recoded, along with time, location of the sea turtle (the island was divided in three zones) and the presence of singular marks, wounds, fibropapillomas and epibionts. Finally, all the information was sorted, analyzed and compared with previous data.

Results and Discussion

A total of 181 female green sea turtles were tagged during the monitoring period (July 11th to September 13th 2002). This total is three times greater than in 2001, because in this season the monitoring included the peak nesting period. Thirteen tagged turtles were detected coming back to nest at different intervals between four and twenty days. The majority of the turtles (54%) came back every ten to twelve days, which matches to the average already determined for this area. The total number of recaptures were 28 animals, mainly tagged between 1993 and 1996. It is remarkable that only one sea turtle was observed with the fibropapilloma disease.

The mean standard curved length and curved carapace width (111.5 cm and 101.2 cm, respectively) were lower than during the 2001 monitoring (112.5 cm and 104.3, respectively) and previous surveys.

Conclusions and Perspectives

The results indicate that the green turtle nesting population from Aves Island is stable and in good health. There is an apparent important recruitment of young females, considering that the mean of the carapace measurements of this season are lower than in 2001.

An important goal during 2003 will be the consolidation of a database in order to facilitate further research. Taking in account the new facilities in the Sim3n Bol3var Scientific Naval Base, the next season will include one or two undergraduate thesis.

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AN INTEGRATED PROGRAM FOR SEA TURTLE CONSERVATION AND DEVELOPMENT IN THE ARCHIPELAGO DE LOS ROQUES NATIONAL PARK, VENEZUELA

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The Archipelago de los Roques National Park is a coralline atoll in the south Caribbean some 70 nautical miles north of the central coastal area of Venezuela, and measures about 36.6 kilometers long and 24.6 kilometers wide. The National Park was declared in 1972, with an 221.12 Ha surface area, some 46 coralline keys, and the most important reef formations in the country and a great quantity of marine fanerogam habitats. The FCLR has carried out conservation works on turtles from 1976, and starting in 1999 began an integrated conservation and development program with five components that integrate the scientific work with that of conservation, environmental education, and integration of the local communities in the conservation processes for these species. Sea turtle nesting has been confirmed in 32 of the 46 islands with sandy beaches, with an annual nesting activity of about 262 nests, 180 of these by hawksbill (*Eretmochelys imbricata*), 61 of these green (*Chelonia mydas*), 11 by leatherback (*Dermochelys coriacea*) and ten loggerhead (*Caretta caretta*) turtles. The marine areas are important feeding habitats for hawksbill and green turtles. Work with the communities has been centered on the combining the work of local institutions and transmitting the information on problems in conservation of these species, concentrating efforts of sensitization among children of school ages, fishing communities and tourism associations, and training processes directed to the authorities, diving associations and fishermen's communities.

CONSERVATION AND SUSTAINABLE USE: SOME PRINCIPLES AND PROBLEMS *

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Introduction

The proposition that the conservation of sea turtles could be enhanced by allowing some consumptive use of sea turtles seems intuitively contradictory. Yet "conservation through sustainable use" (CSU), endorsed by the IUCN, CITES, CBD, and WWF suggests this is possible. I discuss some of the principles and problems with CSU, present case histories, and discuss how the results may apply to sea turtles.

What is Conservation?

It is difficult to expect people to agree on the merits of different approaches to conservation if they do not share a common vision about what conservation is. People have a long history of conserving things (paintings, buildings, stories, legends, religious icons, etc.), but have never expended resources conserving items considered useless, valueless, or to have only negative values. A pragmatic definition (Webb 1995, 1997, 2002) is: *Conservation is the sum total of actions taken to preserve and maintain items to which we attribute a positive value. Value can be expressed in intrinsic or instrumental terms, and valuing wildlife for a diversity of reasons, may be more effective than promoting any one value, claiming others have no legitimacy.*

People, Poverty and Conservation

All people have an inherent interest in wildlife conservation, in the sense that none promote the eradication of all wildlife species, and most would mourn the loss of some species. However, the capacity of individuals, communities, peoples and even nations to pursue conservation is highly variable. Poverty is the worst environmental threat (Brundtland *et al.* 1987), which is both obvious, but chilling. Obvious, because we would kill critically endangered animals to feed our own children if it were necessary. Chilling, because the time scale required to solve the problems of poverty are long relative to those needed to prevent irreversible losses of biodiversity today. We cannot alleviate poverty as a prerequisite for conservation action, but nor can we afford to ignore it. It is one of the major factors creating the conservation problems we are trying to solve at local, national and international levels.

Benefits to People

Local people, often living in poverty, are the proximate cause of many conservation problems, and are classically considered *the enemy* of conservation. An increasing body of people (Hutton and Dickson 2000) believe that conservation will be better served if local people are partners and beneficiaries of conservation efforts (IUCN 2003b). This requires tangible and sustainable benefits to be derived for them, most easily obtained through consumptive uses. Ecotourism can work in some contexts, but requires significant resources and infrastructure to promote visitation, especially to remote areas, and is highly prone to the uncertainty of world events.

To “Use” or “Not Use”?

Decisions about whether consumptive uses of particular species are acceptable or not need to be made nationally, on the basis of culture, tradition, religion, ethics, needs, morality, politics, etc. The technical issue of sustaining uses only come into play after a use is deemed socially acceptable.

What is Sustainable Use?

To sustain anything is to keep it going, and humans have a long history of keeping activities going that provide them with benefits - vegetable gardens, televisions, personal transportation, marriages, etc. The critical elements are always: use, monitoring, assessment and adjustment (Webb 1995, 1997). Sustainable use is thus: *use associated with a process aimed at ensuring the use and the benefits it provides can be continued indefinitely and that its impacts are maintained within acceptable or defined limits*. Whether a particular use was sustained or not can only be decided in hindsight: *was the use kept going?* The probability of a use being sustained can sometimes be predicted from available information, but in most cases, the data needed can only be obtained once use starts. The gap between *what I think might happen* and *what did happen* can be vast. *Experimental management* and *adaptive management* are the two critical learning tools. If use is defined broadly in terms of consumptive and/or non-consumptive uses, and values as intrinsic and/or instrumental, the argument that conservation is sustainable use is sound. No uses can be sustained unless the species being used is conserved.

Confusing Elements

Confusion about CSU comes mainly from a failure to differentiate between the separate goals of animal rights, animal welfare and conservation. The concept that animals have rights is a philosophical issue - much like a religion, it is a matter of personal choice. However, actions that transfer rights of access from people to animals, for example moving local people off their lands for the creation of national parks, can alienate the people and undermine any interest they have had in conservation. Animal welfare can be justified on anthropocentric grounds - people have little to gain from inflicting unnecessary pain and suffering on animals - but it is context-specific issue. An Aboriginal immobilising a kangaroo with a spear cannot be expected to follow the same codes of animal welfare as people caring for an orphaned kangaroo in an urban backyard. Conservation can be seriously undermined by actions taken or not taken because of animal rights and animal welfare concerns (King 1988; Webb 2002).

The Critical Elements

All wildlife conservation problems involve interacting social, cultural, biological, economic and political variables. Biological variables are often the easiest to solve, and the failure to consider social and economic variables is a major impediment to conservation success (Freese 1998; Ahmed *et al.* 2001; Campbell 1998; Campbell *et al.* 2002). Within the biological variables, the distinction between population dynamics and dynamic populations is important. When wildlife densities are reduced through harvest, adjustments (compensations) take place which promote recovery. The late Graeme Caughley likened wildlife populations to a metal spring. Initial harvesting reduces the population and compresses the spring. A sustainable harvest removes the annual expansion thereafter. Maximum sustainable yield (MSY) is the maximum annual harvest obtained by compressing the spring to an optimal level. Exceeding MSY means the annual harvest is not as big as it could be (an economic problem) and not that extinction is approaching! Severe overharvests can lead to “depensation”, where the ability to recover is compromised.

Case History 1: Kangaroos:

In the 1960s in Australia, kangaroos were being killed by farmers as agricultural pests, and by commercial kangaroo hunters for skins and meat - to feed urban pets. It was presumed that a serious conservation problem existed. Today, 40 years later, we know that the "calls for action" were largely unnecessary. Kangaroo populations are remarkably well adapted to compensating for harvests (Environment Australia 2003a). The annual, sustainable quota for kangaroos to be killed in Australia in 2003 is 6.55 million (Environment Australia 2003b). The kangaroo industry provides employment for 4000 people, is valued at some

\$AUD200 million per year (Kelly 2002), and provides sound economic reasons for Government to act if any conservation problems arise. There is another aspect of the consumptive use of kangaroos in Australia that is important. Within Australia, sheep cause serious erosion problems and promote the loss of biodiversity (Grigg and Beard 1996). If kangaroos could replace sheep as standard grazing animals, generating equivalent wealth [which is under test (FATE 2003)], the conservation advantages would be profound. However, opposition to the annual cull, to any consumptive use of kangaroos, and to the replacement of sheep with kangaroos, remains strong amongst animal rights and welfare groups, even if it involves questionable logic [see reviews in Grigg and Beard (1996), Environment Australia (2000a) and Kelly (2002)]. In this case, conservation is being seriously constrained (Grigg and Beard 1996) by arguments that the public and politicians assume are coming from the conservation community!

Crocodiles and Sea Turtles

Crocodiles and sea turtles are both large, semi-aquatic reptiles, that at a broad level of resolution share many basic biological characteristics and conservation problems. They are long-lived, slow growing, late-maturing, and share similar life histories. Juvenile sea turtles play these life stages out in a greater geographic area than crocodiles, but there are many parallels. One striking difference is that CSU programs are common with crocodilians (Hutton and Webb 2003), but not with sea turtles (Webb 2000), despite the same basic biology. So one may well ask whether all the dire predictions made about using sea turtles occurred with crocodiles?

Case History 2: American Alligators

By the late 1960s the total population (juveniles, subadults, adults) of American Alligators (*Alligator mississippiensis*) in the coastal marshes of Louisiana (USA) was down to around 130,000 individuals, and 6000-7000 nests per year. Adult nesting females were around 5% of the total population (Joanen and McNease 1987), which is a similar to an estimate derived for hawksbill turtles in Cuba (4%; CCMA 1998). Nest surveys and extrapolations to total number of nests per year was used to monitor the population recovery. The recovery started with an annual rate of increase of 13-14% per year (1971-72), and stabilised between 1996 and 2002 at $34,250 \pm 2872$ (SE; N= 7) nests per year: a wild population of about 700,000 individuals (Joanen and McNease 1987; additional data provided by Ruth Elsey). However, throughout the period of recovery an annual wild harvest of larger alligators occurred: 1350 removed in 1972, increasing to 35,263 in 1999. Mean size of harvested animals fluctuated around a stable mean of 218.2 ± 7.0 cm total length (SE; N= 23 years; range 200 to 231 cm). In addition to this, in 1986 an egg harvest program (ranching) was introduced, which increased from 2903 eggs taken in 1986 to 354,636 eggs taken in 2001. To compensate for the egg harvest, farms were obligated to return 18% of raised juveniles to the management agency each year, for release back to the wild. The wild population recovered dramatically in Louisiana between 1972 and 2002, despite 602,541 alligators and 3.62 million eggs being harvested, which generated some \$US342 million. Landowners were primary beneficiaries, and with income from other wildlife species (eg ducks, nutria, crayfish, catfish, frogs) the wetlands became valuable assets in their natural state.

Case History 3: Chinese Alligators

Chinese Alligators (*Alligator sinensis*) were historically distributed throughout the Yangtse River basin, but by 1992 less than 1000 survived in the wild, in 13 small ponds (Webb and Vernon 1992). By 1999, this was down to 150 individuals in 10 ponds (Thorbjarnarson *et al.* 2000a,b), within a 600 sq km Chinese Alligator Reserve shared with 2 million people pursuing intensive agriculture (Thorbjarnarson *et al.* 2000a). To most local people the alligators were pests that ate domestic ducks and burrowed into and drained rice fields, and few supported the concept of enhancing their recovery. In the early 1980s, the Government of China captured 20-30% of the remaining wild population and successfully promoted captive breeding. CITES gave China permission (1992) to trade internationally in captive bred stock, despite the critically endangered status of the wild population. In 2000, the Government of China embarked on an ambitious recovery program and is committed to engaging local people as partners. Even a modest payment for new clutches of wild eggs may be all that is needed to create a vested interest in the wild population recovering.

Case History 4: Saltwater Crocodiles

In 1971 the wild population of saltwater crocodiles (*Crocodylus porosus*) in the Northern Territory of Australia had been depleted by at least 95% (Webb *et al.* 2000). By 2003, 32 years later, it was back to pristine levels (70,000) occupying their complete historical range. The success of this program is linked to CSU. In 1971, the central goal was to increase the wild population. By 1979-80, 9-10 years later, when crocodiles were becoming common, calls for culling mounted. A public education program, problem crocodile removal program and commercial use program were all initiated to increase positive values and reduce negative values. An egg harvest program and wild harvest program were both introduced. Throughout the period of recovery, use occurred continually: Aboriginal subsistence harvest (150 animals per year); problem crocodile removal (200 per year); incidental catch in fishing operations (500 per year); ranching of eggs (220,000 eggs between 1983 and 2003); and landowner harvests (250 per year). Giving crocodiles an economic value was the key to winning public support and sustaining Government investment in crocodile conservation.

General Discussion

Like crocodilians and kangaroos, sea turtles are another group of wildlife species valued for a diverse range of reasons (Witherington and Frazer 2003). Each of these values can be used potentially to stimulate conservation action, and the argument

for relying on only non-consumptive uses (Witherington and Frazer 2003) is a weak one: if it applied to sea turtles, why not to crocodilians? Cuba's Hawksbill Turtle program (Manolis *et al.* 2003) is a good example of what can be achieved. The program is considered a model one in the Caribbean by Fleming (2001) and TRAFFIC (2002), and it generates social, cultural, economic, scientific and conservation benefits. The small amount of consumptive use that does take place, in less than 1% of available habitat, is demonstrably sustainable (Manolis *et al.* 2003). Yet this part of the program ruffles the feathers of some conservationists (Campbell 2002), and both science (Mrosovsky 1983, 2000, 2002) and Cuba's program are threatened.

With the exception of Cuba (Manolis *et al.* 2003), there are relatively few management case histories involving sea turtles that are directly comparable with those available for crocodilians. But given similar life histories and population dynamics, the two groups can be expected to respond in similar ways, as they appear to be doing in Cuba. With American Alligators and Saltwater Crocodiles, population reductions of 80-90% did not constrain the potential of the wild populations to recover when given the opportunity. Various results [Table 8 in IUCN (2002)] suggest sea turtles are the same. Economic incentives have assisted conservation with many crocodilian species, but the status of Chinese Alligators is a stark reminder of what can occur when local people have no incentives to participate. Density-dependent adjustments are continually operating in crocodilian populations (Hines and Abercrombie 1987; Webb and Manolis 1992), and may well prove common in sea turtle populations when research at the experimental management level becomes more widespread. Significant uses of wild crocodile populations have been made while the populations were recovering, without detrimental effect - the same is no doubt possible with sea turtles. There are now some 31 countries legally using and trading in crocodilians, and legal international trade has almost completely replaced illegal trade (Hutton and Webb 2003); there is no reason to expect that the same would not occur with sea turtles.

Whether we support CSU, understand it, are sceptical of its potential, or oppose it vehemently, it is now a mainstream conservation strategy, and this is unlikely to change. The IUCN Policy on Sustainable Use (IUCN 2003b) provides excellent guidance on the key elements needed to achieve sustainability. In the case of sea turtles, use is occurring all over the world at different levels, and it is not going to stop. Conservation interests may be better served if more resources were allocated to sustaining uses, rather than to trying to stop them.

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DEVELOPMENT OF THE INTER-AMERICAN CONVENTION FOR THE PROTECTION AND CONSERVATION OF SEA TURTLES AND ITS IMPLEMENTATION IN THE GALAPAGOS ISLANDS, ECUADOR

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Introduction

When species that disperse and migrate across oceans and between different sovereign territories are involved, national governments are crucial for effective cooperation in planning and implementing conservation strategies and actions. It is thus essential to understand the basic political and administrative characteristics of the states that are involved. The Republic of Ecuador has been an active player in the development of the only legally binding treaty focused on the conservation of marine turtles and their habitats: the Inter-American Convention for the Protection and Conservation of Sea Turtles (IAC). Given its internationally renowned position in conservation, focused on the Galapagos Islands, Ecuador has the potential to play several critical roles in further development and implementation of this treaty. This paper provides a brief description of the political and

administrative situation in Ecuador, the special case of Galapagos, the history of Ecuador's involvement in the IAC, and suggested future actions to support the Treaty.

Political and Administrative Situation in Ecuador

The Constitution of Ecuador states that it is the policy of the State to protect and manage biological diversity, natural reserves, protected areas and national parks, but at the same time take into account that their conservation and sustainable use also depend on the participation of the communities involved and should be in consort with international agreements and treaties (Article 248 of the Constitution, R.O/N^o 1, 11 August 1998). Within this context, the Law of Environmental Management (Ley de Gestión Ambiental) establishes the Ministry of Environment as the national authority, which is to apply the policies relevant to the protection and management of biological diversity (Ley No. 37. RO/N^o 245, 30 July 1999). Living marine resources, including marine turtles, are clearly within the mandate of the Ministry of Environment. By law it is this Ministry that must regulate development and fisheries activities, even though they are promoted and supported by other government Ministries and entities.

The Special Case of the Galapagos Islands

The Galapagos Islands, about 1000 km from the mainland, constitute one of the 22 provinces of Ecuador. Nearly 97 % of the Islands are protected as a National Park, and an area of 133,000 km² has been declared as Marine Reserve. In 1978 Galapagos National Park was declared as a World Heritage Site for Nature (under the UN Convention Concerning the Protection of the World Cultural and Natural Heritage) and also included in the IUCN list of Biosphere Reserves, in recognition that its unique natural, scientific, and educational assets should be preserved for perpetuity. "Protect and conserve the terrestrial and marine ecosystems of the Province of Galapagos, its exceptional biological diversity, the integrity and functionality of the particular ecological and evolutionary processes for the benefit of humanity, local populations, science and education" is a priority for the Ecuadorian state. Hence, in 1998 the Law of Special Management for the Conservation and Sustainable Development for Galapagos (Ley de Régimen Especial para la Conservación y Desarrollo Sustentable) was enacted. Under this law an advisory council has been established: INGALA (Galapagos National Institute); chaired by the Ministry of Environment, the Council includes representatives from other governmental entities, NGOs, local authorities, and a representative of the artisanal fishers of Galapagos. In addition, the Inter-institutional Management Authority (Autoridad Interinstitucional de Manejo, AIM) was created. Also chaired by the Ministry of Environment, the responsibility of this organization includes the establishment and implementation of policies for the Galapagos Marine Reserve, which includes the zone 40 nautical miles seaward of the coast of all the islands, totaling some 133,000 km².

The administrative situation of Galapagos National Park is unique. Income generated by the Park does not go to the state treasury, but is managed in special autonomous accounts and budgets. This is true for both productive/commercial activities in the islands, as well as for donations, grants, and development and conservation projects spearheaded by the Park. In this context, conservation programs in the Galapagos have had considerable success, due largely to the political stability and administrative and fiscal autonomy.

Background – Ecuador's involvement with the IAC

The Ministry of Commerce, Industry, and Fisheries represented the Government of Ecuador during the development of the Inter-American Convention for the Protection and Conservation of Sea Turtles. A representative of this Ministry participated in the rounds of negotiations and was present at the final round in Salvador, Bahia, Brazil on 4 September 1996 when the text of the treaty was adopted. During the period when the IAC was open for signing, from 1 December 1996 to 31 December 1998, neither the Ministry of Commerce, Industry, and Fisheries, nor the Ministry of Foreign Affairs advanced with the political and administrative procedures to subscribe to the treaty. The Ministry of Environment was not created until 1996 (Decree N^o195-A; R.O/N^o 40, 4 October 1996), and so did not participate in the development of the treaty, and in fact was not well informed about it. In early December of 1998 information came to the Ministry of Environment from national and international NGOs. With the determination of former Minister Sra. Yolanda Kakabadse, also past President of IUCN, diverse political and administrative procedures were completed in approximately three weeks, so that on the last day, 31 December 1998, Ecuador signed the IAC in Caracas, Venezuela. Not only was time extremely short, but the process was complicated by the fact that neither the Ministry of Foreign Affairs nor the Ministry of Commerce, Industry and Fisheries had supported the treaty. The environmental and academic communities in Ecuador were of great assistance during this very rushed process of signing the treaty before the deadline.

The Ministry of Environment continued with follow-up activities, including working closely with the authorities in the Ministry of Foreign Affairs and the National Congress, so that on 29 August 2000 the President of Ecuador signed Decree N^o 719 for the ratification of the treaty. On 6 October 2000 Ecuador became the sixth country to deposit its Instrument of Ratification with the Depositary, the Government of Venezuela.

Since the treaty entered into force on 2 May 2001, the Ministry of Environment has continued to support its development. On 4 June 2002 (Letter N^o 1107/MA) the Ministry submitted a draft resolution to the Secretariat of CITES, promoting cooperation and synergy between CITES and the IAC. This draft was considered in Committee during the 12th CITES Conference of the Parties, in November 2002 in Chile, and although it was not adopted, the Ministry will continue to explore ways to promote enhanced cooperation between these two international treaties.

In 2000 it was planned to conduct a technical workshop in Ecuador, namely in Galapagos, to produce briefing papers for the contracting States to the IAC at their first Conference of the Parties (COP). This initiative of the Ministry in collaboration with a local NGO was not fulfilled due to lack of funding. However, a technical representative from the Ministry participated in the workshop conducted in Birri de Santa Barbara, Costa Rica, from 23 to 29 June 2002. This meeting, attended by representatives from nearly all of the signatories, produced several briefing papers that were distributed to the Parties, and the Ministry played a critical role in the final edition and homogenization of the workshop documents. Representatives from the Ministry of Environment, together with representatives from the Ministry of Commerce, Industry, and Fisheries, formed the Ecuadorian Delegation to the First Conference of the Parties, held in Costa Rica from 6 to 8 August. The draft Rules of Procedure (ROP) resulting from the technical workshop in Birri were the basis of the Mexican proposal at the COP, and this proposal became one of the main working documents. After advancing with the Rules of Procedure, agreeing that Costa Rica would act as the Interim Secretariat for two years, adopting a resolution to establish a special fund to support the work of the Treaty, and adopting the Ecuadorian resolution on IAC-CITES cooperation, the Parties agreed to adjourn the First Conference of the Parties and to continue at the earliest opportunity in 2003. It is expected that the Rules of Procedure, which are nearly finalized, will be adopted at the second round of the First Conference of the Parties, tentatively scheduled for August 2003. Another of the key documents produced by the Birri workshop was a draft on the structure, organization and function of the Scientific Committee. This workshop draft has formed the basis of a recent draft proposal, now being circulated by the Interim Secretariat, and the Ministry will be collaborating in the development of this, and other basic documents for the establishment of the Treaty.

Proposed Future Activities in the Development and Implementation of the IAC

The Galapagos, and particularly the National Park, provides a unique administrative and political situation, with considerable international recognition and importance, and many successful conservation initiatives, to provide support for the development of the treaty. Plans are being evaluated to explore the possibility of making use of Galapagos as an administrative base to support the development and implementation of the IAC. If instituted, this would integrate well with the already existent global strategies, as well as with regional policies and plans for international cooperation in the conservation and management, particularly regarding marine resources. Among the actions that must be developed at a national level are:

1. Ensuring the implementation of laws, regulations and other measures, national and international, related to the protection and conservation of marine turtles and their habitats through the Inter-Institutional Authority for Management of the Marine Reserve (this will require updating the legal regime and conducting an awareness campaign).
2. Promoting scientific investigations related to marine turtles and their habitats and an efficient monitoring system, "...considering the environmental, socioeconomic, and cultural conditions" (Article I of the IAC).
3. Developing, improving, and training specialists and fishers in techniques and gear designed to reduce the capture, retention, damage or incidental death to marine turtles during fishing activities (Article IV, 2, h of the IAC), and
4. Establishing an advisory board of local leaders and actors, to put into place action plans that are practical and based on community participation.

Actions that should be developed at an international level include:

1. Promoting mechanisms of international cooperation in the conservation of marine turtles and their habitats.
2. Collaborating with the Interim Secretariat and the other Parties in the development of working drafts for the Conference of the Parties.
3. Evaluating the possibility of collaborating with the Interim Secretariat in the organization of the next COP, including document preparation before and after the meeting.
4. Collaborating with the Interim Secretariat and the Parties in the organization of a future Conference of the Parties, evaluating the possibility of hosting the meeting in Ecuador, possibly in Galapagos.
5. Collaborating with the Interim Secretariat and the Parties in the organization of a meeting of one of the Committees of the Convention: the Consultative Committee or the Scientific Committee, evaluating the possibility of hosting a meeting in Ecuador, possibly in Galapagos.
6. Evaluating the possibility of establishing the full time Secretariat in the Galapagos, and
7. Supporting the development of the Galapagos-Cocos Marine Corridor project, integrating marine area conservation with the objectives and measures of the IAC.

Recommendations

1. The central objective of the Galapagos is their conservation, hence, all activities in the Galapagos Islands must be designed and executed in concert with this overarching goal.
2. Plans and programs focused on the implementation of the Convention need to be coordinated, supported and monitored.
3. Efficient mechanisms are needed for interchanging information and experiences at regional and international levels.

Acknowledgements

Former Minister Yolanda Kakabadse provided the initial vision and impetus for the Ministry to take on the process by which Ecuador is supporting this important regional treaty. After her leadership, subsequent Ministers Rodolfo Rendon y Lourdes

Luque have also supported the ongoing process. Countless marine turtle biologists and conservationists, environmental lawyers, and other concerned citizens in Ecuador and the region have provided steadfast support for the development of the Treaty. The workshop in Birri was made possible with financial support from Friends of the National Zoo, Inter-American Tropical Tuna Commission, MesoAmerican Reef Program, National Fish and Wildlife Foundation, National Marine Fisheries Service, and World Wildlife Fund - International. Thanks to the Western Pacific Fisheries Council and International Fund for Animal Welfare or making possible my participation in this event. Finally, I would like to thank Dr Jack Frazier for the valuable support and advice he gave during the whole process.

THE LEATHERBACK SEA TURTLE CONSERVATION SYSTEM AT JAMURSBA MEDI, INDONESIA

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Jamursba Medi beach is one of the only nesting sites for large leatherback sea turtles in the Pacific Ocean. On this 18 km long nesting beach, every year there are some 3000 leatherback sea turtle nests. Among the main predators of leatherback nests are wild pigs. They destroy more than 80 percent of nests every year. Since 2001, the Indonesia Sea Turtle Research Center has installed a high voltage fence in this area to prevent depredation of the nests and it has reduced the number of destroyed nests to < 10 %. The Indonesia Sea turtle Research Center, along with other institutions, has trained local people to help in surveying, monitoring and protecting turtle nests in the last five years. Currently, all sea turtle eggs in Jamursba-Medi beach are hatched naturally. This poster will explain the current status of nesting condition and the system used.

SEA TURTLE CONSERVATION AT ST. MARTIN ISLAND, BANGLADESH

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Background

Sea turtle conservation and research activities started in 1996 at St. Martin island (Fig. 1). This is the only rookery in Bangladesh where hawksbill turtle nesting has been recorded, although it is extremely rare. In 2000, the Under Ministry of Environment & Forests, NCS (National Conservation Strategy) started sea turtle project and since then one of the major activities of the ongoing St. Martin's project is to protect the sea turtle population (Islam, 2001). Several decades ago the nesting population was high but this has declined due to severe exploitation of eggs and illegal killing of adult females by fishing and other activities.

Five species of marine turtle travel in the territorial water of Bangladesh: *Lepidochelys olivacea* (Olive Ridley) *Chelonia mydas* (Green turtle) *Eretmochelys imbricata* (Hawksbill turtle), *Caretta caretta* (loggerhead turtle) and *Dermochelys coriacea* (Leatherback turtle). The first three have been recorded nesting on the island in the past. The nesting season normally starts in August and continues up to March-April for Olive ridleys, while Greens nest during the late season and during the monsoon (Fig. 2). Due to extreme human disturbance, nesting sea turtles of St. Martin's avoid moonlight nights or periods of moonlight on any single night. Rock barriers along the edge and boulders in deep have been found to interrupt nest-making. Most of the nests are situated at the major western beach and also at northern and southernmost Cheradia beaches. The local name of *C. mydas* nesting beach is Badam Gonia, and is confined to a small stretch at southwestern beach. The curved sandy beach named Shil Baniar Gula, extending from 20°36.572'N, 92°19.512'E to 20°36.186'N, 92°19.483'E, is 900 meters long and is the main *L. olivacea* nesting beach, with about 70% of all nests (Islam & Islam et. al. 1998, 1999, 1999a, 2002).

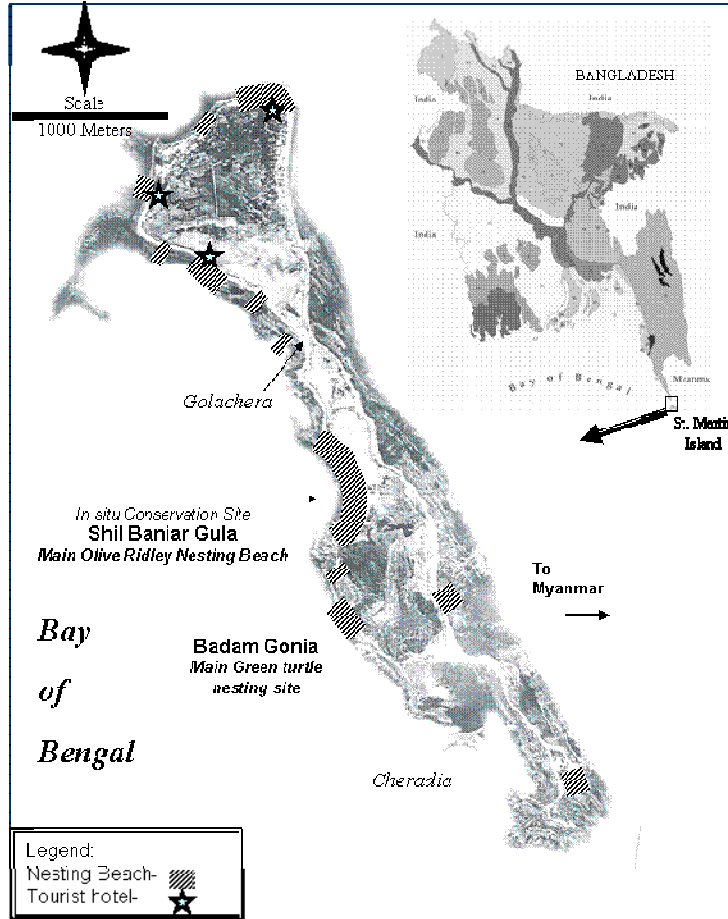


Fig. 1: St. Martin's island and its location in Bangladesh.

***In situ* Conservation Activities and Findings**

From November 2002 three local people have been recruited to start 24-hour guarding to support *in situ* protection. Due to personnel shortage and management problems *in situ* conservation could not be initiated earlier, and about 12-13 sandy beaches identified as nesting all areas are not suitable for *in situ* management. The main ridley nesting beach Shil Baniar Gula, is a single stretch hosting 69% of all nesting during the last seven seasons. Based on this the beach was selected for *in situ* work and provided with 24-hour guards to protect the original nests from any sort of deleterious effects. Observation sheds at each sides of the nesting beach are used for day and night observation. One 4 ft x 6 ft billboard with Banner and English text regarding sea turtle conservation highlights the importance of the *in situ* program on the beach. Until nests hatch we do not know how many eggs were laid by nesting individuals. If the nesting turtle is new as we tags the turtle and collect morphological measurements. After completion of nesting and on her return to the sea we install a perforated simple bamboo fence 5 ft x 5 ft size with four-corner bamboo pillars buried one ft under sand to protect the nest from predatory dogs. Finally, we install a cautionary signboard with the words "Warning! Sea Turtle Nest Conservation" and its Bangladeshi version. This notice also records the designated nest code and number. This complete structure over each nest raised the awareness among local people and tourists about turtle nest and *in situ* conservation.

Our first season of *in situ* work was really promising. So far, 44 nests have been conserved and 42 nests had hatched by April 2003. The maximum hatching rate was 96.70% and minimum was 68.41%. The incubation period was 50-56 days. The bamboo fencing may have some delaying effect on incubating eggs since about 40% of the area under the fence remained in the shade. After 40 days of incubation each designated nest was kept under continuous observation to monitor hatchling emergence and to save the emerging hatchlings from dogs patrolling the beach. Hatchlings were allowed to run over the sandy areas to reach the surf. After all hatchlings had departed we removed the ground fence and dug up the hatched nest to count unhatched and hatched eggs and determine the hatching rate. Five nests took 3-4 days to complete their hatchling release. The overall hatching rate was 20 % higher comparing the incubation of transplanted eggs within hatchery ground (Table-1A).

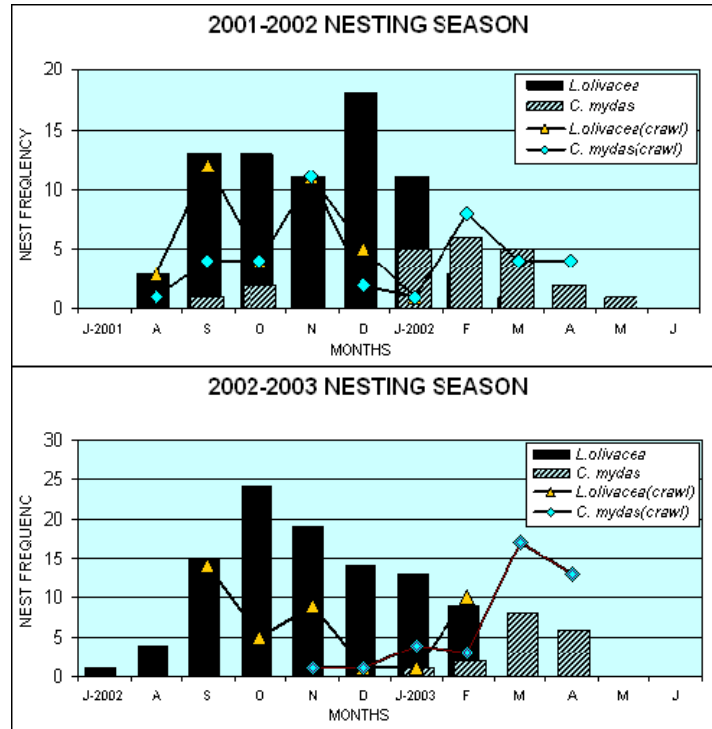


Fig. 2: Nesting at St. Martin’s Island, Bangladesh

Ex-Situ Activities

For *ex situ* conservation activities, a turtle hatchery was built on the beach in an area of 1200 sq ft. During the 2002-03 season (up to March), 4499 olive ridley eggs from 35 clutches and 782 green turtle eggs from 8 nests were collected and buried inside hatchery. First hatchlings emerged in December 2003. The overall hatch success rate was 57–92% ($n=35$; $x=71.86\%$) for Olive ridleys. Only one clutch of Green turtle hatched by April 2003. This individual nest was included in additional data sets for suitable measurements of quantifying the hatching. Each nest inside hatchery was separated by a metal mesh net of about 1.5 ft diameters x 1 ft height to maintain individual respective nest hatchlings counts (Table: 1).

Table I: Summary of the egg incubation. * = one clutch.

	A. Hatchery		B. In-situ
	<i>L. olivacea</i>	<i>C. mydas</i>	<i>L. olivacea</i>
No of clutches collected	35	8	44
Total no of eggs	4499	782	5079
Total no of hatchlings	3233	*71	4351
Average hatching rate	71.86 %	*66.49 %	85.65%
Highest hatching rate	92.10 %		96.70%
Lowest hatching rate	57.22 %		68.41%

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GENETICS AND EVOLUTION

GENETIC ANALYSIS OF OLIVE RIDLEY (*LEPIDOCHELYS OLIVACEA*) POPULATIONS FROM THE EAST COAST OF INDIA USING MICROSATELLITE MARKERS AND MITOCHONDRIAL D-LOOP HAPLOTYPES *

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The conservation of olive ridley sea turtles (*Lepidochelys olivacea*) on the east coast of India, particularly Orissa, has been a matter of great concern due to large scale trawling mortality over the past few years. The Orissa coast has three major mass nesting sites, of which Gahirmatha is among the largest in the world. This study attempts to understand the genetic structure of these turtle populations along the east coast of India. For the purpose, olive ridley sea turtles sampled from four major nesting sites, three in Orissa and one in Tamil Nadu, were analysed using cross-species microsatellite markers and also nucleotide diversity in the mitochondrial control region. The microsatellite analysis revealed moderate to high level of polymorphism among the >80 individuals from four sites. Interestingly, all the samples exhibited heterozygosity for at least one microsatellite loci analysed in the study. This observation, in conjunction with the considerable variability seen earlier in the multilocus fingerprints, suggests that olive ridley turtles in Indian waters have reasonably wide genetic base and represent a genetically vibrant population. Further, allelic diversity at microsatellite loci as well as the mitochondrial haplotypes were found randomly distributed across the samples, suggesting that there is no genetic differentiation between the populations from different nesting sites and that these probably represent the continuum of the same one large interbreeding population all along the East coast of India. This observation provides support to the field data that olive ridley sea turtles routinely use more than one nesting beach in Orissa.

ANALYSIS OF THE PHYLOGENETIC DIVERSITY OF THE GREEN TURTLE (*CHELONIA MYDAS*) IN THE GULF OF VENEZUELA

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The Gulf of Venezuela is an important feeding, supply and migration zone for green turtles, yet this investigation represents the first efforts towards an understanding of turtle genetics in the northern parts of South America. This initiative is of extreme importance because the investigations of population genetics represent a fundamental tool in the creation of handling and conservation plans. Molecular biology investigations carried out in feeding zones provide fundamental information for the ecological understanding of the area; since they allow determination of the zone use and the nesting origin of genetically different populations.

Random Amplified Polymorphic DNA (RAPD) consists of amplifying, by means of short (10 mers) primers, random sections of DNA by means of a conventional PCR. These amplified products are visualized in high-resolution (2.5%) agarose gels and the presence of bands are then finally analyzed with Statistica software, using indices provided by Jaccard and Sorensen.

The Gulf of Venezuela is strategically located with respect to main nesting beaches in the Caribbean (Isla de Ave-Venezuela, 900 km away, and Tortuguero, Costa Rica, 1400 km distant). This relative proximity increases the probabilities that individual adults and sub-adults of both populations (phenotypically different) are sharing this feeding area, without the need for genetic interchange. The use of green turtles by Wayúu natives as nutritional and economic resources represents a threat for all the foreign populations that come to feed in the Gulf of Venezuela, diminishing turtle abundance in the foraging zone as well as the

provident nesting zones.. It is necessary to continue the genetic studies in this area, using additional technical options such as sequencing of DNA mt (d-Loop) to identify the geographical origins of these populations.

PRELIMINARY MIXED STOCK ANALYSIS OF JUVENILE GREEN TURTLES IN URUGUAY USING MITOCHONDRIAL DNA SEQUENCES *

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We analyzed 20 tissue samples from juvenile green turtles (*Chelonia mydas*) collected in Uruguay. These consisted of beach strandings, incidental captures by artisanal fisheries and captures from our netting efforts. Following DNA extraction, we sequenced a 486 base pair fragment of the mitochondrial DNA control region, commonly used in phylogeographic studies of this species in the Atlantic. Sequence editing and alignment showed that our samples exhibited 6 different haplotypes (CM5, CM6, CM8, CM9, CM10, CM24), all previously described and occurring in Atlantic nesting populations. In addition, we carried out mixed stock analysis using the program BAYES to obtain estimates of the proportion of nesting populations contributing to the juvenile stock. Preliminary results indicated that the main contributor was the Ascension Island rookery followed by, among others, Matapica (Suriname) and Aves Island (Venezuela). Thus, mortality due to fishing activities in Uruguayan waters may be depleting endangered nesting populations elsewhere in the Atlantic. This work furthers our understanding of the distribution and migratory routes of green turtles in the southern Atlantic region and confirms the importance of international cooperation in conservation.

THE CONSEQUENCE OF TURTLE FISHERIES IN AUSTRALASIA FOR LOCAL POPULATIONS *

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Marine turtles are culturally significant and provide a source of nutrition and income in communities throughout many parts of the world. As local stocks are depleted, fisheries expand to exploit more distant populations, which increases pressure on other stocks. Breeding populations of green turtles have declined throughout much of their range indicating that past levels of exploitation are unsustainable. We studied the impact of two large turtle fisheries (Bali and the Torres Strait) on different breeding stocks in the Australasian region, using mtDNA markers that define 17 genetic stocks throughout this region. The Bali fishery operates within a wide geographic range and four major stocks (Sulu Sea, Aru, PNG and Gulf of Carpentaria,) contribute to this catch. The Torres Strait fishery has a local focus and influences the NGBR stock, almost to the exclusion of all other stocks.

We discuss the implications of the scale of these fisheries on local populations with Aru as a case-study. Aru is an archipelago in Southeast Indonesia, directly between these two turtle fisheries. Its population of nesting green turtles is a fraction of historical abundances. The Aru nesting population is genetically distinct for both mtDNA and nuclear DNA markers. The nearby feeding grounds support a genetically mixed population with three major contributors (Aru, PNG and NGBR). Half of the recruitment into this population is sourced from the adjacent Aru genetic stock. What is the ecological consequence if this population were completely eradicated? This case-study emphasizes the relevance of defining Management Units for regional conservation.

GREEN TURTLE POPULATIONS IN THE INDO-PACIFIC: A (GENETIC) VIEW FROM MICROSATELLITES

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A high priority in the conservation of marine turtles is the identification of breeding populations, their geographic range and the effects of human caused mortality upon these populations. Over the last ten years, the use of genetic markers has become a powerful tool to gain this information, particularly within short time frames. During this period there has been a large research effort in Australia to identify breeding populations and the origins of turtles in foraging populations and within harvests throughout the Indo-Pacific using genetic markers. To date, the research on green turtles has focused on the use of mtDNA markers to identify breeding populations and mixed stock analysis to describe the composition of feeding grounds and harvests. Analyses of the breeding populations have been completed on 670 nesting females from 27 rookeries throughout the Indo-Pacific (Moritz et al. 2002). Of these, 17 Management Units (Moritz 1994) were identified as: Coral Sea Platform, New Caledonia: Papua New Guinea, Micronesia, Aru, SE Sabah, Berau Islands, Sulu Sea, Sarawak, Peninsular Malaysia, West Java, Gulf of Carpenteria, Ashmore Reef (Eastern Indian Ocean), Scott Reefs (Eastern Indian Ocean), Northwest Shelf, Australia, Northern Great Barrier Reef and Southern Great Barrier Reef.

A subset of the same samples was used to determine whether Management Units, as determined from mtDNA, also constitute discrete populations when the contribution of gene flow from males and females is considered using nuclear microsatellite markers. Samples from 520 nesting females at 23 rookeries (excluding Micronesian and Sarawak) were analysed using nine nuclear microsatellite markers. Tests of genetic differentiation (exact test performed in Genepop; Raymond and Rousset 1995) indicated significant heterogeneity in most pairwise comparisons between rookeries ($p < 0.05$ after correction for multiple tests, 253 tests). These results support previous studies that indicated significant genetic differentiation among most Australian green turtle populations (FitzSimmons et al. 1997a, 1997b). Additionally, significant genetic differentiation was uncovered at several loci in tests between the Northern and Southern Great Barrier Reef Management Units (previously undifferentiated at microsatellite loci) and between populations of the Northwest Shelf Management Unit (Lacepedes and North West Cape). Only 5.0% of tests did not display genetic differentiation between mtDNA-based Management Units, suggesting that in most cases for this region, Management Units apply to the entire breeding population, not just the nesting females.

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**POPULATION GENETIC STRUCTURE OF THE ASCENSION ISLAND GREEN TURTLE ROOKERY;
DIVERSITY, SAMPLING AND ERROR ***

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We collected samples from a large number (n = 187) of green turtles (*Chelonia mydas*) from ten nesting beaches across the entire Ascension Island rookery. Sequence analysis of the mitochondrial DNA (mtDNA) control region revealed ten different haplotypes, four of which were previously undescribed. We examined fine-scale structure among three primary and seven minor nesting beaches on the island over three nesting seasons. Weak but significant differentiation among the primary beaches when pooled with nearby minor beaches suggested a degree of regional philopatry to specific areas of the island and to Long Beach (the major nesting beach) in particular. We used rarefaction analysis to estimate sample sizes adequate to describe a desired proportion of the mtDNA variation in a sea turtle nesting population and compared our results with previous genetic studies in Ascension using fewer samples. We stress the implications of sampling error in the study of green turtle rookeries and confirm the importance of increased resolution and statistical power when examining large-scale variation.

Acknowledgements

We would like to thank the Ascension Island Turtle Group and the administrators of Ascension Island, Roger Huxley and Geoffrey Fairhurst, for their assistance. Funding was provided by the Natural Environment Research Council of the UK, the Department of the Environment Transport and Regions -Darwin Initiative, the Foreign and Commonwealth Office Environment Fund for the Overseas Territories and the European Union Marie Curie Training and Mobility of Researchers Programme. Travel to the symposium was funded by the Sea Turtle Symposium.

**MITOCHONDRIAL DNA D-LOOP ANALYSIS: POSSIBLE EVIDENCE OF NATURAL HYBRIDIZATION
BETWEEN SPECIES OF SEA TURTLES- FOCUS ON *L. KEMPI* AND *C. CARETTA***

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Over the course of the summer of 2002, twenty-three samples of turtle blood were collected: twelve from *C. caretta* and eleven from *L. kempi* and placed in Lysis buffer. DNA, extracted from these samples, was then ran through PCR and sequenced.

Since mt-DNA is passed maternally through generations any differences within the mt-DNA of a species most likely originated from mutations. It is the purpose of this research to sequence mt-DNA from the samples collected and then to contrast the findings with previously sequenced mt-DNA from sea turtles. A statistical study will be conducted in order to compare the different base-pair sequences found in the mt-DNA d-loop between and within species of sea turtles.

Much of this research has yet to be completed; however, it is planned that the project be finished by March 2003. We present a quick introduction depicting the origins and reasons for beginning this research. Materials and methods will also be briefly covered. The remainder of the presentation will be devoted to presenting the conclusions and supporting arguments for the ability to utilize mt-DNA as evidence for natural hybridization between species of sea turtles (pending upon the final results of the research).

**EXPLORING THE POPULATION STRUCTURE OF LOGGERHEADS IN THE DEVELOPMENTAL AREA OF
NORTHWEST MEDITERRANEAN SEA BY MTDNA ANALYSIS ***

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The Western Mediterranean sea is an important developmental habitat for thousands subadults loggerhead turtles. The great abundance of *Caretta caretta* feeding near the western coast coincides with the long line fishery season. This activity has become an increasing threat and the most important mortality factor known in the Mediterranean Sea. Studies on marine turtle bycatch show an alarming situation of some 35,000 or more loggerheads caught annually in the western and central Mediterranean sea, of which some 15,000 to 20,000 are caught every year by Spanish long line vessels alone.

Population structure studies on marine turtles are key components of conservation programs. Given this, CRAM started a research program to evaluate the temporal stock of loggerhead turtles in the NW Mediterranean Sea and explore the possibility that incidental captures by long line fishery in our study area could be counterbalanced by Atlantic population immigration. We present the outcome of a joint research project initiated in 1999 based on the analysis of the sequences from control region of mtDNA and morphological characterization of 112 incidentally captured loggerhead to assess the genetic composition of the NW Mediterranean sea *Caretta caretta* population.

MODELING AND POPULATION BIOLOGY

ASSESSMENT OF THE TORTUGUERO, COSTA RICA GREEN TURTLE POPULATION *

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The renewal of an intensive marine turtle fishery in Caribbean Nicaragua over the past decade poses a potential threat to the green turtle population that nests at Tortuguero, Costa Rica, the largest remaining rookery for this species in the Caribbean. Although the nesting population at Tortuguero has not shown evidence of a decline in recent years, an assessment of the population as a whole is needed because impacts of harvest may not be evident on the nesting beach for some time after a decline has begun. In this study, we use matrix population models to heuristically evaluate the status of the Tortuguero green turtle population and potential for future changes on the nesting beach. Because there is uncertainty in all demographic parameters, as well as the proportion of the Tortuguero population that is subject to the fishery, we constructed distributions of models through a Monte-Carlo resampling process and simulated several scenarios of population status.

SEX RATIO OF LOGGERHEAD TURTLE (*CARETTA CARETTA*) JUVENILES IN THE CENTRAL MEDITERRANEAN THROUGH DIRECT OBSERVATION OF GONADS

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Sex ratio is an important population parameter needed for population modeling and for developing successful conservation strategies. Unlike adults, juveniles do not show external sexual dimorphism, and sex can be assessed only through indirect methods (e.g. testosterone levels) or through direct observation of gonads, difficult to make in live specimens (laparoscopy) while fresh dead specimens for necropsy are often difficult to obtain in large numbers.

During 2000-2002, at the sea turtle rescue centre on Lampedusa island, Italy, 42 turtles died while under treatment. They ranged from 24 to 62 cm CCL, smaller than the minimum size recorded for a nesting female in the Mediterranean (65 cm CCL; Broderick and Godley, 1996). They were originally caught by longliner vessels (n = 21), trawlers (n = 7), or found afloat / stranded (n = 9). The origin of five turtles was unknown. The five specimens found afloat or stranded had signs of a previous capture by longline, and it is likely that most of these specimens were in the pelagic/oceanic phase, where they are more likely to be caught by longline. Necropsies were performed and gonads identified as testes or ovaries through visual examination (Wyneken, 2002).

Twenty-four turtles (57.1%) were males. Most sex ratios of loggerhead turtle juveniles from other areas are highly female-biased, while our results indicate that it is not the case for the central Mediterranean. This either suggests a non-female-biased primary sex ratio on Mediterranean nesting grounds or supports a recent hypothesis of male-biased juvenile immigration in the area (Casale et al., 2002). Similar results from the Adriatic (non female-skewed juvenile sex ratio) were also found by Lazar et al. (this volume). Additional data on primary sex ratio at nesting grounds and on juvenile sex ratio in other areas, as well as stock assessments at sea, are needed for understanding the sex ratio dynamics in the Mediterranean.

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PIT TAGGING LEATHERBACK TURTLES (*DERMOCHELYS CORIACEA*) IN SURINAME: AN UPDATE 1999-2002

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Introduction

Suriname is situated on the northern coast of South America in between French Guiana and Guyana. Suriname and French Guiana support one of the largest leatherback nesting colonies world-wide with 30,000-60,000 nests annually (Chevalier and Girondot 2000, STINASU unpublished data), and nest numbers in Suriname have shown a strong increase since the 1960's (Fig.1). Nesting beaches are only found in eastern Suriname (total beach length varies between 16-22 km), and the peak nesting season is from April to August. Passive Integrated Transponder (PIT) tagging in the Guianas was initiated in 1998 in French Guiana (Chevalier et al. 2000). In Suriname, a PIT tag program started in 1999 as a collaborative effort between Biotopic and STINASU. Objectives of the PIT tag program are population identification and thereby assessment of size and trends of this nesting population.

Materials and Methods

TROVAN tags and scanners are used. Unfortunately, these scanners cannot read AVID tags, which are used in most of the rest of the Caribbean. Tags are inserted in the muscle of the right shoulder of nesting females. In the 2002-nesting season, tagging was carried out on three major leatherback nesting beaches. Table 1 shows the PIT tag effort, presented as beach coverage in space and time, in Suriname for the years 1999-2002. For calculating the mean observed internesting period (OIP), values between 7-14 days were used. The estimated clutch frequency (ECF) was calculated by dividing the number of days in between the first and last observed nesting dates for an individual by the mean OIP, adding one for the first nesting. We used only the individuals with a first oviposition date before June 15th, thereby rejecting the possibility that the turtle continued nesting after the survey period (Reina 2002). Amongst other collected data were curved carapace lengths and widths (CCL/CCW).

Results

During the 2002-nesting season, we identified 2289 individual leatherback females. New tags were applied to 1833 individuals, three were remigrants from 1999, 45 from 2000, and three from 2001 (Fig. 2). A total of 405 turtles had unknown PIT codes (turtles tagged in French Guiana/Guyana and wrongly recorded codes). Mean OIP was 10.1 days, mode 9 days (Fig. 3). Of all individuals, 41.2% was seen only once, but for the two best-monitored beaches where monitoring commenced before June 15th, 33.6% were seen only once. Mean ECF per female was 3.3 ± 2.1 including one-time nesters and 4.3 ± 1.6 to 4.5 ± 1.8 depending on the OIP used (Fig. 4). Of the 62 turtles tagged in 1999, 23 turtles (37.1%) re-nested by 2002. Of the turtles tagged in 2000, this was only 9.1% (35 individuals). After correction for missed turtles, these numbers are higher (Hilterman and Goverse 2003). Of the individuals that were observed twice or more, 11.1% made one or more within-season shifts between the Surinam beaches. Mean CCL was 154.9 ± 7.1 cm, mean CCW 113.1 ± 5.1 cm.

Discussion

A large nesting colony spread over several, often highly dynamic, beaches such as Suriname and French Guiana can never be covered completely. From our ECF value of 4.5 it is clear that a large proportion of nesting attempts were missed notwithstanding the maximum possible tagging effort. Combining PIT data with the degree of beach coverage, we estimated that the minimum number of leatherback females that visited the Surinam beaches in 2001 was 5,500 and in 2002 was 3,000. This confirms the present status of Suriname as a major leatherback rookery. Combined with recent reports from French Guiana (Girondot et al. in press), Guyana (de Freitas, in press.), Trinidad and Gabon (Billes and Fretey in press) it can be concluded that the Atlantic leatherback populations, in contrast to the Pacific ones (Spotila et al. 2000) seem stable or even increasing. The PIT tag program is yet too young to have valid data on population parameters such as remigration rates, and further regional data sharing should elucidate the patterns of beach exchange by leatherbacks in the Guianas.

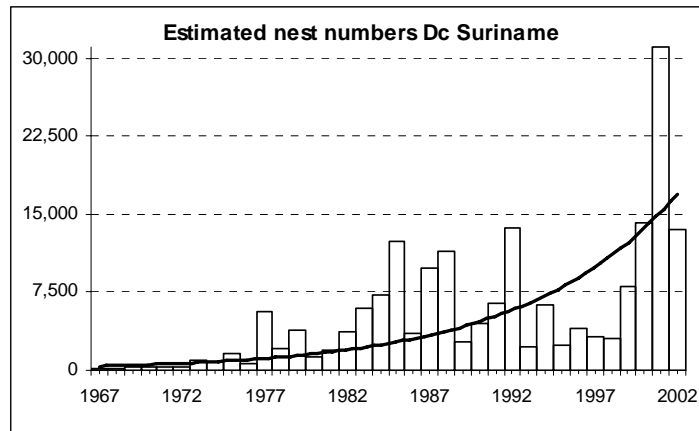


Figure 1: Estimated nest numbers for *Dermochelys coriacea* in Suriname.

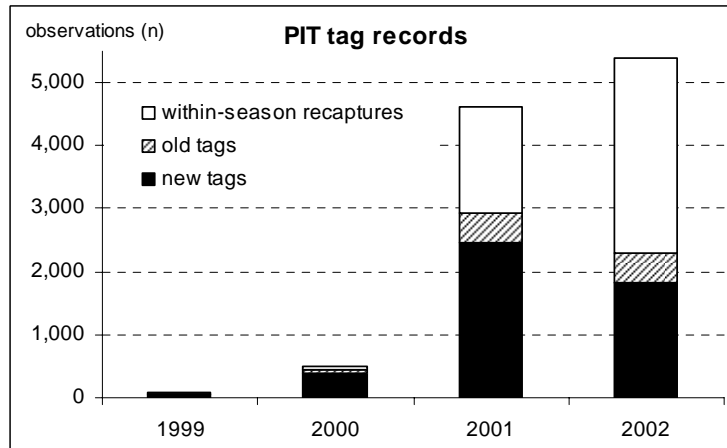


Figure 2: Number of PIT tag records (un-tagged individuals that received a new tag, turtles that had a tag already and within-season recaptures) in Suriname 1999-2002.

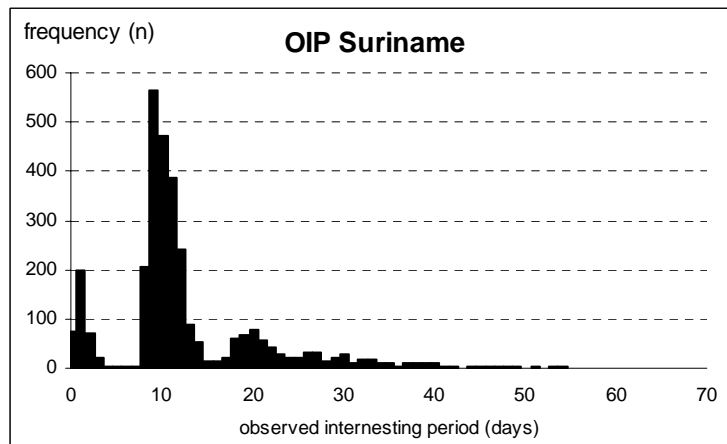


Figure 3: Observed interesting period (OIP) for Suriname. Interesting periods of 6 days or less are considered false crawls.

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Table 1: PIT tag efforts in Suriname for the years 1999-2002 expressed as the degree of beach coverage in space and time.

Beach coverage	1999		2000		2001		2002	
	time	distance	time	distance	time	distance	time	distance
Babunsanti	--	--	-/+	-	++	+	++	++
Matapica	no tagging		no tagging		-	-	-/+	-/+
Kolukumbo	no tagging		no tagging		--	+	++	++
Samsambo	no tagging		no tagging		--	--	no tagging	
Estimated min. no. of individuals	1,600		3,000		5,500		3,000	

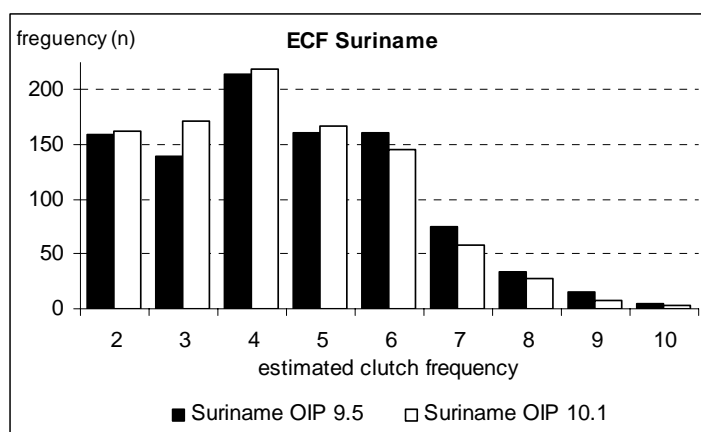


Figure 4: The estimated clutch frequency (ECF) for Suriname using an OIP of 10.13 and 9.5.

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HISTOLOGY OF GONADS AND PRELIMINARY SEX RATIOS IN JUVENILE LOGGERHEAD SEA TURTLES, *CARETTA CARETTA*, IN THE EASTERN ADRIATIC SEA

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Introduction

Sex ratio is among the most important demographic parameters that significantly affect the viability and conservation of endangered species. As with most reptiles, the sex of sea turtles is environmentally determined by temperature. Sea turtles exhibit sexual dimorphism only as adults; hence diagnosing the sex of hatchlings and juveniles request employment of different direct and indirect techniques which differ in the level of accuracy, and costs (Mrosovsky & Benabib 1990, Marchant-Larios in Eckert et al. 1999, Wibbels in Eckert et al. 1999).

The Mediterranean contains one of the largest populations of endangered loggerheads turtle in the world, with the major nesting sites in Cyprus, Greece, Libya and Turkey (Margaritoulis et al. in press). Recent studies on Mediterranean nesting beaches showed skewed sex ratios of hatchling production, with an 81.6-99% bias towards females (Kaska et al. 1998, Godley et al. 2001a, b), and a pivotal temperature of about 29°C (Kaska et al. 1998, Mrosovsky 2002). On the other hand, testosterone analyses of juvenile loggerheads in central Mediterranean (Casale et al. 1998) suggested, surprisingly, a male skewed sex ratio (24M:11F).

Therefore, with this study we addressed two questions: first, what is the sex ratio of juvenile loggerheads in the Adriatic Sea, and second, what is a pattern of histological differentiation of gonads in regard to size classes (carapace length) of juveniles. We conducted our study in the eastern Adriatic Sea, in the territorial waters of Slovenia and Croatia, between 42° and 46° N, which host one of the most extensive developmental and foraging habitats for loggerheads in the Mediterranean (Lazar & Tvrtkovic 2001, Margaritoulis et al. in press). Tag recovery analysis has emphasized this region as a migratory pathway and foraging habitat primarily for loggerheads from the nesting grounds in Greece (Lazar et al. 2000, Margaritoulis et al. in press).

Materials and Methods

We performed a general necropsy on carcasses of juvenile loggerhead turtles captured dead in fisheries or stranded on the beach. For each individual, the determination of sex was undertaken by two methods: (i) visual examination of reproductive organs (Wyneken 2001), and (ii) histological analysis of gonads (Yntema & Mrosovsky 1980, Merchant-Larios in Eckert et al. 1999). In the latter case, the tissue samples were fixed in 10% formalin for a minimum of 48 h, dehydrated through a graded series of alcohol, embedded in paraffin, and sectioned at 8 micrometers. Sections were stained with hematoxylin and eosin, and examined with a light microscope.

We presented these data as two sets: gonadal morphology and gonadal histology data sets. In all cases where data obtained by these two methods have not concurred, we adopted a conservative approach and excluded such individuals from analysis. This data set is presented as the conservative data set. The sex ratios are given as a male/female ratio (M:F). Based on the curved carapace length notch to tip (CCL)(Bolten in Eckert et al. 1999), we divided loggerheads into three size classes: pelagic juveniles (<30.0 cm), post-pelagic juveniles (30.0-49.9 cm) and benthic juveniles (50.0-70.0 cm). We tested a difference between sex ratios in all three data sets and between size classes by the means of a chi-square test and Kruskal-Wallis test.

Results and Discussion

We morphologically and histologically examined gonads of 33 juvenile loggerheads with CCL ranging from 25.0-70.0 cm (avg. = 41.3; SD: 10.6); most of them (81.8%) were found in the northern waters of the study region. The tissue samples of six specimens were too decomposed for histological study of gonadal development. In the other twenty-seven samples, the testes of males with CCL of 25-40 cm were composed of flat, monostratified surface epithelium which frequently contained germinal cells. Epithelial cells formed medullary cords, but the seminiferous tubules were also present at this stage, with the mass of germ cells in the lumen. In larger males (CCL: 48.9-62.4 cm) the seminiferous tubules contained more differentiated spermatogenic cells, surrounded with connective stromal tissue. Ovaries exhibited membranous structure, folded, often partly transparent, enclosing spherical follicles. The stromal tissue was abundant in the medullar region, containing blood vessels. Comparing the gonadal developmental stages of small (CCL: 25-40 cm) and larger females (CCL: 40.4-70.0 cm), we found no such obvious differences.

Sexes of 30 and 32 juveniles were determined by a visual examination of gonads and histological analysis, respectively. In the case of three loggerheads (9.1%), the sex determination differed between these two methods. Visual examination of gonads resulted in sex ratio of 1:1, while histology and conservative data gave a slightly male-biased sex ratio (Table 1), but not significantly different from a 1:1 ratio (chi-square = 2.00, p = 1.157, df=1; chi-square = 0.33, p = 0.564, df = 1, respectively). We have found no significant difference in sex ratios between size-classes in any of data sets analyzed.

Our results suggest slightly male skewed sex ratios of juvenile loggerheads in the eastern Adriatic Sea (Table 1), in contrast to the strong female-biased loggerhead hatchlings production on the Mediterranean nesting beaches. These findings do, however, confirm, in part, the results from Casale et al. (1998), and are accordant with the study of Casale and Freggi (this volume) from central Mediterranean (Table 1). Even if the hypothesis on a slightly male-biased hatchling production at some nesting sites in Greece and Turkey in some years stands (Godley et al. 2001b), it would difficulty explain such disproportion of sex ratios between nesting beaches and the two marine regions studied in the Mediterranean.

Table 1. Sex ratios of juvenile loggerhead turtles *Caretta caretta* in two marine habitats in the Mediterranean (*see Materials and Methods for details).

Data Source	Males	Females	Unknown	Sex ratio	Region	Reference
Gonadal morphology	15	15	3	1.00	Eastern Adriatic Sea	This study
Gonadal histology	20	12	1	1.66	Eastern Adriatic Sea	This study
Conservative*	15	12	6	1.25	Eastern Adriatic Sea	This study
Testosteron titers	24	11	35	2.18	Central Mediterranean	Casale et al. 1998
Gonadal morphology	24	18	0	1.33	Central Mediterranean	Casale & Freggi, this volume

A recent comparison of testosterone levels and mtDNA haplotypes in loggerheads from central Mediterranean indicated a male-biased dispersal of northwestern Atlantic pelagic juveniles into Mediterranean (Casale et al. 2002). Such difference in migratory behavior between male and female juveniles is larger for specimens further from their natal areas, and consists in a stronger male-bias. If we consider that about 50% of pelagic juveniles in the Mediterranean originate from northwestern Atlantic populations (Laurent et al. 1998), most of them being males (Casale et al. 2002), we can expect that in shared habitats male-skewed immigration would buffer the original female-bias of the Mediterranean pelagic juvenile populations. Considering a strong female skewed hatchling production on the Mediterranean nesting beaches, such unexpected ratio in our study suggests that the male-biased dispersal of northwestern Atlantic juveniles (Casale et al. 2002) also reaches the Adriatic Sea. Our results therefore suggest that Adriatic Sea is a habitat shared by small juveniles belonging to both Mediterranean and western Atlantic populations; however genetic analyses are needed before a final conclusion can be drawn. Present findings support the theory that sex ratios in marine habitats is not necessarily representative of the sex ratios of whole population (Casale et al. 2002), at last where the juvenile size class is concerned

Casale et al. (2002) suggested that in marine areas far from nesting sites the sex ratios would be more skewed towards males. Consequently, considering the assumed higher reproductive value of females, human impact, such as fishery, would affect more populations from closer nesting sites than the distant ones (Casale et al. 2002). If the sex-biased dispersal happens already in the pelagic juvenile phase, considering higher reproductive value of females, high by-catch level in Adriatic fisheries (Lazar & Tvrtkovic 1995, Casale et al. 2001) would have the most detrimental effect for loggerheads from the regional nesting grounds.

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LMC AND AMC OF LEATHERBACK HATCHLINGS (*DERMOCHELYS CORIACEA*) ON PARGUITO BEACH, NUEVA ESPARTA STATE, VENEZUELA

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Introduction

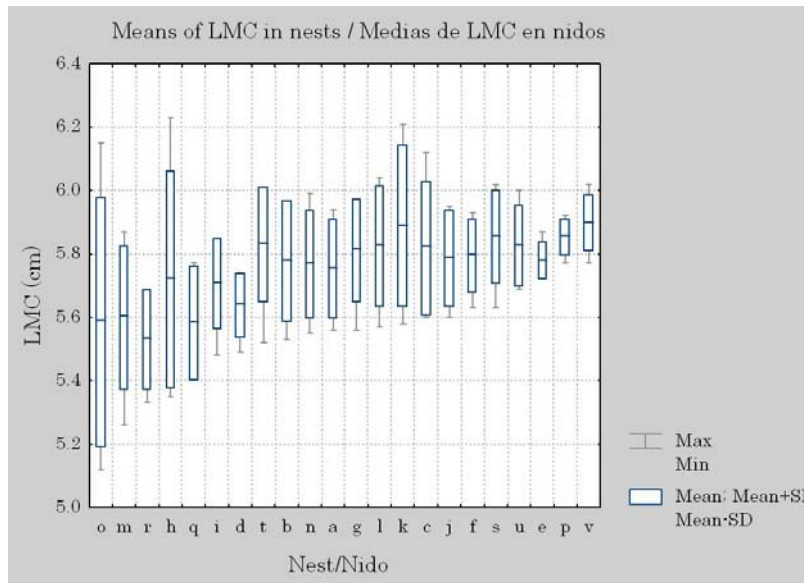
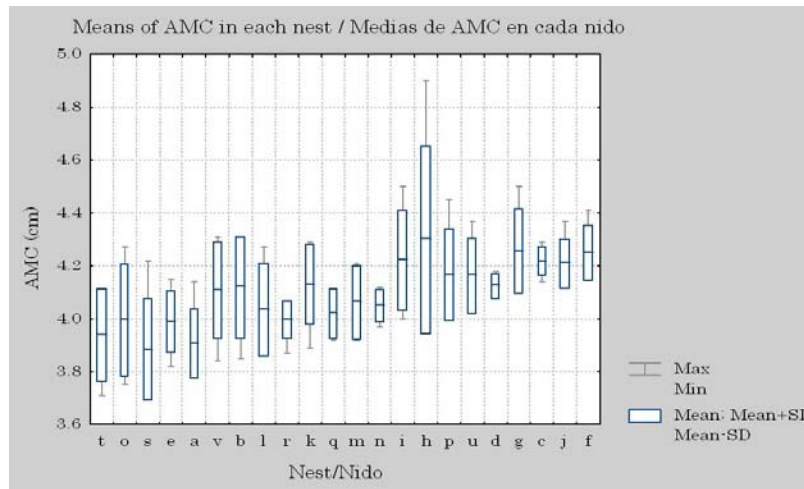
Investigations carried out in hatcheries are experiencing a growing boom, since these installations represent a fundamental tool in the recovery and conservation of the populations of marine turtles. Margarita island (10°51' to 11°11'N, and 63°46' to 64°24'W), is located in the South Caribbean, approximately 23 km of the coast of Venezuela. It is the biggest of three islands that forms Nueva Esparta state encompassing 1,071 km². This island is an important nesting site for four sea turtle species: *Dermochelys coriacea*, *Caretta caretta*, *Eretmochelys imbricata* and *Chelonia mydas*. "Parguito" beach, on the northeast of the island, is approximately 900 m long and 20 m wide, and is one of the most important beaches for the leatherback turtle. This study aimed to create a database for Maximum Carapace Length and Maximum Carapace Width measurements of a representative number of leatherback turtle hatchlings.

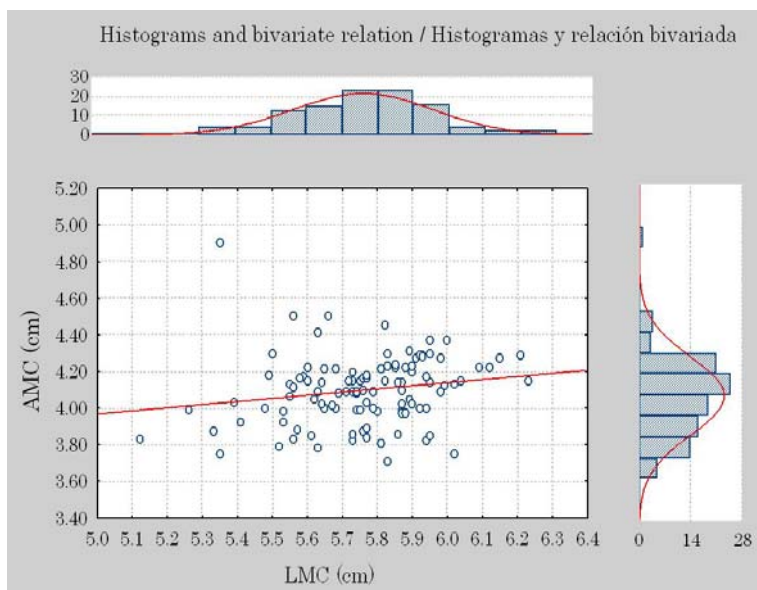
Methods

During 2001, we measured the Maximum Carapace Length (LMC) and Maximum Carapace Width Maximum (AMC) of five hatchlings per nest from 22 nests. We calculated the mean and the standard deviation among hatchlings and among nests, and conducted Kruskal-Wallis tests to determine if these differed significantly by nests. Finally, we used an r-Pearson coefficient to test correlation between AMC and LMC.

Results and Discussion

The mean of LMC was 5.8 cm (range 5.1 – 6.2, SD = 0.19 cm). The mean AMC was 4.0 cm (range 3.7 – 4.9, SD = 0.18 cm). The Kruskal-Wallis test revealed that neither the LMC nor the AMC differed significantly among nests (pLMC = 0.358 and pAMC = 0.351). This indicates that hatchlings were of similar sizes among all nests. The correlation among both variables was very low ($r = 0.182$, $p < 0.1$, not significant), suggesting carapace shape is variable in this growth phase for this species.





MONITORING OF NESTING SEA TURTLES ON YALIMAPOS BEACH, IN THE AMANA NATURAL RESERVE, FRENCH GUIANA, SOUTH AMERICA

Noemi Morgenstern, Ronald Wongsopawiro, and Sylvain Lieutenant

Natural Reserve of Amana, 270 av. Paul Henri, Awala-Yalimapo, French Guiana GF 97319

Different methods are used for the monitoring and survey of the nesting sea turtles populations on Yalimapos beach, in the Amana Natural Reserve, French Guiana. We present the methods and the monitoring results of the crawls counting method for three sea turtle species: leatherback, green and olive ridley.

VARIATION OF REPRODUCTIVE PARAMETERS OF THE LEATHERBACK TURTLE (*DERMOCHELYS CORIACEA*) IN PLAYON DE MEXIQUILLO, MEXICO, OVER SIXTEEN YEARS OF CONSERVATION

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³ *DGVS-SEMARNAT*

Background

The beach of Mexiquillo, Mexico has been one of the major nesting sites for leatherback turtles *Dermochelys coriacea*, and the only one with continuous records on several reproductive and ecological aspects for the species over 16 years in Mexico. On this beach, as has occurred in the rest of the Eastern Pacific, the leatherback nesting population has suffered a drastic collapse. Over time, biologists have observed some changes in reproductive parameters such as size of the females, clutch frequency, clutch size and total fecundity, and the purpose of this work is to highlight these variations, with an overall objective of analysing reproductive and population parameters obtained from 1983 to 1999 on this nesting beach. Specific objectives were to show fluctuations over time in Curved Carapace Length, Clutch Size and Total Fecundity, and Clutch Frequency.

Methods

Standard Curved Carapace Length (CCL) was taken as the total longitude of the carapace following Bolten (2000). Clutch Frequency was the number of clutches from each female, and Ttotal Fecundity was taken as the total number of eggs laid by a female over a season. We obtained averages of these parameters per season, and performed linear regressions in order to find the relations between the variables and a one-way ANOVA to find the differences between seasons. The data were analyzed using STATISTICA 6 and EXCEL 2000.

Results

Female Size: The size of the females decreased from 147.3 cm CCL to 136.9 cm in 2002 (Fig. 1). An ANOVA indicated significant differences between seasons with $F_{15, 4797} = 12.32, p = 0.05$. Standard error has become larger over the last seasons, as an effect of the reduction of the population size (a smaller sample size in terms of number of turtles available for measuring; Fig. 1). The relation between CCL and CCW ($r = 0.73$) was similar to that of other populations (Fig. 2). It is possible that the smaller females observed in the latest season are younger females with a higher reproductive capacity.

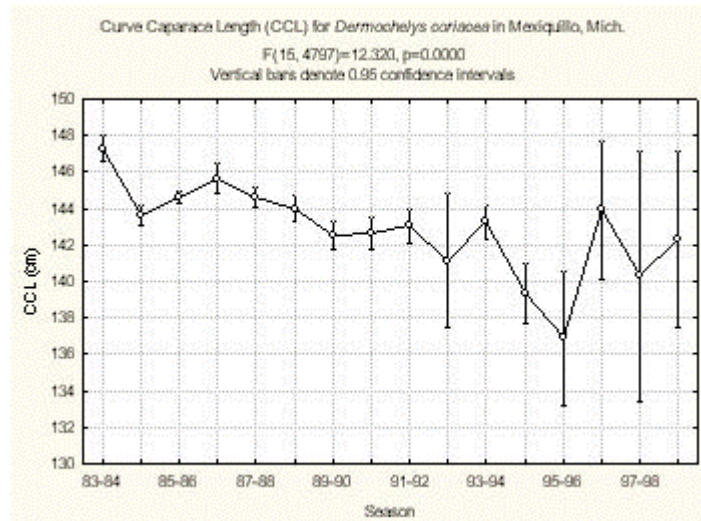


Fig. 1. Curve Carapace length for *Dermochelys coriacea* in Mexiquillo.

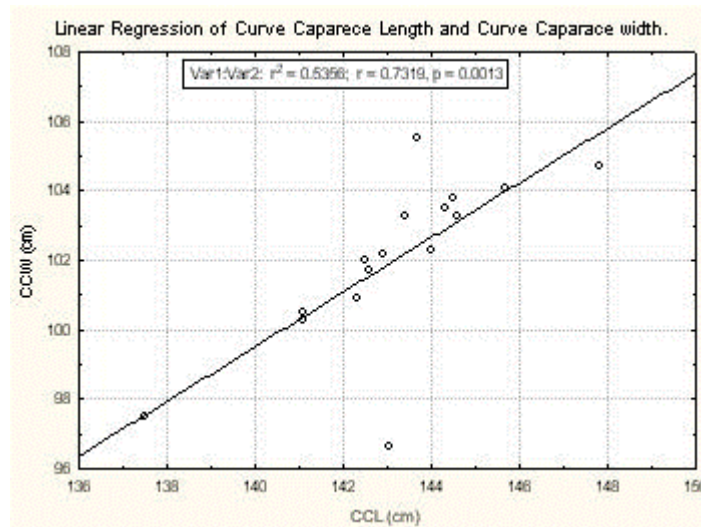


Fig 2. Linear Regression of curve carapace and curve carapace width.

Clutch Size: An ANOVA of reproductive characteristics indicated significant differences in average clutch size, with increases during 1996-1997 and 1998-1999 (Fig.3). We found a negative relationship between clutch size and CCL ($r^2 = 0.1638$). In general, smaller females on average were laying more eggs (Fig. 3, 4 and 5). This result does not agree with previous work (*C. caretta*: Bustard 1972, Hirth 1980 and Ehrhart 1982; *D. coriacea*: Frazier and Richardson 1986, Tucker and Hall 1984; *C. mydas*: Bjorndal and Carr 1989), which suggest larger turtles lay more eggs than smaller ones. We believe this apparent fluctuation in the

clutch size can be attributed to the drastic reduction in the population size, which results in biased sampling for individuals which are further from the average values.

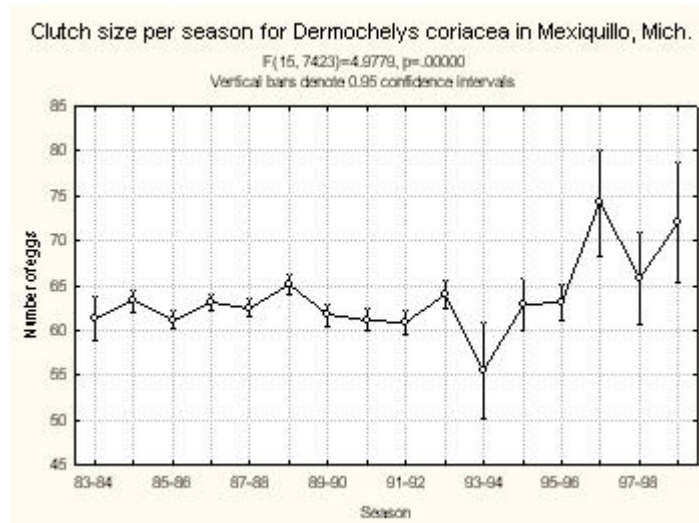


Fig. 3. Clutch size per season for *Dermochelys coriacea* in Mexiquillo.

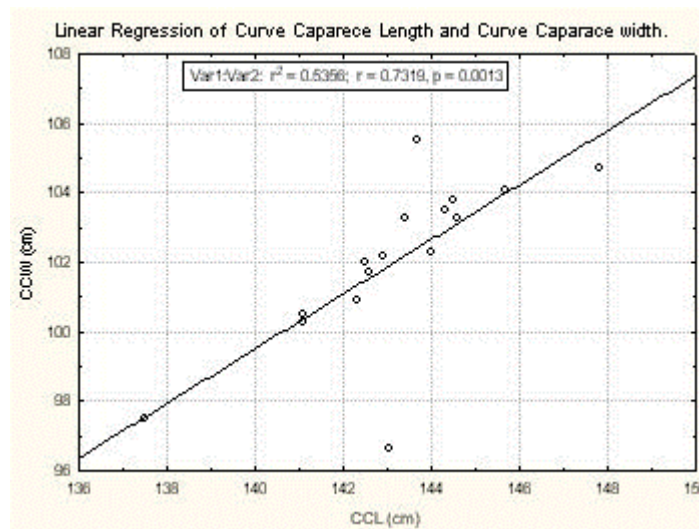


Fig. 4. Linear Regression of clutch size vs curve carapace length.

Fecundity: The variation in fecundity has increased from 143 to 236 eggs laid per female per season and shows significant differences per season $F_{15, 1466} = 42.63, p = 0.0000$ (Fig. 6), but lower fecundities were observed in 1983-1984 and 1987-1988. Other leatherback beaches show higher fecundity averages, such as Jalova, Costa Rica (Hirth, 1980) and Sandy Point NWR, USVI (Boulon et al., 1996), which report from 500 to 1200 eggs laid per females per season. The lower fecundity in the Mexican Pacific leatherbacks could be linked to genotypic characteristics as well as ecological factors, in the same way as average clutch size.

Clutch Frequency: Clutch frequency showed significant differences per season $F_{15, 1467} = 12.24, p = 0.0000$, with a slight increase over the years (Fig. 7). In spite of this, the total number of clutches laid on this beach has decreased, and the population shows signs of collapse as highlighted previously by Sarti et al. (1999) (Fig. 8).

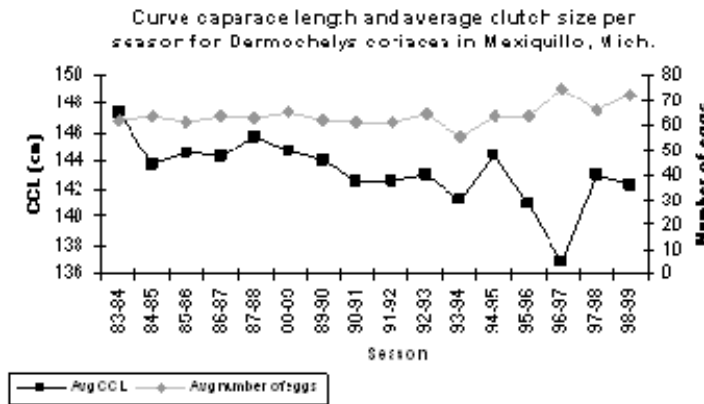


Fig.5. Curve carapace length and average clutch size per season for *Dermochelys coriacea* in Mexiquillo.

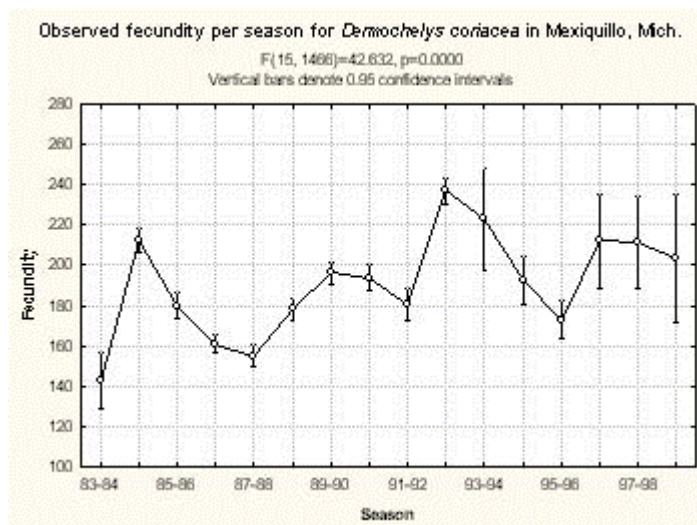


Fig. 6. Observed Fecundity per season for *Dermochelys coriacea* in Mexiquillo.

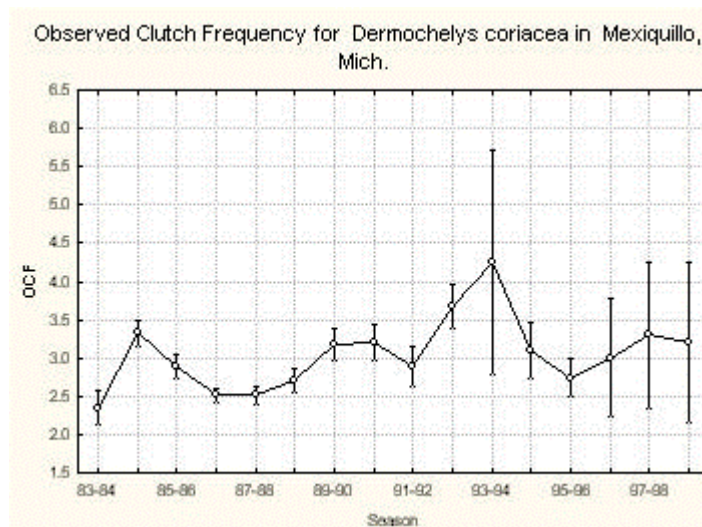


Fig. 7. Observed Clutch Frequency (OCF) for *Dermochelys coriacea* in Mexiquillo.

Understanding the variations in these parameters has only been possible following the continuous monitoring of this population for over 16 years. During this time, the information gathered has helped build the largest database for leatherback biological characteristics in Mexico. The fluctuation in reproductive parameters can be noted mainly because of the rapid reduction in the population size in Mexiquillo, since every season we have access to fewer females, standard deviations get higher and values get farther from the mean. Also, it is evident that this population shows atypical reproductive characteristics that could be attributed to the collapse of the population.

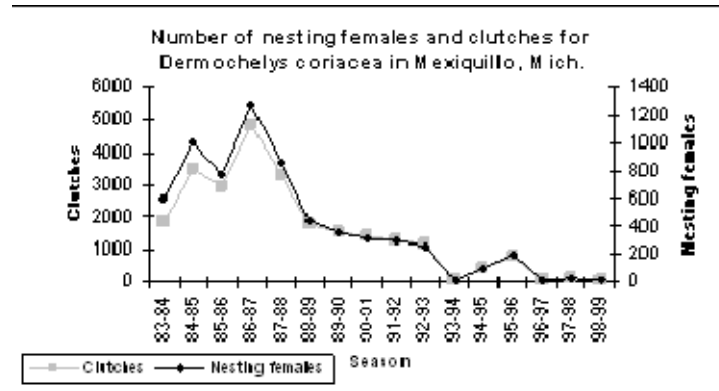


Fig. 8. Number of nesting females and clutches for *Dermochelys coriacea* in Mexiquillo.

Acknowledgements:

The senior author gratefully acknowledges the generous donation of the Western Pacific Fishery Council that made possible for him to attend the symposium. Thanks also to the Symposium's travel committee. Last but not least, we are forever grateful to the hundreds of people that have participated during such a long time gathering biological and reproductive data for the leatherbacks in Mexiquillo, we are still hopeful for the recovery of the population.

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ENERGY EXPENDITURE OF MEDITERRANEAN LOGGERHEAD SEA TURTLE EMBRYOS

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The rate of embryonic development in oviparous reptiles is determined by environmental factors, primarily incubation temperature. During their development sea turtle embryos utilise a limited energy store deposited in the egg yolk, and any residual yolk at the time of hatching may provide a valuable energy store for the hatchling. Minimising energy use during development may therefore influence hatchling fitness. Eggs incubated at hotter temperatures develop faster, but energy expenditure is also greater at higher temperatures. An interesting question touched on by recent studies, is how these two features interact to define the total costs of embryonic development.

During 2002 in Kyparissia Bay (mainland Greece) we collected 90 eggs laid by two *Caretta caretta* females on the morning after deposition. The eggs were divided into boxes of ten, and incubated artificially on moist vermiculite at 27.5°C, 29.9°C, and 31.8°C. Each incubator contained three boxes of ten eggs. Measurements of oxygen consumption and carbon dioxide production of the developing embryos, using open-flow respirometry, were first carried out on day ten of the incubation. Further measurements were performed on each box of eggs at approximately three-day intervals throughout the incubation duration, under temperature conditions similar to their incubator. The volume of oxygen consumed, carbon dioxide produced, respiratory quotient (RQ), daily energy expenditure, and incubation duration of the developing embryos were subsequently calculated for each temperature treatment. For the purpose of this analysis, incubation duration was defined as the number of days which elapsed between laying date (taken as the morning after the eggs were laid) and the day of first pipping. Hatching success was high (97%) for each temperature treatment. All hatchlings were subsequently released.

At all three temperatures, oxygen consumption and carbon dioxide production increased rapidly during the second half of incubation, peaked, and declined towards hatching. Maximum rates of oxygen consumption were highest at 31.8°C, and lowest at 27.5°C. Incubation duration was dependent on incubation temperature, and total energy expenditure of the developing embryos declined with increasing incubation temperature. Embryos developing at 27.5°C consumed a total of 31,727 J during their incubation, embryos at 29.9°C consumed 29,453 J, and at 31.8°C consumed 27,897 J. Lower incubation temperatures, and subsequently longer incubation durations, were therefore more energetically expensive for developing embryos.

RQ declined significantly as incubation progressed, suggesting that embryos do not use yolk constituents proportionately throughout incubation. RQ values indicated that yolk carbohydrate was utilised initially, followed by protein, and finally fat. It is important to remember that RQ values provide only an indication of substrate utilisation, and that more adequate testing is required to verify these findings. We suggest that (as there was no temperature or temperature-time effect on RQ) embryos incubating at higher temperatures utilise relatively little fat during development, but may use up more protein, while embryos incubating at lower temperatures use up considerably more fat.

Acknowledgements

We would like to thank ARCHELON, the Sea Turtle Protection Society of Greece, Linde Hellas, and The Meteorological Centre, Athens for help during this study. We are also extremely grateful to The Symposium Overseas Travel Committee and the funding assistance from the Sea Turtle Symposium, Fisheries Canada, and WWF (UK).

THE EFFECTS OF CLIMATIC CONDITIONS IN THE PACIFIC ON LEATHERBACK REPRODUCTIVE SCHEDULE AND POPULATION FEASIBILITY *

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We investigated the effect of climatic conditions on the reproductive schedule of leatherbacks nesting on the Pacific coast of Costa Rica and modelled these effects on the feasibility of the population. During 1997/98 there was a major climatic transition in the Pacific from El Niño to La Niña conditions, associated with an increase in primary productivity of oceanic waters through which these leatherbacks migrate. We determined that the reproductive schedule of leatherbacks nesting at Las Baulas was accelerated after a lag of about one nesting season following the transition, with a significant reduction in the interval between nesting seasons after the transition compared with the interval before the transition. In addition, a large number of turtles returned that had not been seen for five or more years previously. We propose that this change in reproductive schedule can be attributed to more favourable environmental conditions improving the abundance, distribution or quality of leatherback prey so that they reached reproductive condition more quickly than in the El Niño conditions that dominated before the transition. Our modelling of population feasibility showed that El Niño conditions reduce the feasibility of the population by increasing the age at maturity and increasing the time between breeding seasons. A dominance of these conditions requires an increased rate of adult and juvenile survival in order for population stability or recovery. These results are important because we show that climatic changes can affect the outcome of conservation activities for sea turtles.

MID-DOMAIN EFFECT: AN HYPOTHESIS FOR SPATIAL AND TEMPORAL NESTING PATTERNS

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As a result of the mid-domain effect, the ranges and midpoints of various species within a shared geographic domain with defined biological boundaries will produce a parabolic curve in species richness, with the greatest number of species concentrated towards the center of the domain. Using data collected between 1972 and 2000 on nesting emergences of green turtles at Tortuguero, Costa Rica, we demonstrated that the mid-domain effect, which was developed to evaluate patterns of species richness, can also be applied to intraspecific patterns of reproductive investment within well-defined spatial and temporal biological boundaries. We predict that other sea turtle nesting beaches with well-defined boundaries and a large nesting population would support the mid-domain model in the absence of overriding biological and environmental factors.

EFFECTS OF EMERGENCE LAG ON PERFORMANCE, SIZE AND ENERGY RESOURCES OF *CHELONIA MYDAS* HATCHLINGS: IMPLICATIONS FOR HATCHERY MANAGEMENT

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Hatchery managers around the world must decide at what depth to relocate eggs to maximise the production of high quality hatchlings. It was the primary objective of this study to determine the effects of nest depth on the emergence lag of hatchlings and how this effected their quality in terms of running performance, mass:length ratio and triglyceride levels. This study further aimed to investigate the difference in quality of hatchlings that successfully emerged and those found alive in nests excavated six days after the emergence of the first hatchlings.

In 2001, *Chelonia mydas* clutches from Ma'Daerah beach, Terengganu, Malaysia were relocated alternatively at depths of 50cm and 75cm to elicit a difference in emergence lag. When the hatchlings emerged, a sample of the clutch was run, measured, weighed and had blood samples taken, which were analysed for plasma triglycerides.

Hatchlings from 75cm deep nests had a 48 hour longer emergence lag than hatchlings from 50cm deep nests. Hatchlings from 75cm nests had similar running speeds but lower mass:length ratios and triglyceride levels than hatchlings from 50cm deep nests. Hatchlings found alive in nests excavated six days after the first emergence of each nest showed further reduced running speed, mass:length ratios and triglyceride levels. These results indicate that the longer hatchlings spend in the nest between hatching and emergence, the further their quality is depleted in terms of running speed, mass:length ratio and triglyceride levels. These factors need to be considered when making decisions as to which depth to relocate clutches in hatcheries.

THERMAL BIOLOGY OF *CHELONIA MYDAS* NESTS IN EASTERN PENINSULAR MALAYSIA

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Controlled laboratory incubation of eggs of *Chelonia mydas* was conducted over a three-year period in Eastern Peninsular Malaysia. Investigations included controlled-temperature incubations of a series of clutches collected from two beaches: Chendor, Pahnag, a mainland, coloured sand beach, and Mak Kepit, Terengganu, an offshore island, white-sand beach. Incubation success, incubation period, sex ratios, pivotal temperatures, and hatchling morphometrics were measured. Hatching success at intermediate temperatures was over 75% in all three years of the study with eggs collected from Chendor but was more variable, particularly in 1998, with eggs collected from the offshore island. Incubation period was significantly and inversely related to incubation temperatures, with a one-degree increase in temperature decreasing incubation period by 6.25 days. Pivotal temperatures were found to be 29.4 +/- 0.6°C at both beaches, with 100% males produced at nest temperatures below 27.0°C and 100% females produced above 32.0°C. These data document the critical sex-determining pivotal temperatures of *C. mydas* nesting in the Peninsular Malaysia, and together with data on in situ and hatchery nests will permit better informed management of turtle nests in the region.

**RESPIRATORY AND METABOLIC VARIABLES OF CAPTIVE AND WILD CAUGHT JUVENILE GREEN
(*CHELONIA MYDAS*), KEMP'S RIDLEY (*LEPIDOCHELYS KEMPI*) AND LOGGERHEAD (*CARETTA CARETTA*)
SEA TURTLES**

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Morreale³, and Frank Paladino³**

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³ *Cornell University, Ithaca, NY USA*

Few studies have examined the respiratory and metabolic variables of juvenile sea turtles. The reports that do exist have not measured physiological and metabolic variables simultaneously as was done in this study, with the exception of work done on leatherbacks by Paladino et al. (1996). The goal of this investigation was to measure eight respiratory and metabolic parameters, including heart rate, respiratory frequency, respiratory ventilation, tidal volume, core body temperature, oxygen consumption, carbon dioxide production, and a calculation of the respiratory quotient (VCO_2/VO_2), on the same individual juvenile sea turtles. We analyzed these variables on two Kemp's ridley (*Lepidochelys kempi*), one loggerhead (*Caretta caretta*), and two green (*Chelonia mydas*) sea turtles, all estimated to be between 1-3 years of age. The turtles were studied either at the Cayman Islands sea turtle farm or after recovery and before release as cold-stunned animals in Long Island Sound. We collected data for fasting and non-fasting juvenile turtles both at rest and during terrestrial exercise. However, active heart rates were obtained immediately after exercise because of EMG interference with EKG recordings.

The metabolic and respiratory analyses on the juvenile greens did not reveal any surprising results. Respiratory frequencies ranged from 0.46 to 0.54 breaths per minute for resting greens and then increased eightfold for exercising greens. Predictably, heart rate, carbon dioxide production, tidal volume, oxygen consumption, and core body temperature also increased during exercise. Breath frequencies of two resting greens were similar despite a more than twofold difference in mass (28.64 kg vs. 12.96 kg). However, tidal volume for the larger green was three times the tidal volume of the smaller green turtle, which was more in proportion with the difference in their sizes.

Exercising Kemp's ridleys had respiratory quotient (RQ) values greater than 1.0, ranging from 1.19 to 1.55, which may be indicative of growth (Kleiber, 1975). These higher values could also indicate these turtles were relying on anaerobic metabolism, rather than using fat reserves as a metabolic source. Resting oxygen consumption ranged from 1.02 to 1.19 ml/min/kg for the larger Kemp's ridley (18.18 kg) and from 0.42 to 0.9 ml/min/kg for the smaller Kemp's ridley (6.62 kg). This observation is inconsistent with a study on adult greens which found that resting oxygen consumption decreased with increasing body mass (Jackson and Prange, 1979).

Although heart rate increased between resting and exercising juvenile loggerheads, unlike the green and Kemp's ridley sea turtles, there was no corresponding substantial increase in oxygen consumption, breath frequency or tidal volume.

For all green and loggerhead turtles tested, fasting RQ values were less than 1.0 indicating a reliance on fats as a fuel source. Non-fasted green turtles had RQ values of approximately 1.0, which is indicative of using carbohydrates as a fuel source for metabolic processes (Kleiber, 1975). In contrast, fasting did not appear to affect RQ values of Kemp's ridley turtles. RQ values for fasted Kemp's ridleys ranged from 0.7 to 1.55, while non-fasted Kemp's ridleys had RQ values from 0.85 to 1.37. Future research will focus on the unusually high RQ values for the exercising Kemp's ridley sea turtles to determine if these rates are a product of their lifestyle and/or diet. We hope to design studies to determine if these elevated RQ values are consistently found for Kemp's ridleys exercising terrestrially and to investigate the physiological reason Kemp's ridleys seem to use anaerobic metabolism while greens and loggerheads apparently do not.

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NESTING AND FORAGING BEHAVIOR

INTERACTIONS BETWEEN *LYNGBYA MAJUSCULA* AND GREEN TURTLES (*CHELONIA MYDAS*) IN MORETON BAY, AUSTRALIAShantala R. McMaster¹, Janet M. Lanyon¹, Judith M. O'Neil², and Colin J. Limpus³¹ Department of Zoology and Entomology, University of Queensland, Brisbane, Australia² Centre for Marine Studies, University of Queensland, Brisbane, Australia/Centre for Environmental Science, University of Maryland, Cambridge, USA³ Queensland Parks and Wildlife Service, Brisbane, Australia**Introduction**

Lyngbya majuscula, a toxic marine cyanobacterium, grows epiphytically on seagrasses and forms extensive blooms. In Moreton Bay, Queensland, Australia, these blooms appear to be increasing in frequency and magnitude (Dennison et al. 1999; Watkinson, 2000; Osborne et al. 2001). Since the seagrass beds in Moreton Bay are an important food source for the green turtle (*Chelonia mydas*), the presence of toxic *L. majuscula* may affect these herbivores. This study investigated whether captive *C. mydas* would (i) exercise choice if given the option of diets with and without *L. majuscula*, and (ii) show the ability to avoid seagrass with *L. majuscula*. The effect of toxin (lyngbyatoxin a, LA) on the amount of *L. majuscula* ingested was examined. Potential ingestion rates of *L. majuscula* by wild green turtles in Moreton Bay were also estimated.

Methods

Feeding trials: Feeding trials were conducted on six juvenile green turtles (42.0-47.5 cm curved carapace length; mean weight 9.66 kg). Twenty-four trials were performed (four per turtle) in March-April 2002. Turtles were housed in separate tanks. Each turtle was presented with two equally-available and randomly-placed food choices during each trial: seagrass with, and seagrass without *L. majuscula* attached (Figure 1). Two seagrass species were tested (*Zostera capricorni* and *Syringodium isoetifolium*). At the conclusion of each feeding trial (mean duration 19±0.42 hrs), the uneaten seagrass and *L. majuscula* remaining in the tank was collected and weighed, to estimate intake of each food item. Diet preference was expressed in terms of weight of food item ingested. Toxin content of *L. majuscula* (LA) was determined by mass spectrometry (LC/MS/MS).

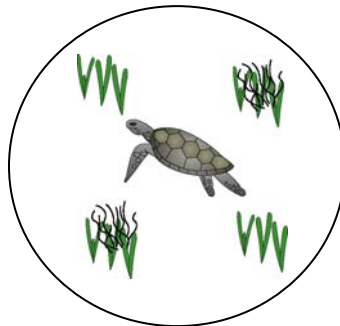


Figure 1: Experimental set-up of feeding trials, with 2 seagrass mats with *L. majuscula* attached and 2 without *L. majuscula*

Simulated grazing: To estimate the potential amounts of *L. majuscula* ingested by wild green turtles during a *L. majuscula* bloom in Moreton Bay, green turtle grazing was simulated in both low-density (2% cover), and high-density *L. majuscula* areas (85% cover). Seagrass standing crop (shoots with leaves) within 10 quadrats per site was clipped to the sediment level, to simulate the 'cropping' behaviour of green turtles (Bjorndal, 1980; Lanyon et al. 1989). The *L. majuscula* and harvested seagrass were oven-dried at 60°C and weighed. The toxin content of five *L. majuscula* samples from each site was determined by mass spectrometry.

Results

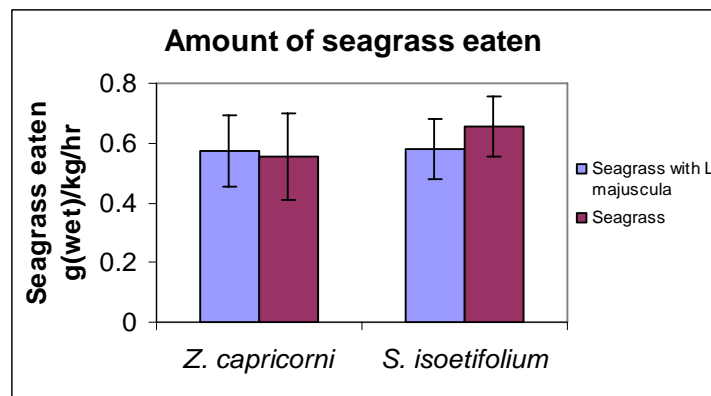
Feeding trials: All turtles in all trials ate a measurable amount of *L. majuscula* (range 0.01-0.22 g wet weight/h/kg turtle) (Table 1). An average of 46.79±4.55% of available *L. majuscula* was ingested.

Table 1: Mean ingestion rates (g wet wt/h/kg turtle) of *S. isoetifolium* and *Z. capricorni*, with and without *L. majuscula* attached, and of *L. majuscula*.

	Seagrass + <i>L. majuscula</i> (gwet/h/kg)	Seagrass (gwet/h/kg)	<i>L. Majuscula</i> (gwet/h/kg)
<i>S. isoetifolium</i> trials	0.58±0.10	0.66±0.10	0.06±0.01
<i>Z. capricorni</i> trials	0.57±0.12	0.55±0.14	0.10±0.03

The amount of seagrass eaten without *L. majuscula* was not significantly higher than that with *L. majuscula* attached in either the *Z. capricorni* ($p = 0.86$) or *S. isoetifolium* ($p = 0.68$) trials (Figure 2).

The lyngbyatoxin a content of the *L. majuscula* in the captive feeding trials did not significantly affect the ingestion rates of *L. majuscula*, nor of either *Z. capricorni* ($r^2 = 0.25$) or *S. isoetifolium* ($r^2 = 0.15$) attached to *L. majuscula*.

**Figure 2: Ingestion rates of seagrass with and without *L. majuscula* attached (g wet wt/h/kg turtle).**

Simulated grazing: We estimated that an 8 kg juvenile turtle feeding at the low-density *L. majuscula* site in December 2001 would ingest 1.65 g dry weight *L. majuscula* per day, and up to 63.54 g dry weight *L. majuscula* per day at the high-density site. This estimation was based on a turtle of this weight ingesting 0.3% of its body weight in seagrass (dry weight) per day (Bjorndal, 1980). Toxin load of *L. majuscula* varied spatially in Moreton Bay. The *L. majuscula* from the high-density site produced undetectable amounts of LA, whereas the low-density site *L. majuscula* contained an average of 0.16±0.02 mg/kg LA. Potential daily ingestion rates of LA by an 8 kg turtle feeding at these sites ranged from zero up to 2.64x10⁻⁴ mg LA.

Discussion

This is the first study to conclusively demonstrate ingestion of *L. majuscula* in captive green turtles. The turtles in these feeding trials did not appear to exercise choice with respect to offered food items and did not avoid *L. majuscula* when it was attached to seagrass. The toxin (LA) content of *L. majuscula* did not significantly alter the ingestion rates of *L. majuscula*, or associated seagrass. If wild green turtles show the same indiscriminate feeding and deliberate ingestion of *L. majuscula* as do captive turtles, levels of *L. majuscula* toxins may reach potentially harmful levels in turtles. *L. majuscula* has recently been recorded in gut contents of wild turtles in Shoalwater Bay, Queensland, Australia (Arthur et al., this volume), and in gut contents of stranded turtles in Hawaii (Russel and Balazs, 2000; Arthur et al., this volume).

Assuming that green turtles will not select against seagrass with *L. majuscula* attached, we have estimated that they may potentially ingest substantial amounts of *L. majuscula* in the wild, depending on its abundance. *L. majuscula* is highly variable in terms of extent and density during blooms. The amount potentially ingested by an 8 kg green turtle feeding in these areas in December 2001 may vary between 1.65-63.54 g dry weight *L. majuscula* per day. This represents a potential toxin load of up to 2.64x10⁻⁴ mg LA per day. The effects on green turtles of *L. majuscula* ingestion, and of this particular toxin load, are unknown.

L. majuscula contains more than 70 biologically active compounds, many of which are toxic. These include tumour promoters and immunosuppressants (Osborne et al. 2001).

Marine tumour promoters have been implicated as a potential factor in causing the turtle disease fibropapillomatosis (Landsberg et al. 1999). The increasing number and/or sizes of large *L. majuscula* blooms in Moreton Bay (Dennison et al. 1999; Watkinson, 2000; Osborne et al. 2001) may be related to the incidence of fibropapillomatosis in this area (Aguirre et al. 1999). Other potential effects may include a direct toxicological effect on sea turtles, resulting in reduction of breeding rates. Further, the immunosuppressants contained in *L. majuscula* (Koehn et al. 1992; Zhang et al. 1997) may lower the turtles' resistance to other diseases. Seagrass declines caused by *L. majuscula* blooms (Dennison et al. 1999; Watkinson, 2000) may also affect reproductive rate by reducing the quantity and/or quality of available food.

Acknowledgements

Financial support for this project was provided by the Healthy Waterways Partnership, Queensland EPA, and an ARC Linkage Lyngbya grant. A Travel Grant supplied by the Western Pacific Fishery Council and the 2003 Sea Turtle Symposium enabled me to attend the Symposium. I thank Nicholas Osborne from the National Research Centre for Environmental Toxicology (NRCET) for performing the *Lyngbya majuscula* toxin analyses. I am grateful to the DPI Southern Fisheries Centre for the use of their captive facility, and also to the UQ Marine Botany Group for assistance with field and laboratory work, and the many volunteers.

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THE DECLINE OF THE EASTERN PACIFIC LEATHERBACK AND ITS RELATION TO CHANGES IN NESTING BEHAVIOR AND DISTRIBUTION

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Background

The leatherback turtle (*Dermochelys coriacea*), the largest of all living sea turtles, has been considered an endangered species worldwide since the early 80's and was recently listed as Critically Endangered in IUCN Red List. In the Mexican Pacific, Playón de Mexiquillo is the only Mexican leatherback nesting beach that has maintained continuous monitoring coverage for almost two decades, and during this time a drastic decline in the number of nesting females has been documented. Other

important rookeries for the leatherback in the Eastern Pacific occur in Costa Rica, and at Playa Grande, where long-term continuous protection activities have taken place, the same sort of decline has been observed (Steyemark et al., 1996). The current declining trend in the nesting populations of Mexico and Costa Rica have caused great concern regarding the fate of the Pacific leatherback, and has motivated new conservation strategies.

Since 1995, Proyecto Laúd has encouraged coordinated conservation efforts between different institutions working in the Mexican Pacific, in order to more accurately estimate population status for the leatherback. As a result, we have the most complete long-term database for some biological characteristics of the leatherback in Mexico, from which some trends can be observed. The purpose of this work is to highlight some of those trends that could be related to the collapse of the Eastern Pacific leatherback population.

Methods

Ground surveys to count leatherback tracks have been regularly performed during the whole nesting season in the index beaches of the Mexican Pacific for almost a decade, and for 20 years in the case of Playón de Mexiquillo. In addition, aerial surveys have been made each year in mid-January since 1995 along the Mexican and Central American coast. This information was used to develop a population estimate model, along with information from a saturation tagging program in the major nesting beaches (Mexiquillo, Tierra Colorada, Cahuitán and Barra de la Cruz). We also worked in collaboration with colleagues from Central America to monitor the population changes in the whole region.

Results

Mexiquillo is by far the beach with the most complete database of leatherback track surveys in Mexico. On this beach, aside from the depletion in the nesting numbers, we have observed changes in the duration of the nesting season. In the 1980's, nesting seasons typically started in mid-October and ended in late March, with a marked peak in mid- to late December (Figure 1). By the 1990's, the first nests were not recorded until mid-November, and the seasons lasted through mid-March. An extreme was recorded in 2001-2002, which only lasted from late November to late January, with no evident peak in nesting activity. A similar shift in the starting time of the nesting season and lack of a peak has been observed for all the index beaches in the Mexican Pacific.

The nesting in 2001-2002 was also atypical in the lack of homogeneity of the nesting season's duration among the Mexican index beaches. While in Mexiquillo the season ended in late January, in Tierra Colorada leatherbacks kept nesting until mid-March, and in Cahuitán they did so until late March. This affected the population estimate model which assumes that the index beaches have equal length nesting seasons, and caused an over-estimate of the nesting numbers on beaches close to the Mexiquillo.

Although the first years of the aerial surveys were only done along the Mexican Pacific coast, some changes have been observed in the distribution of the high-density nesting areas (darker spots on the maps, Figure 2) along the Eastern Pacific over time. The major rookeries in the coast of Michoacán, Guerrero and Oaxaca maintain higher nesting densities than other beaches; however, the proportion of the total nesting activity that they represent has changed in later seasons. During the 1990's, the major beaches in Mexico comprised more than 40% of the total number of leatherback nests along the Eastern Pacific coast. During 2001-2002, this proportion dropped to 30%, and during the aerial survey it was evident that some non-index beaches had similar counts to index beaches. Also, a lot of new beaches with very low nesting densities (1 or 2 nests) have been recorded in later seasons.

The leatherback turtle is known to have a weak nesting site fidelity (Barragán and Dutton, 1998; Dutton et al, 1999), with some females traveling many miles between consecutive nesting events. In Mexico, movements of females have been recorded between index beaches with saturation tagging programs. It is possible that some females from the major nesting beaches are moving to areas where there are no protection activities, and this effect is more evident with an extremely depleted population.

It seems that the collapse of the Eastern Pacific leatherback population is affecting the nesting behavior of the females in ways that we are only beginning to understand. Unfortunately, long-term studies are not common, and we have few other examples of similar effects in a nesting population. Further research is needed, and in the meantime, the monitoring of the Eastern Pacific leatherback population will continue to provide the information necessary for appropriate regional conservation measures.

Acknowledgements

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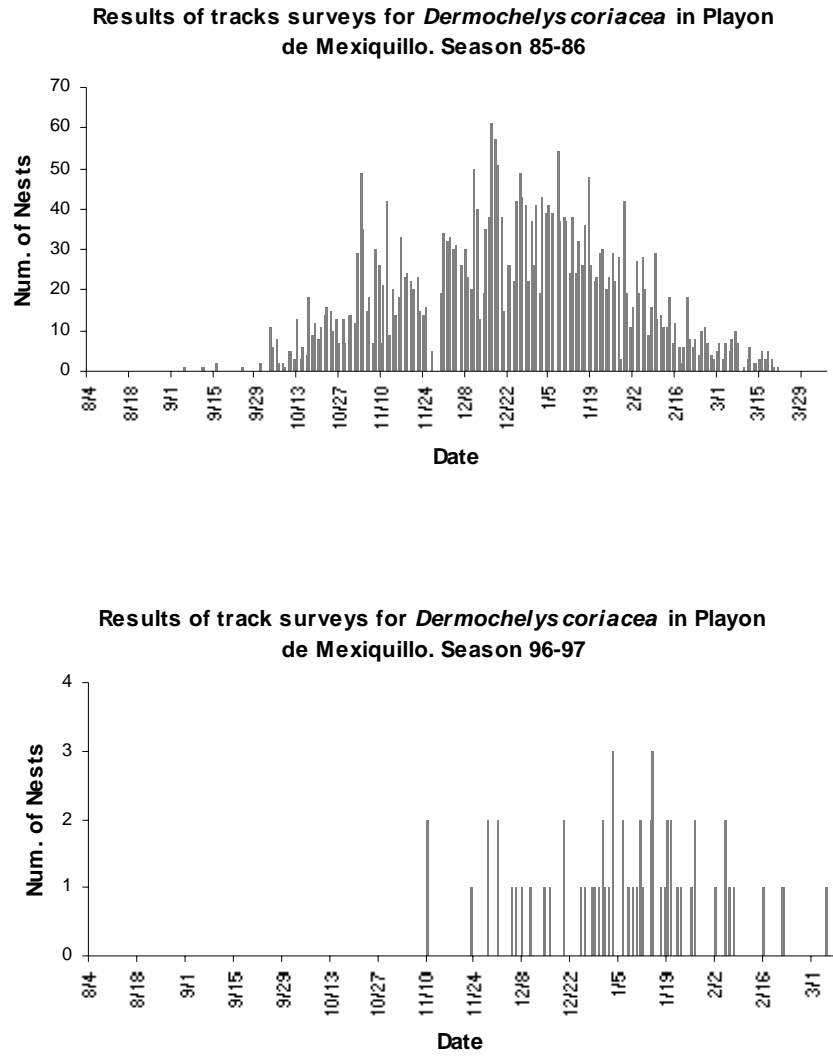


Figure 1.- Changes in the duration of the leatherback nesting season documented over time at Playón de Mexiquillo, Mexico.

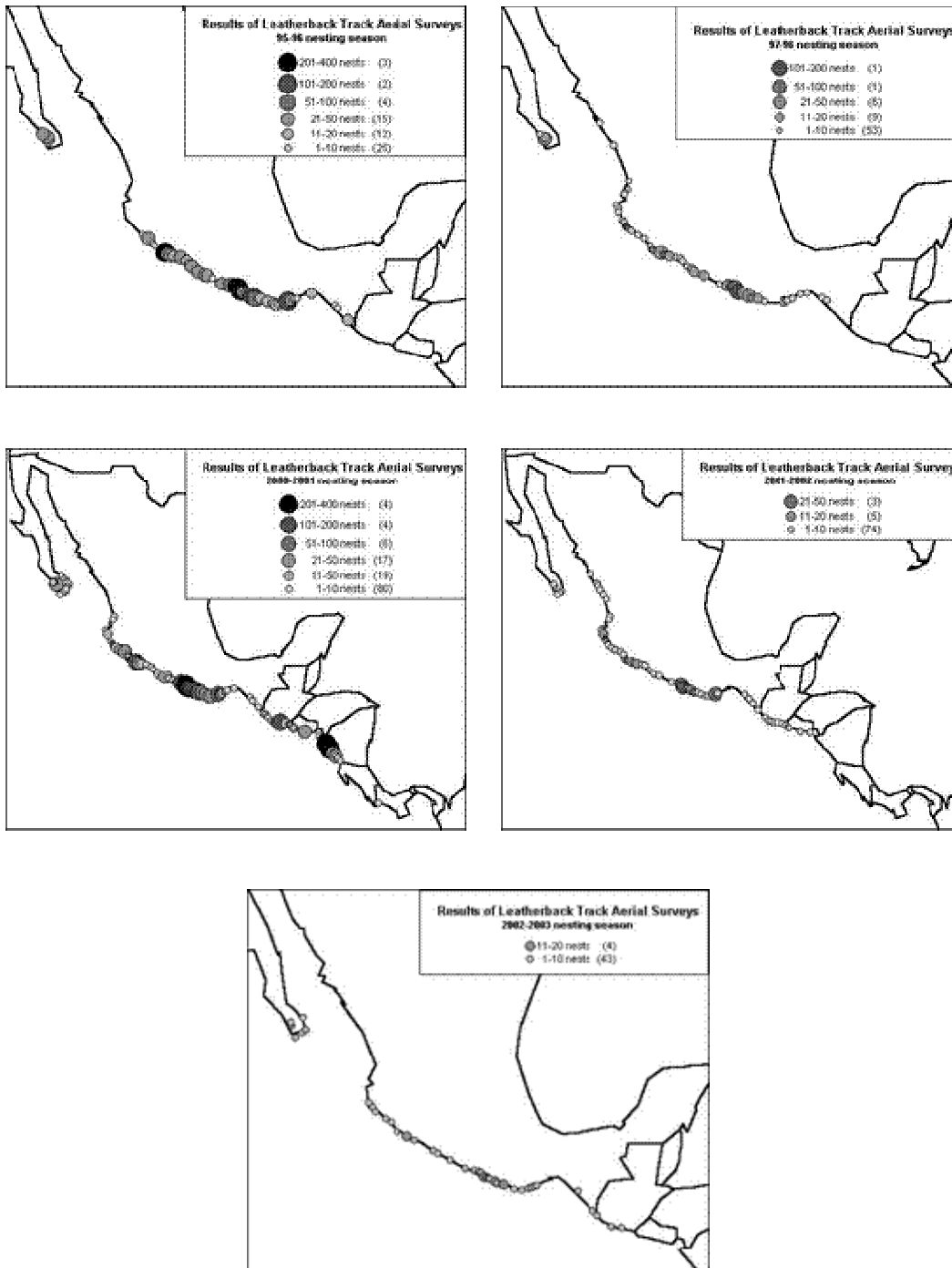


Figure 2.- Changes in the distribution and density of the nesting activity for the leatherback in Pacific Mexico and Central America, as documented by aerial surveys.

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BEHAVIORAL SCHEDULING AND TIME-ACTIVITY BUDGETS OF GREEN TURTLES (*CHELONIA MYDAS*) AT A TEMPERATE FEEDING AREA IN THE EASTERN PACIFIC OCEAN *

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We studied the timing of in-water behavior and developed time-activity budgets for green turtles (*Chelonia mydas*) at a temperate foraging area in the Gulf of California, México. A total of 24 green turtles were equipped with time-released time-depth recorders (TDRs) and tracked with radio and sonic telemetry. Over 2,000 hours of dive data were collected. Green turtles ranged from 57.9 to 99.0 cm in straight carapace length and 27.3 to 145.4 kg in mass. We quantified resting, foraging, and surface activity based on TDR dive profiles and direct observation. The correlation between dive profile and inferred behavior was corroborated with the use of carapace-mounted video cameras (Cittercam). Green turtles exhibited diving patterns unlike those reported from other green turtle foraging habitats. We observed a mean of 65.5 and 38.8 foraging and resting dives per day, respectively. The mean time allocated to foraging activity per 24-h period was 11.2 h (46.7%) while that of resting activity was 8.6 h (35.8 %). The mean time allocated to surface activity per 24-h period was 1.4 h (5.9 %). Foraging dives were significantly shorter and shallower than resting dives. The mean foraging and resting depth modes were 7.5 m and 10.3 m, respectively. There was no correlation between turtle size and mean resting depth mode. In addition, the implications of changing oceanographic conditions on green turtle in-water behaviors and time-activity budgets are discussed.

LOGGERHEAD TURTLES FORAGING IN ARGOSTOLI HARBOUR, KEFALONIA

Michael White

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This 20-minute colour film shows some close-up observations of loggerhead turtles *Caretta caretta* foraging in the Argostoli area of Kefalonia, Greece. Adult males and large untagged short-tailed turtles have been observed over several years in this area. Current research is based at the fishing-boat quay, which has proved to be an excellent study site. Sometimes loggerheads are as close as one metre away. Certain turtles were observed feeding on the small fish discarded by professional fishermen during net cleaning, which included *Oblada melanura* and *Mullus surmeletus*. This film includes the angle of approach adopted by a turtle when feeding at the surface, prey capture, and some interesting aspects of the ecological role played by turtles locally. Some very close interactions between turtles and humans were observed at this shallow-water urban site.

LITTLE LOGGERHEADS PACKED WITH PELAGIC PLASTIC

Blair Witherington and Shigetomo Hirama

Florida Fish and Wildlife Conservation Commission, Florida Marine Research Institute, 9700 South A1A, Melbourne Beach, FL US 32951

Posthatchling loggerheads inhabit oceanic fronts where floating material collects. During tropical storms, these young turtles are occasionally swept onto Florida (USA) beaches. Between 1994 and 1999, there were 686 posthatchling loggerheads stranded in Florida, predominantly on the central Atlantic beaches of the peninsula. In a sample of 102 loggerheads that had stranded dead, 83 had yolk sacs of less than 1 cm and had begun feeding. Of these 83 turtles, 83.1% had ingested plastics and 33.7% had

ingested tar. Gut contents of 50 of these turtles were analyzed for volumetric proportions of items using microsterology. Animal material was greatest in mean volume (46%), followed by plant material (44%) and anthropogenic debris (10%). Ingested debris was mostly plastics (90% by volume), followed by tar (7.8%), and other debris (1.8%) including latex and paraffin. Nearly all ingested plastics were consistent with high-density polyethylene that had photo-degraded into small shards or that was ingested as spherical precursor pellets. Colors of ingested plastics varied greatly but were principally white, light (off-white), or translucent. Size frequency data suggest that loggerheads newly recruited to the open ocean take weeks to gain the plastic loads observed. It is clear that young turtles suffer lethal and sublethal effects from plastics and tar ingestion and that the frequency of this problem is alarmingly high.

Acknowledgements

Turtles were collected by the dedicated volunteers of the Florida Sea Turtle Stranding and Salvage Network, especially Bill Ahern, Andrew Derlkowski, Mary Devos, Kristin Fick, Stephen Gard, Toni Giovino, Jerry Heyes, Karen Holloway, Dori Hughes, Lee Hughes, Rita Karpie, Marcia Keating, Chris Koeppe, Beth Libert, Marye Marshall, Diane Miller, Carly Pfistner, Andrew Rich, Kirt Rusenko, Karrie Singel, and Paul Tritaik. Extra thanks go to the Sea Turtle Preservation Society of Brevard County and to the Volusia Turtle Patrol. Research support came from the Florida Fish and Wildlife Conservation Commission Marine Turtle Protection Trust Fund, the US Fish and Wildlife Service, and the in-kind service of data collectors. Author's travel to the Symposium was funded by a grant from NOAA National Marine Fisheries Service.

NESTING BEACHES

MONITORING NESTING SEA TURTLES IN THE CENTRAL CARIBBEAN COAST OF COLOMBIA *

Diego Amorocho

*Monash University, School of Biological Sciences, Australia***Introduction**

This work summarizes the results of the research and conservation activities carried out jointly by WIDECAS, WIDECAS-Colombian Association (AWC), the National Parks System (UAESPNN), the Colombian Ministry of the Environment (MMA) and local communities along the Central Caribbean coast of Colombia during the 2001 sea turtle nesting season. The plight of sea turtles and their distribution in nesting grounds as determined through Rapid Nesting Assessment Surveys (RNAS) conducted in four protected coastal areas are presented. The following research-driven objectives were prioritised during the Rapid Nesting Assessment Surveys:

1. To update information concerning the current situation of nesting sea turtles along the protected areas of the Colombian Caribbean coast, useful for their conservation management, and
2. To assess the nesting biology of the loggerhead sea turtle (*Caretta caretta*) on the beaches of the Central Caribbean coast of Colombia.

Methods

The geographic scope of the 2001 sea turtle nesting assessment project included the following protected areas: Salamanca Island National Road Park, Tayrona National Park, Sierra Nevada de Santa Marta National Park, and Flamencos Fauna and Flora Sanctuary. In addition, as the largest loggerhead nesting ground in the Colombian Caribbean, the project focused on the following buffer zone beaches connecting the Tayrona and Sierra Nevada National Parks: Mendihuaca, Guachaca, Buritaca, Don Diego and Quintana (SNSMNP) beaches.

Rapid nesting assessment surveys were conducted between May and September of 2001 in Magdalena and La Guajira on the central Caribbean coast, during which trained field teams gathered information through local interviews, tagged and measured turtles and relocated nests into protected hatcheries. Hatchlings released from relocated nests were weighed with precision balances and measurements of Straight Carapace Length (SCL) and Straight Carapace Width (SCW) were taken using vernier calipers. Information about threats and their impact on sea turtles, hatchlings and nests was also gathered in each visited beach. Nesting beaches were positioned using a GPS and incorporated into a Geographic Information System (GIS).

Results

Salamanca National Road Park: In this protected area the presence of sea turtle species was confirmed in two sectors (between 11°09'N, 74°34'W and 10°76'N, 74°19'W): Tasajera-Cangarú and Bocas de Ceniza- El Torno. The local inhabitants reported 15 nests during 2001, the majority attributed to leatherback (*Dermochelys coriacea*) in the Tasajera-Cangarú sector. Two leatherbacks and a hawksbill (*Eretmochelys imbricata*) nesting female were slaughtered between Bocas de Ceniza and El Torno. Threats to the survival of sea turtles in this protected area and nearby beaches are mainly overexploitation of nests and adults. Longline fishing is a serious risk to the females that approach the nesting zones in the Bocas de Ceniza-El Torno sector. These threats, along with erosion of the nesting beaches, are responsible for the virtual local extinction of loggerhead (*Caretta caretta*) and green turtles (*Chelonia mydas*), and the critical condition of the hawksbill and leatherback rookeries.

Tayrona National Park: The survey was conducted (between 11°17'N, 73°53'W and 11°19'N, 73°58'W) in the eastern sector of this protected area between July and August 2001, and identified twelve potential sea turtle nesting beaches. Between June and September the hawksbill was the most active species in this sector (n = 17), followed by loggerheads between March and June (n = 10). Sporadic leatherback (n = 6) and green turtle (n = 1) nesting occurred in March and May at the beginning of the season. Fishing and tourist boats, construction activities, sewage and dumping of solid waste are presently affecting the habitats frequented by sea turtles in the Tayrona National Park. The constant change in the morphology of the nesting beaches, the capture of nesting females and looting of nests, and illegal fishing methods such as dynamite, have been identified as the main threats to sea turtles at the beaches and marine areas of this National Park.

The Flamencos Fauna and Flora Sanctuary: The two sectors historically known to be sea turtle nesting areas in this protected area, inhabited by the Wayúú indigenous people, were surveyed between July and August 2001. Two hawksbills (*Eretmochelys imbricata*), three leatherbacks (*Dermochelys coriacea*) and one green turtle (*Chelonia mydas*) were recorded between May and

September. The customarily over-exploitation of sea turtles by the Wayúú indigenous people and incidental capture in fishing gear other than Wayúú turtle nets, are critical issues for the recovery of depleted populations of the aforementioned species in La Guajira. Moreover, shrimp trawlers are deteriorating the marine habitats critical for sea turtles such as sea grass beds and coral reefs bordering the coast, and capturing individuals in violation of the regulations concerning the use of TEDs in the Wider Caribbean.

Mendihuaca, Guachage, Buritaca, Don Diego and Quintana Beaches: The total combined length of the five beaches is 21 km of which 18 km were surveyed between April and November. These beaches lie between 11°15'N, 73°42'W and 11°15'N, 73°51'W). This area has been historically considered the main nesting ground for turtles in Colombia and appears to host the southernmost colony of the Atlantic loggerhead (*Caretta caretta*). In 2001, nesting activity occurred between May and September. During this time 46 loggerhead arrivals were observed, of which 29 resulted in false crawls and 17 in true nests. Only two females were tagged: P4736 (CCL = 89 cm; CCW = 72 cm) and P4734 (CCL = 100 cm; CCW = 90 cm).

Relocation of Nests into Beach Protected Hatcheries: Two hatcheries were used for relocation and protection of collected nests. The first was on “Arroyo el Tigre” a private farm located on Buritaca beach, 7 km from the bank of the Guachaca’s river mouth, and the second one on Don Diego beach, some 200 m from the mouth of the Don Diego river. A total of 12 nests with 681 eggs were relocated into the two protected hatcheries. Seven nests were moved to the Don Diego hatchery, in which the average number of eggs per nest was 97. A total of 242 hatchlings emerged and 238 were released. The average hatching success was 31.7% and the average incubation period was 47 days. Four nest from Mendihuaca and one from Buritaca were transplanted into the Buritaca – Guachaca hatchery, in which the average number of eggs per nest was 112. Of the 561 relocated eggs, 258 emerged and 239 hatchlings were released into the sea. The hatching success was 52% with an average incubation period of 48 days. The total number of loggerhead hatchlings that emerged in the study area was 495, of which 477 reached the sea. The average egg diameter was 37 mm with an average Straight Carapace Length (SCL) of 42 mm and a Straight Carapace Width (SCW) of 31 mm. The overall hatching success in 2001 was 40.17%, the lowest recorded for this species in this region over the last five years.

Project Outcomes

This project has updated information on the current status of nesting sea turtles along the Caribbean coast of Colombia, and contributed toward the reclassification in 2002 of loggerhead (*Caretta caretta*) and leatherback (*Dermochelys coriacea*) sea turtles from Endangered to Critically Endangered (CR) in the Colombian Reptiles Red Book (Castaño-Mora, 2002), following IUCN Red List categories and criteria (2001).

Recommendations

- It is recommended that seasonal surveying of the beaches of the Central Caribbean region of Colombia continue in order to determine the population trends and the conservation status of those sea turtle species.
- It is recommended to genetically identify the loggerhead-nesting colony in the region. This will make it possible to determine if there has been displacement of individuals of the nesting population from Don Diego and Buritaca to the beaches of Sierra Nevada de Santa Marta and Tayrona Natural National Parks.
- To review and improve hatcheries management. The methods of relocating nests in the protected hatcheries must be standardized and improved in order to guarantee higher hatching success. Other options like relocation to safer places on the nesting beach must be explored.
- To encourage community-based conservation practices. The conservation programs in effect in the zone should work towards providing alternative sources of income for the local communities, to reduce overexploitation of adults and eggs.
- To evaluate the impact of local fishery activities. Identified alternative projects fostering the upgrade of fishing gear to increase fishermen income should be evaluated before such activities are introduced in sea turtle nesting zones.

Acknowledgements

I would like to thank WIDECAS, UAESPNN, the Colombian Ministry of the Environment, NMFS/NOAA, NFWF, US-FWS, C.I., Anneth Vasquez, Yina Marrugo, FTMSM, Don Diego Fishermen’s Committee, and WIDECAS-Colombia’s Association. Special thanks to the 23rd Annual Symposium on the Biology and Conservation of Sea Turtles, Monash University and the Western Pacific Fishery Council for having provided financial support to attend this meeting.

SEA TURTLES OF THE ANDAMAN AND NICOBAR ISLANDS, INDIA: A REVIEW AND CURRENT STATUS

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Four species of marine turtles occur in the Andaman and Nicobar Islands: the leatherback (*Dermochelys coriacea*), the hawksbill (*Eretmochelys imbricata*), the green (*Chelonia mydas*) and the olive ridley (*Lepidochelys olivacea*). Status surveys and studies conducted in the Andamans and Nicobars have recorded India's best nesting beaches for three species, leatherbacks, hawksbills and green turtles. Leatherback populations in the Andamans and Nicobars are the largest for India and the most important for the Northern Indian Ocean region and currently the Nicobar population may be globally significant. Green turtles are the most common and widespread species throughout both island groups. Thought in the Andaman Islands the actual ban on hunting and harvesting of turtles came into force only in 1977, all indigenous groups of people, the original inhabitants of the Andaman and Nicobar Islands, are exempted from the Indian Wildlife (Protection) Act.

KAZANLI BEACH, TURKEY: IS THE GREEN TURTLE A SPECIES THAT IS RESILIENT TO INCREASED HUMAN IMPACT ON ITS NESTING GROUNDS?

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Three main Mediterranean green turtle nesting grounds are located along the south east coast of Turkey: Kazanlı, Akyatan and Samandagi. Kazanlı beach with its high nest density was identified as the most important one in the past. Strong human impacts during the last ten years have led to an alarming situation according to several authors. During the 2001 nesting season a survey was conducted from June to end of September. Different threats were observed impacting on the nesting population, such as light pollution, predation, at-sea pollution, human beach use, vehicles on the beach, erosion, restaurants and hotels on the beach, fishing, and agriculture. Even though the list of threats is long, a discrete number of nests was recorded on this small stretch of Mediterranean coast. According to historical information, the area was a perfect green turtle nesting habitat composed of large sand dunes. The author's hypothesis is that we are dealing with the last individuals of the nesting population, which are still emerging following their strong 'site fidelity' and becoming resilient to the increased human impacts. Further scientific investigation is urgently needed in the area to evaluate the status of the population and to apply conservation strategies.

Acknowledgements

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THE SEA TURTLE PROJECT AT PHRA THONG ISLAND, THAILAND: WORKING WITH THE LOCAL COMMUNITY, TOURISTS AND VOLUNTEERS

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The Sea turtle Project at Phra Thong island, South Thailand started six years ago in collaboration with the Phuket Marine Biological Center, Thailand. The project focusses on three main aspects: scientific research, conservation awareness and education. Every season since the first year, the beaches have been monitored in order to evaluate the sea turtle nesting activities. Nesting activity was low (range from 4 to 13 per year) and belonged to three species: *Lepidochelys olivacea*, *Dermochelys coriacea* and *Chelonia mydas*. In 2002, a satellite tracking device was applied on an olive ridley nesting turtle, the first in the Andaman Sea for this species. Thanks to the educational programme which consisted of lessons on different conservation topics in the local schools, the community was involved in the project. Being based in a small tourist resort, Golden Buddha Beach, awareness among tourists was always conducted. Volunteers from different part of the world participated in the project, contribution immensely and valuably to the fieldwork.

In 2002, the project developed a new conservation approach focusing on mangroves in collaboration with the Thai Institute of the Ranong Coastal Resources Research Center. The overall aim of the project is to understand and monitor the vegetation of the island, and to involve the local community. Species of mangroves were identified and a first GIS map of different habitats of the island was produced. Training to students coming from different countries was conducted during the project.

MARINE TURTLE NESTING AT THE ARCHIE CARR NATIONAL WILDLIFE REFUGE, FLORIDA, USA IN 2002: GREEN TURTLE NESTING ACTIVITY CONTINUES TO INCREASE EXPONENTIALLY

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The 21 km stretch of beach in South Brevard County, Florida, USA, known as the Archie Carr NWR, has been surveyed during each nesting season since 1982 to enumerate nest production for three species of marine turtles. Loggerheads (*Caretta caretta*), Green turtles (*Chelonia mydas*) and leatherbacks (*Dermochelys coriacea*) regularly nest on this beach. Green turtle nesting has been growing exponentially since 1990 and set a new record again in 2002 with 2,588 nests. Loggerhead nesting finished as the second lowest year (11,631 nests) since 1990 but that number still constitutes a 25.1% increase above the long term average of the 1980s. Leatherback nest production at 11 nests was the lowest since 1997. We relate a number of especially significant tag recovery events that occurred during the 2002 season. Long term trends and related issues are discussed.

**CONSERVATION OF THE LEATHERBACK TURTLE *DERMOCHELYS CORIACEA* IN PLAYA AGUA BLANCA,
BAJA CALIFORNIA SUR, IN 2000-2001**

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Introduction

The main leatherback nesting beaches in Mexico have been classified as major (four beaches) and minor (three beaches) depending on the number of nests per season. Approximately 65% of the total of nests along the Pacific coast of Mexico are concentrated in these main beaches. Agua Blanca, in Baja California Sur, is considered among the minor beaches; located north of Todos Santos, and is the northernmost leatherback nesting site in the country (Fig. 1).

Agua Blanca was first recorded in 1982 by Fritts and Marquez as an important nesting area, and the number of nests have been monitored since 1996 by means of aerial surveys. The average number of leatherback nests have maintained its proportion relative to the other beaches in Mexico.

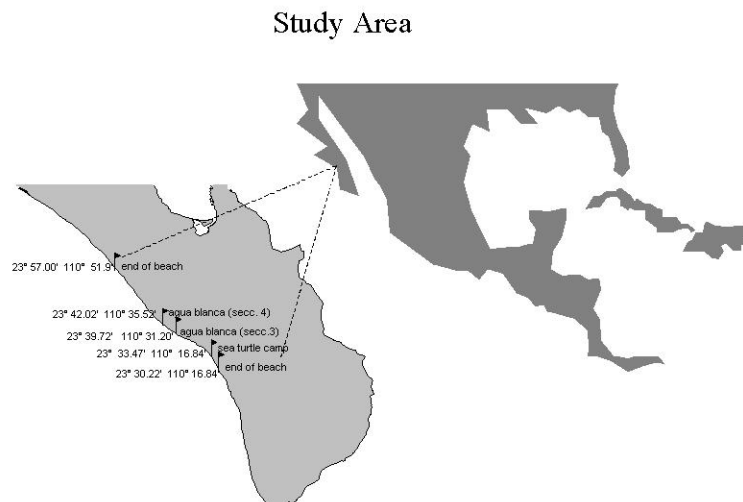


Figure 1.- Location of Agua Blanca, Baja California Sur, Mexico.

Fieldwork started in 2000, when ASUPMATOMA attached a satellite transmitter to a nesting female. During this period we noted that the hatchling production was negligible. We recognized the importance of re-evaluating the significance of the beach for the leatherback reproduction, and the first hypothesis for the absence of hatchling production was the very low incubation temperature. For this reason, we established as main objectives to start monitoring the leatherback nesting activity using daily track counts, to evaluate incubation success in a season, and to start a pilot program for *ex situ* incubation of eggs, in controlled temperature conditions.

Methods

Daily track counts were carried out along the 12 kms of beach with the highest nesting density to evaluate leatherback nesting activity. Night patrols looked for nesting females, which were tagged with Monel and PIT tags. Standard curved carapace length (CCL) and width (CCW) were obtained for each female, and the general body condition and oviposition success were recorded. Most clutches were left *in situ* and the location of the nest was marked by triangulation. Some clutches were relocated into Styrofoam boxes, which were placed in an incubation chamber equipped with a gas heater and a digital hygrometer that monitored the chamber's temperature and humidity continuously. We placed several thermocouples at a depth of 80 cm, in a line perpendicular to the sea, to measure ambient sand temperature. Thermocouples were placed in some *in situ* nests, and in all the nests relocated in Styrofoam boxes. One control thermocouple was placed in a Styrofoam box without eggs. The eggs in the boxes were carefully monitored to confirm that the embryos were alive and growing. The incubation success of the relocated

nests was evaluated by opening the nests after the hatchlings emerged or after the average incubation period for the leatherbacks (60 days) in cases when no hatchlings were produced. Fresh dead hatchlings were preserved for later verification of their sex by histology of the gonads. The *in situ* nests were carefully opened after 60 days of incubation to verify the condition of the developing eggs. The nests were excavated when the embryos were found dead, or left to continue their development if the embryos were alive, and these were checked every week until they either hatched or died.

Results

A total of 113 leatherback nests were counted during the daily track surveys, and 16 females were tagged during the night patrols. The females had an average CCL of 143.8 cm and CCW of 101.9 cm, and laid an average of 60 eggs per clutch (range 42-79). For these parameters, the leatherbacks in Agua Blanca were similar to the ones nesting in the rest of the Mexican Pacific. According to previous evaluations, Agua Blanca accounted for around 2% of the total nesting activity of leatherbacks in Mexico (Table 1), and this relationship held in 2000-2001.

During 2000-2001, 17 clutches were incubated *in situ*, with 1,076 eggs. No natural production of hatchlings was observed in Agua Blanca. A very low incubation temperature was recorded for *in situ* nests (20 - 23°C on average; Fig. 2), which is close to the lower threshold of lethal temperatures reported for sea turtles (23°C; Bustard, 1971). This low temperature reduced the development rate and prevented a normal hatchling production.

Table 1.- Total number of leatherback nests in Agua Blanca and the whole Mexican Pacific, for different seasons. “%” is the percentage of the total nesting activity in Mexico represented by Agua Blanca.

Nesting Season	Nests in Agua Blanca	Nests in Total Mexico	%
95-96	165	5,726	2.88
96-97	26	1,097	2.37
97-98	35	1,596	2.19
98-99	41	1,125	3.64
99-00	256	4,317	5.93
00-01	113	4,603	2.45

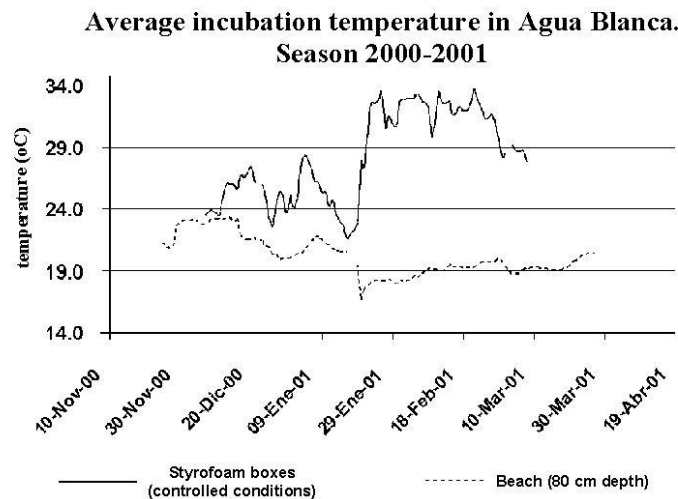


Figure 2.- Average incubation temperature in the sand at a leatherback nest depth, and in Styrofoam boxes under controlled conditions.

Seven clutches (403 eggs) were incubated *ex situ*. Ambient air temperature was more stable inside the incubation chamber than outside, and it was possible to maintain controlled conditions of temperature and humidity in spite of the rustic facilities. Once the method was standardized, the average temperature inside the boxes was 29.9° C after the 1st third of the incubation period (Fig. 3). Three of the clutches in Styrofoam boxes hatched, producing 25 hatchlings; the rest resulted in dead embryos of different stages. Histology revealed the sex of some hatchlings found dead inside the boxes; all of which were females. Since it was not possible to stabilize the incubation temperature early in the season, the maximum incubation period found was 80 days.

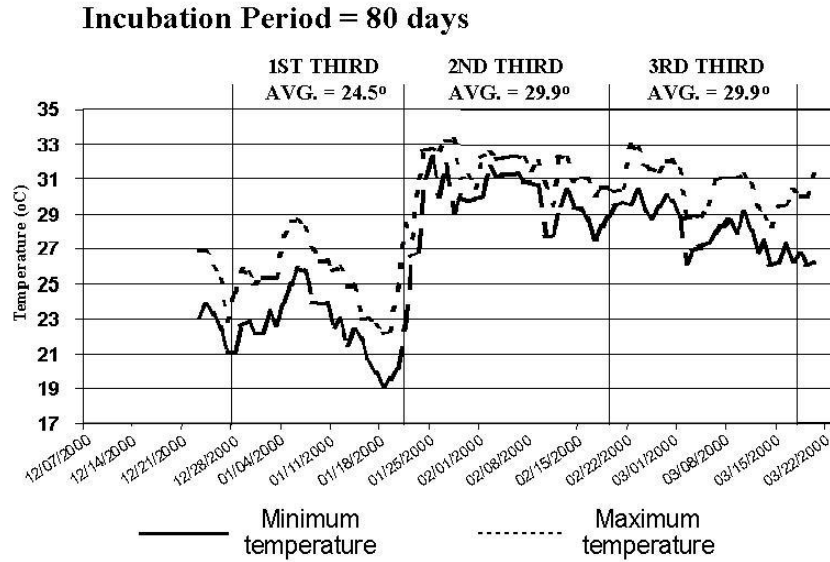


Figure 3.- Temperature throughout the incubation period of leatherback nests in Styrofoam boxes under controlled conditions.

This study confirmed that Agua Blanca is an important beach for a continuous monitoring program, since the nesting activity has maintained a similar proportion compared to the mainland over several years. It is believed that the low incubation temperature on the beach is the main cause of the long incubation period and the lack of hatchling production of nests *in situ*. It would be of great interest to know if there is ever hatchling production under natural conditions (e.g. if some embryos remain latent until the temperature raises later in the year). In the meantime, incubation *ex situ*, in Styrofoam boxes under controlled conditions of temperature and humidity, may be an option for the production of leatherback hatchlings in this beach. Nevertheless, great attention must be paid to the technique, since incubation in boxes with poor regulation of the temperature conditions can bring either a significant bias in the sex ratio of the hatchlings, or the production of unhealthy hatchlings due to inadequate oxygen supply during development. It is recommended an exhaustive evaluation of the conservation objectives be conducted before considering the establishment of *ex situ* incubation as a protection and conservation practice in this beach.

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SEA TURTLE PROJECT OF NORTH CAROLINA

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North Carolina has nearly 500 km of sandy beaches that represent the northern extreme of the nesting range of the NW Atlantic loggerhead population. Some green turtle and leatherback nests are also occasionally found in North Carolina. The North Carolina Sea Turtle Project, coordinated by the Wildlife Resources Commission, monitors sea turtle activities during the nesting season (May through August). We present an overview of nesting data from 1991-2001, and discuss the various trends and implications of results.

AGUA BLANCA, BAJA CALIFORNIA SUR, MEXICO: A CHALLENGE FOR CONSERVATION OF THE LEATHERBACK SEA TURTLE

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We present the work and results obtained over three nesting seasons on a beach known as Agua Blanca, Baja California Sur, Mexico.

This leatherback nesting beach is of importance in Mexico because it is the furthest north distribution in the Eastern Pacific Ocean and needs constant investigation, studies and protection. We present the results of the 1999-2000 season as a nest census and embryo development study, and the installation of a satellite tracking transmitter on a leatherback sea turtle. Likewise, we will present the results of the 2000-2001 season and the census achieved after the Hurricane Juliet, and of the tracks of the 2001-2002 season

Acknowledgements

ASUPMATOMA was able to perform the work of this program with the assistance of the following professionals; M.C. Laura Sarti, Instituto nacional de Pesca and S.B. Dr. Scott Eckert, Hubbs Sea World research Institute.

LOGGERHEAD NESTING AT BALD HEAD ISLAND, NORTH CAROLINA: A REVIEW OF 19 YEARS OF NESTING

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Bald Head Island, North Carolina USA, hosts one of the largest nesting populations in that state. Nesting over 19 years has shown a downward trend, and there is no evidence of stabilization in this population. A tagging program has been running since 1991 but return data has been scarce. As an intern-run program, the level of tag loss is high and the program has started PIT tagging all nesting females. Satellite transmitters will be applied to nesting females in 2003. Analysis of nesting data has not shown any clear factor contributing to the decline in nesting and further more detailed studies are required.

REPRODUCTIVE ACTIVITY ASSESSMENT OF SEA TURTLES IN QUEREPARE, SUCRE STATE, VENEZUELA, DURING 2002

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The Paria Peninsula is the most important nesting ground in Venezuela, hosting green (*Chelonia mydas*), hawksbill (*Eretmochelys imbricata*), loggerhead (*Caretta caretta*) and leatherback turtles (*Dermochelys coriacea*). Of these, *D. coriacea* is the most common nesting species. Querepare (11°82.72N, 51°39.50W) is one of the important nesting beaches on the peninsula, so this beach was carefully surveyed starting in 2002 as part of a major nesting area census. Research activities were carried out

between May 3rd and September 12th, and comprised daily nocturnal beach monitoring from 20:00 through 4:00 hours. A total of 20 nesting females leatherback turtles were tagged during this period with a recapture of a female tagged in Cipara (another nesting beach included in the same project). A total of 2253 eggs from 32 nests were relocated to hatcheries. The hatching success was 52%, while the emergence rate was 15%. Diurnal censuses were also done with a record of a hawksbill turtle (*Eretmochelys imbricata*) nest that later was poached by a member of the local community.

ASSESSMENT OF THE REPRODUCTIVE ACTIVITY OF SEA TURTLES IN QUEREPARE, SUCRE STATE, VENEZUELA, DURING 2002

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Background

The “Research and Conservation of the Sea Turtles of the Peninsula of Paria” project has been carried out since 1999 on Cipara beach. Based on previous estimates, Querepare is the most important nesting locality on the peninsula, and following recommendations of the “Sea Turtle Recovery Action Plan for Venezuela” (Guada, 2000; Guada and Solé, 2000), we decided in 2002 to initiate a turtle conservation project there. The research goals were to gather data about the reproductive biology of the sea turtles on the beach, while the conservation goals were the protection of the gravid females and their eggs and involving the local community in conservation efforts.

Methods

The beach was monitored from May 3rd to September 12th, 2002. Night beach patrols was made and diurnal censuses were conducted (Alvarado and Murphy 2000; Hernández 2002). The females were checked for tag scars and tagged with metallic tags in the left hind-flipper and with PIT tags in the right shoulder. Pictures of the pink spot on the head (crown) of the turtles were taken. Straight and curved carapace measurements (SCL and CW) were also taken for the females, and their general condition was recorded. The nests were tranlocated to a protected hatchery and a few were simply relocated on the beach. We counted the number of hatchlings, embryos, the presence of eggs without apparent development, and the number of released hatchlings (Sarti and García, 1999). Awareness activities within the community were conducted between May and September.

Results and Discussion

Turtles Tagged: Nineteen leatherback females were tagged, fewer than expected based on previous estimates, but we did not monitor the beach during April, which might have accounted for some of this difference. Several of the gravid females displayed evidence of fishing gear damage (presumably of gill nets) in their bodies.

Nestings: We estimate some 29 females laid 47 nestings on the beach. The nesting frequency was 1.5 times per female and the internesting period was of 17.7 days. The inferred nesting frequency and internesting period are of 1.6 times per female and 14.9 days. Nesting success was 100%. In addition, a nest by a hawksbill turtle (*Eretmochelys imbricata*) was also recorded.

Nesting on Adjacent Beaches: A female from Querepare nested on Cipara and one from Cipara was sighted in Querepare (Guada and Rondón, 2003). In San Juan de las Galdonas, immediately to the east of Querepare, we recorded a nesting leatherback turtle but the tag number was not registered and its origin could not be established.

Protection of Nests and Hatchlings: Thirty-two leatherback nests were relocated to the hatchery and two were relocated *in situ*. A total of 1,137 hatchlings were released to the sea. The hatching success and the recruitment success were of 55.93% and 52.29%, respectively. The low hatching success could be related to the location of the hatchery.

Nest Poaching: Before the presence of the project staff on the beach, the majority of nests were poached and even during our stay, a hawksbill turtle nest was poached. Police reproached to the transgressors, but they not were arrested.

Awareness Activities: Two lectures were conducted in the village, in addition a workshop to make artisanal paper with the participation of adults and youths. Education materials were distributed among the community and traditional activities were conducted for the children.

Training and Academic Research: Two of the Research Assistants (and Biology students), one from Venezuela and the other from Ecuador were conducting their thesis in Querepare (currently under preparation).

Acknowledgements

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17 YEARS OF MONITORING AND MANAGEMENT OF LEATHERBACK SEA TURTLES ON THE NORTHEASTERN COAST OF PUERTO RICO (1986-2002) *

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Since 1986, the leatherback (*Dermochelys coriacea*) sea turtle nesting population of the northeastern coast of Puerto Rico has been monitored and managed. The monitoring area includes 18 km of shoreline, from the east of Punta Picua, Municipality of Rio Grande, up to Cape San Juan, Municipality of Fajardo. Detailed attention was paid to some 6 km of index beach area extending from the East of Sabana River, Municipality of Luquillo, up to the Governor's Beach Mansion, Municipality of Fajardo. More than 1,700 nesting attempts were identified and the nests managed through incubation. As a result, approximately 75,000 hatchlings were released to the wild. Over 200 females were identified and tagged during the nesting activities. Constant interesting migrations of females between Culebra and this beach area have been observed since 1996. Environmental education programs and research such as “Post Nesting Movements of Leatherback Turtles tracked from Culebra and Fajardo, PR”, with

popup archival and TDR Satellites Tags, have been integral parts of this program. As a result, there are more interactions with the coastal communities.

THE EFFECT OF CLUTCH SIZE AND NEST DEPTH ON THE INCUBATION DURATION OF FLATBACK SEA TURTLES, *NATATOR DEPRESSUS*, IN THE NORTHERN TERRITORY, AUSTRALIA *

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Introduction

Flatback sea turtles *Natator depressus* nest in the tropical environment of Northern Territory, Australia, between May and October (Guinea 1994). *N. depressus* lay an average of 50 eggs at an average nest depth of 50cm (Limpus 1995). Variation in clutch size may occur at the time of laying due to maternal variation or the nesting turtle being disturbed or from a later reduction in clutch size from predation, embryonic death or partial clutch harvest such as by some Aborigines in northern Australia. Differences in nest depth may occur at the time of laying or subsequently due to sand movement from strong winds or unstable dunes. Different clutch sizes and nest depths expose the nests to different environmental conditions during incubation.

This study aimed to determine how a reduction from the mean clutch size and nest depth effects the duration of incubation, temperature within the nest, success of nests and the size of hatchlings. Determining how clutch size and nest depth affect these parameters will provide management advice for nests in threat of erosion and provide advice for harvest practices.

Longer incubation durations have previously been found to be associated with lower nest temperatures (Mrosovsky & Yntema 1980, Standora and Spotila 1985), a greater proportion of male hatchlings produced (validation by Mrosovsky et al. 1999), and may produce different morphological features of hatchlings (Packard et al. 1988, Janzen 1993, Booth & Astill 2001). Longer incubation durations may also expose the nests to greater threats and may thus affect nest success. In determining the relationship between incubation duration and other physical and environmental parameters, it may be possible to infer nest characteristics based on incubation duration data that is already available.

Methods

The study was conducted at Bare Sand Island (12°32'S, 130°25'E), in northern Fog Bay, Northern Territory, Australia. The study period lasted from June to August 2002 in the middle of the flatback nesting season, at which time ambient temperatures were at their lowest (Guinea 1994). During this time strong trade winds move large amounts of sand especially on the eastern side of the island. Eggs were incubated within a natural hatchery located in the middle of the natural nesting beach. Nests were separated by one metre and were located within an eight metre by four metre grid. All eggs were collected from nests in peril of destruction from tidal inundation or wind erosion. The eggs were reburied at experimental clutch sizes of 10 eggs, 30 eggs and 50 eggs and nest depths of 20cm, 35cm and 50cm. All combinations of clutch sizes and nest depths were investigated and four replicates of each treatment combination were used.

Data loggers recorded temperatures every 20 minutes. Probes were placed in the centre of experimental clutches of 10, 30 and 50 eggs and in the sand column at the surface and at depths of 20, 35 and 50cm.

Hatchlings were collected on emergence and their straight carapace length (SCL) and mass were measured. All nests were excavated following emergence and the contents were identified. Hatching success was defined as the proportion of the clutch that hatched from the egg (Miller 1999) and emergence success was defined as the proportion of the clutch that emerged from the sand (Miller 1999). The duration of incubation was defined within this study as the time from when the eggs were laid until 50% of hatchlings emerged from the nest.

Results

Incubation Duration: Incubation duration was found to be inversely proportional to clutch size ($P = 0.001$). Incubation in clutches of 10 eggs varied from 59 to 65 days (mean = 62, sd = 2.40, n = 7), 30 eggs varied from 59 to 62 days (mean = 60, sd=1.32, n = 9) and 50 eggs varied from 55 to 61 days (mean = 59, sd = 1.81, n = 12). The duration of incubation was not correlated with the depth of the nest ($P = 0.116$). Similarly, incubation duration was not affected by interrelationships between clutch size and nest depth ($P = 0.334$).

Temperature: An increase in temperature above the surrounding sand temperature was recorded within all clutch sizes and the increase was more pronounced within larger clutches. The maximum increase of 1.73°C was observed within nests containing 50 eggs, followed by 1.70°C within the nest of 30 eggs and 0.89°C within the nest containing 10 eggs. The overall mean temperature did not vary greater than 0.1°C within the sand at different depths, with an average temperature over the study period of 27.9 to 28°C. However, daily fluctuation in sand temperature decreased from 3.21°C at 20cm depth to 1.49°C at 35cm depth and 0.99°C at 50cm depth. All recorded temperatures were within non-lethal ranges for the development of sea turtles of 24 to 33°C (Limpus et al. 1983).

Hatchling Size: The larger clutches (50 eggs) produced longer hatchlings with greater mass ($P = 0.00$). The mean SCL (mm) within clutches of 10 eggs was 56.5 (sd = 1.98, n = 59), 30 eggs was 56.8 (sd = 1.98, n = 165) and 50 eggs was 55.7 (sd = 2.24, n = 355). Clutches incubated for longer durations also produced longer, heavier hatchlings ($r^2 = 0.16$). However, nest depth did not have any significant influence on the size of hatchlings ($P = 0.147$). A comparison between the SCL and mass of hatchlings indicated that there was no significant difference within the different clutch sizes ($P = 0.10$). Within the shallowest nests at 20cm, larger hatchlings in comparison to their mass were produced ($P = 0.00$).

Nest Success: Neither clutch size nor nest depth was correlated to hatching success ($P = 0.642$ and $P = 0.437$ respectively) or emergence success ($P = 0.888$ and $P = 0.367$ respectively). The duration of incubation was similarly not related to either hatching success ($r^2 = 0.12$) or emergence success ($r^2 = 0.16$). There did appear to be a slight decrease in both hatching and emergence success with increased incubation duration but this relationship was not statistically significant.

Discussion

The mean temperature within the nest was influenced more by clutch size than by the depth of nest. The greater temperatures within larger clutches are likely due to metabolic heat produced during development. This metabolic heating caused the shorter incubation durations observed within the larger clutches. The daily fluctuation in sand temperature is unlikely to affect the incubation duration of flatbacks as there was no significant difference in incubation duration for clutches at different depths.

Larger clutches and shorter incubation durations produced smaller hatchlings. This high temperature and short development time may not allow the hatchlings to fully utilise all of their egg yolk and are thus smaller on emergence. Being smaller may affect their ability to survive. Neither incubation duration nor clutch size influenced the proportional size to mass of hatchlings. The amount of yolk converted to tissues compared to the remaining yolk is therefore unlikely to differ within different clutch sizes or incubation durations. Longer hatchlings in comparison to their mass were produced from the nests at 20cm and thus likely have a smaller amount of residual yolk.

Although nest success was not significantly related to incubation duration, there was an apparent decrease in hatching success with increased incubation duration. This may be more pronounced at different times within the nesting season or at other nesting beaches where threats to nests are greater or where climatic variability is greater.

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Acknowledgements

Thanks to the Northern Territory University for supporting the project and to all volunteers who helped with the fieldwork. Thanks also to the Western Pacific Fishery Council and the 23rd Annual Symposium on Sea Turtle Biology and Conservation for financial support to attend the conference.

CURRENT STATUS OF GREEN TURTLE POPULATION IN DERAWAN ISLES, EAST KALIMANTAN: A STARTING POINT

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The Derawan islands are known as one of major rookeries of green turtle (*Chelonia mydas*) in Indonesia, yet scientific reports about this rookery are scarce. Here we compile and analyze data on satellite imagery of the isles, carapace lengths of nesting turtles, nesting census and success, clutch size, hatching success, and estimates of population size. Based on those limited data, we discuss further research required to estimate viability of the population, and to draw-up an appropriate recovery action plan. We also discuss the potential of turtle-based ecotourism as a tool for community based turtle conservation in this area.

LOGGERHEAD NESTING IN KORONI, SOUTHERN PELOPONNESUS, GREECE: NESTING DATA 1995-2002

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Introduction

Greece hosts about 60% of all documented loggerhead nests in the Mediterranean (Margaritoulis *et al.*, in press). Most of the 16,000 km Greek coastline has been investigated for turtle nesting in the context of various projects, mostly undertaken by ARCHELON (Margaritoulis *et al.*, 1995). Nesting is widely distributed from the island of Corfu (in the NW) to the island of Rhodes (in the SE) with five “major” nesting aggregations, i.e. Zakynthos, Kyparissia Bay, Lakonikos Bay, Bay of Chania and Rethymno (Margaritoulis, 2000) (Fig. 1). Nesting in Koroni was first noted during an basic survey of southern Peloponnesus beaches in 1982. From 1995 onwards, the nesting beach at Koroni was systematically monitored. Herein, we present the main nesting data for eight seasons (1995-2002) at Koroni.

Koroni is a small town at the tip of a peninsula, delimiting the western boundary of the Bay of Kalamata (Messiniakos Kolpos) in southern Peloponnesus, Greece (Fig. 1). From the southern side of the town, starts a 2.7 km beach, known locally as Memi (eastern part) and Zanga (western part). The beach has a SE orientation, consists of fine sand with pebbles at places and is generally backed with vegetation, cultivated fields and occasional buildings. A road passes behind the beach at its western part. Due to the proximity of Koroni town and the passing road, parts of the beach are well frequented during the summer months by locals and tourists. Some stretches of beach are covered with umbrellas and beach-chairs for hire and in one spot there is a sea-sports operation that rents small catamarans, kayaks and wind surfers.

Methods

The nesting beach was systematically monitored, on foot, and adult female tracks were counted and classified as “nesting” or “non-nesting”. Nests were marked and followed until emergence of hatchlings or until 70 days of incubation. Egg chambers were located by hand excavation until appearance of top eggs.

To mitigate nest predation by mammals, fences were deployed over nests, to varying extent over different seasons. Variation in levels of protection was a result of availability of materials and manpower. Excavation of post-hatched nests (and nests that had not hatched after 70 days) was undertaken to assess clutch size (CS), hatching success (HS) and hatchling emergence success (HES). The nest site was carefully dug by hand, to avoid injury to any remaining live hatchlings. The nest contents were then removed and sorted into empty shells, unhatched eggs and hatchlings (dead or live). Timing of nest excavation varied between seasons from about 4 days to two weeks after the emergence of the first hatchling. Incubation duration (ID) was defined as the elapsed time (in days) from egg laying until appearance of the first hatchling. HS, HES and ID were recorded only for non-relocated, non-inundated and non-depredated nests, whereas CS was calculated from non-predated nests.

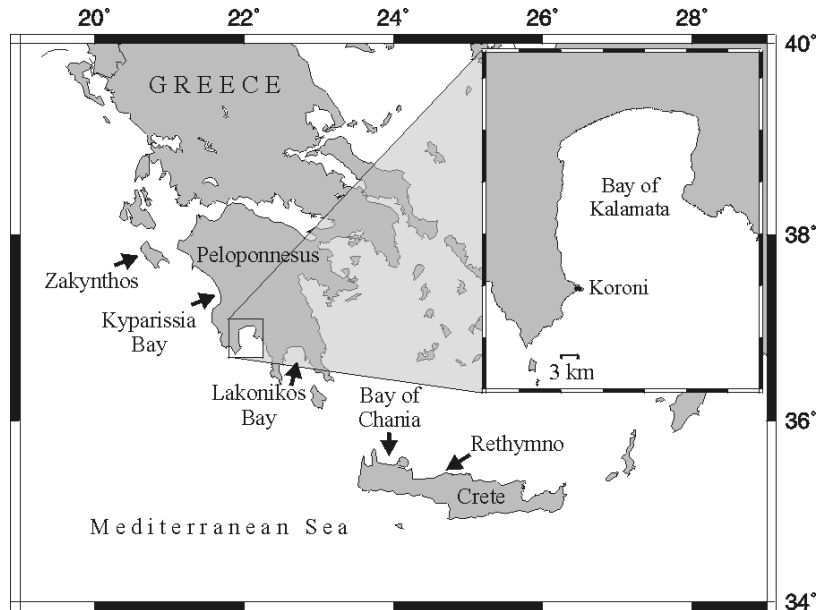


Figure 1. Map of Greece showing the location of Koroni and other loggerhead nesting areas.

Results and Discussion

The nesting magnitude from 1995 until 2002 ranged from 35 to 66 nests/season (mean: 53.0 nests/season, $n = 8$) (Table 1). Nesting success varied from 28.2% until 46.1% and nesting density ranged from 13.0 nests/km to 24.4 nests/km (mean: 19.6 nests/km, $n = 8$).

Using criteria proposed by Margaritoulis (2000) for classification of nesting areas in Greece, the beach at Koroni was considered as one of “moderate nesting”, as it hosted less than 100 nests/season. However, the annual nesting density was substantial and even higher than nesting densities reported in some “major” nesting areas of Greece, e.g. Lakonikos Bay and Bay of Chania (Margaritoulis and Rees, in press).

Further, the nesting habitat at Koroni, despite the small number of nests, was considered important because of its location. No genetic difference (as inferred from mtDNA analysis) was found in the loggerhead population nesting in the five “major” nesting areas of Greece (Ladoukakis *et al.*, in press). It is known that loggerheads are more flexible than other sea turtles with regards to nesting site fidelity (Dodd, 1988 and references therein). Small nesting beaches between “major” nesting areas could contribute in the homogeneity of the nesting population. Koroni beach, found between the western nesting aggregates in the Ionian Sea (Zakynthos, Kyparissia Bay) and the eastern-southern ones of Lakonikos Bay and Crete, probably plays such a role.

Annual values of CS, HS, HES and ID (Table 1) lie within the ranges reported for Greek loggerheads (Margaritoulis, 1988; Margaritoulis *et al.*, in press). Comparing the average ID per season that ranged from 48.3 days to 54.0 days over seven seasons (Table 1) with the recently reported value (56.6 days) of pivotal ID for loggerheads in Kyparissia Bay (Mrosovsky *et al.*, 2002) we can infer that hatchling sex ratio in Koroni is likely predominantly female.

During the six seasons when monitoring of predation was conducted (1997-2002), 2-37 nests/season were predated. This amounts to 3% - 65% of the total annual number of nests (Table 1). The highest predation rate (65%) occurred in 2000 when, because of lack of manpower, nest protection measures were very much reduced. Natural nest predation rate at Koroni is likely to be around 60% (as found in 2000 when little nest protection was undertaken), and compares to that found in major nesting areas in the Peloponnese, for example approximately 50% for Kyparissia Bay (Margaritoulis 1988) reports. Thus the nest screening carried out in other years is seen to be an effective way of reducing nest destruction and increasing hatchling production.

Table 1. Nesting levels, main reproductive data and predated nests at Koroni.

Season	1995	1996	1997	1998	1999	2000	2001	2002
Tracks	149	76	138	154	183	170	131	189
Nests	61	35	49	64	66	57	37	55
Nesting success (%)	40.9	46.1	35.5	41.6	36.1	33.5	28.2	29.1
CS - Mean	-	118.4	111.5	111.5	115.7	111.6	-	122.1
CS - Range	-	77-154	47-146	33-185	70-168	71-151	-	2-171
CS - N	-	14	25	44	60	14	-	30
HS (%)	-	73.7	71.6	60.4	78.3	85.3	-	83.0
HES (%)	-	71.3	63.1	54.6	69.8	74.2	-	73.5
N	-	14	25	42	60	14	-	29
ID - Mean	-	54.0	53.7	50.3	51.9	48.3	50.7	52.4
ID - Range	-	51-57	48-65	47-58	45-62	42-56	43-59	47-64
ID - N	-	11	24	35	53	6	12	25
Predated nests	-	-	12	13	2	37	13	12
Predation rate (%)	-	-	24.5	20.3	3.0	64.9	35.1	21.8

Conservation Outlook

Besides nest predation, other threats to turtles at Koroni include human disturbances on the beach during day and night, disorientation of hatchlings by bright lights and occasional nest inundation by the sea due to southern winds. To mitigate human perturbations the project was enriched since 1999 with a public awareness component. This included the establishment of an information station at the town waterfront in collaboration with the local Municipality. The station is staffed with trained volunteers who inform locals and visitors on the conservation needs of the sea turtles.

Loggerhead turtles are protected in Greece and all “major” nesting areas are managed under various schemes (Dimopoulos *et al.*, in press). Although no specific legislation exists for the protection of the nesting beach at Koroni, it is expected that the continuation of the monitoring work and the public awareness programme, in close cooperation with the local community, will provide a strong basis for the conservation of this important nesting area.

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THE STATUS OF SEA TURTLES IN IRAN *

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The Islamic republic of Iran has a coastline of more than 2000 km on the northwestern shores of the Persian gulf and Oman sea. Part of the coastline, about 900 km, is made up of sandy beaches which are used by sea turtles for egg laying from mid-March until the end of May.

Moreover, there are some 20 islands among which the most important are Hormoz, Queshm, Shidvar and Mond, as important nesting sites for sea turtles. Considering the specific undisturbed situation on some islands, the lack of human populations, local fauna and sandy shores, they are more important than continental shores as nesting sites for sea turtles.

In addition to the nesting seasons in some areas, in other parts of the country there are many juvenile and adult turtles in shallow waters year-round, and it appears that these turtles use these area as foraging and developmental habitats.

The most abundant species in the Gulf area is the Hawksbill (*Eretmochelys imbricata*) which uses mostly the beaches on Nakhiloo, Ommolkaram, and Shidvar islands for nesting and laying eggs. There are also unconfirmed reports of Green and Loggerhead nesting. In the Oman sea, the green turtle is the most abundant species, while there are also reports of olive ridleys in the area. My work has centered on studying nesting of hawksbill in the Gulf, especially in the Mond islands, from where measurements of 10 nesting turtles and nests were obtained.

PRESENCE OF SYMBIOTIC AGENTS IN TRANSFERRED NESTS OF THE LEATHERBACK TURTLE (*DERMOCHELYS CORIACEA*) AT PARGUITO BEACH, NUEVA ESPARTA, VENEZUELA

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Introduction

The island of Margarita represents the most important nesting site for the Leatherback turtle (*Dermochelys coriacea*) in Venezuela. Due to the present critical status of the populations of this species at a world level, the use of hatcheries that protect the eggs and guarantee a high hatching success is becoming more necessary, and a potential measure in international efforts for the recovery of populations. Based on this, studies which promote an improvement in hatchery operations such as the area

selected for the hatchery, the fauna and associated flora, quality of soil, averages and/or fluctuations of temperature, humidity, among many other factors need to be considered.

Methods

Margarita Island (10°51' to 11°11'N and 63°46' to 64°24'W), is located in the southern Caribbean, approximately 23 km of the coast of Venezuela (Figure 1). It is the biggest of three islands that forms Nueva Esparta state (1071 km² surface area). During 2001, 119 leatherback turtle nests were transferred of to the “Antolin del Campo” hatchery on Parguito beach, operated by the Grupo de Trabajo en Tortugas Marinas del Estado Nueva Esparta (GTTM-NE). An inventory was developed for the symbiotic agents invertebrates present in the hatchery.

Results and Discussion

In 84 nests surveyed in the hatchery we classified and quantified the following: 50% Coleoptera (Family Tenebrionidae), 12% Decapoda, 28% Hymenoptera, 22% Diptera, 8% Nematoda. These were recorded in similar amounts outside as in the interior of the nests, but no symbiotic relationship was established between these agents and the leatherback hatchlings. Some nests also had fungi present, of diverse colors between yellow, green, purple and ocher. We did not determine the Class for these fungi, but we presumed that the presence of these was determined by the humidity of the sand in the hatchery.

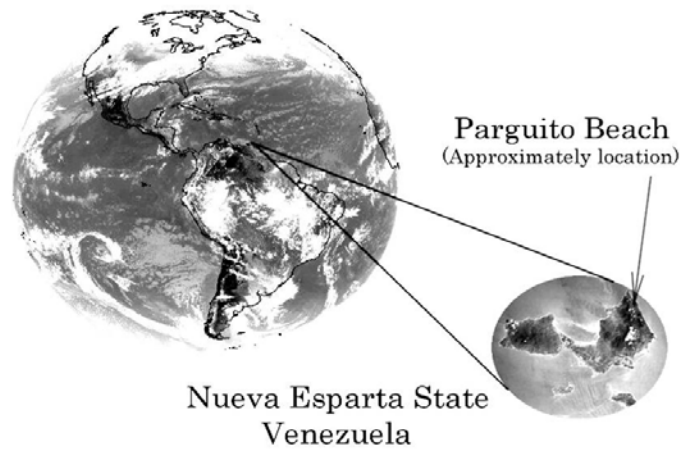


Figure 1. Location of study site.

ECOLOGY STUDY OF LEATHERBACK (*DERMOCHELYS CORIACEA*) NESTING ON PANCUR BEACH, ALAS PURWO NATIONAL PARK, EAST JAVA

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Globally, the population of leatherbacks has decreased due to degradation of nesting habitat, incidental capture, and other threats. This decrease of leatherbacks has also occurred on Pancur Beach in the Alas Purwo Nasional Park, East Java, based on ten years of data collected by National Parks Rangers. Efforts to increase the leatherback population on Pancur Beach through an on-site hatchery have often met obstacles and failed. The main goal of this research is to describe the condition of the leatherback nesting habitat in Pancur Beach, Alas Purwo National Park, and the results will be used as a data base to develop semi-natural incubation conditions for leatherback eggs.

Nesting leatherbacks, nests, and habitat components (beach width; vegetation; sand colour; size of sand particles; and sand temperature) were observed and measured. Correlation tests were used to analyze relationships between habitat components and leatherback nest site preferences.

The results indicate that very dense natural vegetation cover along Pancur Beach protects the nesting beach from human activity. However, in return Pancur Beach provides only a short area above the high tide level and forces the leatherbacks to move into the vegetation line to dig the nest. An ideal leatherback nesting habitat would have a beach with enough space above high tide level, light sand colour, and dense natural vegetation cover.

MARINE TURTLES NESTING IN CUBAN ARCHIPELAGO IN 2002: STORM EFFECTS ON THESE RESOURCES

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Nesting of marine turtles arriving at the Cuban archipelago beaches during the 2002 reproduction season is described. The number of nest and tracks observed for the green turtle (*Chelonia mydas*), hawksbill turtle (*Eretmochelys imbricata*), and loggerhead turtle (*Caretta caretta*) are quantified. Cayo Largo del Sur beach is still recognized as the most important nesting area of green turtle and Doce Leguas for Hawksbill turtle. The two last major storms effects and their influence are described.

SEA TURTLE NESTING NUTRIENT INPUTS TO DUNE VEGETATION: A STABLE ISOTOPE ANALYSIS

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Sea turtles are important biological transporters, bringing nutrients and energy from distant foraging grounds to nesting beaches through egg deposition (Meylan et al. 1983; Bouchard & Bjorndal 2000). Because nesting beaches are typically nutrient-poor, an increase in nitrogen (N) concentrations could be critical for maintaining dune vegetation and promoting stabilization from erosion (Anderson & Polis 1999). The 40.5 km stretch of beach between Melbourne Beach and Wabasso Beach, Florida, supports the world's third largest nesting population of loggerhead turtles (*Caretta caretta*) and the largest nesting population of green turtles (*Chelonia mydas*) in the continental United States. Nest locations of both species exhibit similar clinal patterns, ranging from approximately 100 nests per km in the northern part of the beach to over 1000 nests per km in the southern portion of the beach (Weishampel et al. 2002). Since marine nutrient sources are typically enriched in d15N compared to terrestrial sources, stable isotopes can be used as source markers to track nutrient flows through ecosystems (Ben-David et al. 1998).

Plant samples were collected from 30 sites along a gradient of nesting density (Fig. 1) parallel to the shore and at three locations on the dune (foredune, mid-dune, and top of dune). Stable-nitrogen isotope ratios (15N/14N) of four dominant plants and marine nutrient sources (added turtle eggs) were measured on a continuous flow isotope ratio mass spectrometer.

Two-way ANOVAs were performed to determine isotopic variation between areas of high and low turtle nest density and position on dune. Eggs of carnivorous loggerhead turtles were enriched in d15N by 5.0‰ over eggs of herbivorous green turtles (Fig. 2). Significant spatial patterns also existed, suggesting different feeding grounds for the green turtles nesting on this stretch of beach. In the area of high turtle nest density, isotopic signatures of sea oats (*Uniola paniculata*) were enriched in d15N by 3.1‰ over plants at the top of the dune (Fig. 3). Sea Grape (*Coccoloba uvifera*) d15N signatures were highly variable in regard to turtle nest densities and position on dune. Leaves of this species may contain high amounts of lignin as denoted by their thick venation. Seashore-elder (*Iva imbricate*) in the low density turtle nesting area portrayed a stronger d15N signature than in the high density area ($F_{1,23}=6.02$, $p=0.022$), but showed no evident pattern relative to position on the dune. This plant's shallow, rhizomous roots may be unable to access turtle nutrients. The isotopic signature of Beach Bean (*Canavalia rosea*) was lower by as much as 4.5‰ than other plants, as expected because it is a nitrogen fixer. However, even with this association with nitrogen fixing bacteria, the greater availability of marine nitrogen to plants in the high nest density area was evident in the d15N values of the plants ($F_{1,13}=4.17$, $p=0.062$).

Nesting Beaches

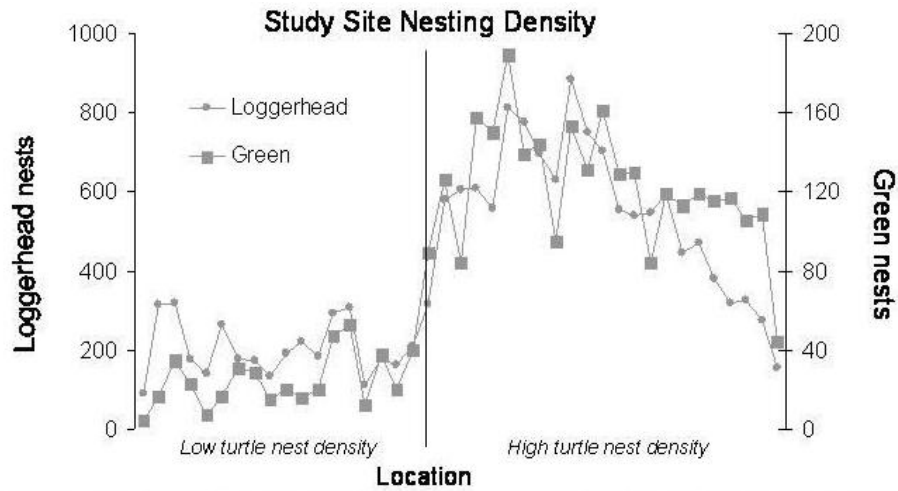


Figure 1: From Melbourne Beach to Wassabo Beach, FL, sea turtle nesting densities during 2002 follow similar clinal patterns.

Overall, plants in the area of higher nest density were enriched in $\delta^{15}\text{N}$, indicating more marine-derived nutrients. This use of nutrients deposited by sea turtles by dune vegetation establishes an important biogeochemical link between marine and terrestrial environments. This relationship between the turtles and the dune vegetation is mutually beneficial, as the turtles provide nutrients and the dune vegetation provides stable nesting area.

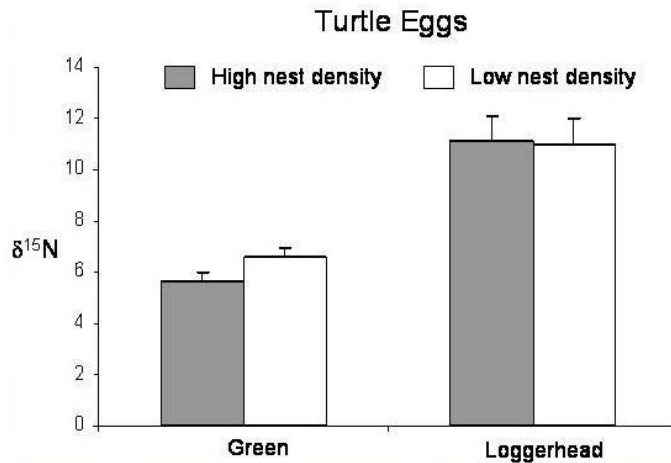


Figure 2: Eggs of carnivorous loggerhead turtles were significantly enriched in $\delta^{15}\text{N}$ over eggs of herbivorous green turtles ($t=44.1$, $p<0.001$), with greater variability evident in the diet of loggerhead turtles. No spatial patterns were evident in loggerhead isotopic signatures ($t=0.20$, $p=0.66$), but green turtle eggs from the high density area were enriched in $\delta^{15}\text{N}$ compared to the low density area ($t=5.80$, $p=0.033$).

Anthropogenic influences appear to have disrupted the spatial patterns of nitrogen across these dune systems. In the northern half of the study area, which is characterized by human development (Fig. 4), the nitrogen sources which are derived from the urban landscape may provide a significant nitrogen source (indicated by the $\delta^{15}\text{N}$ enrichment at the top of the dune). The southern portion is protected from this encroachment and the primary nitrogen sources appear to stem from the natural marine environment.

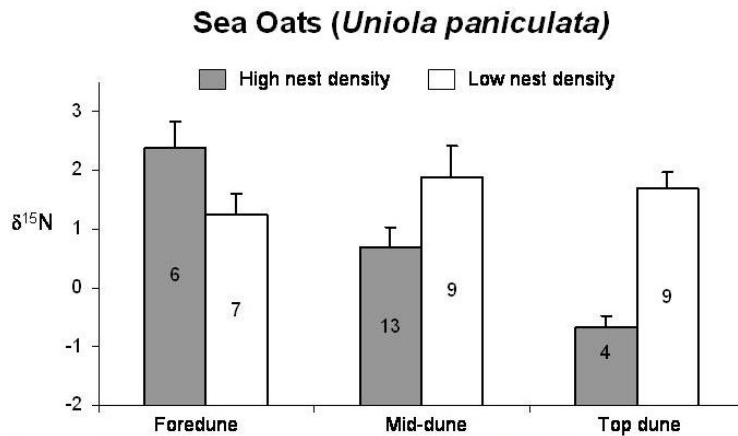


Figure 3: Sea Oats showed a greater marine signature in the area of high turtle nest density ($F_{1,40}=7.39$, $p<0.01$) and in that area, the marine N signature decreases from the bottom to the top of the dune ($F_{1,40}=8.88$, $p<0.001$).

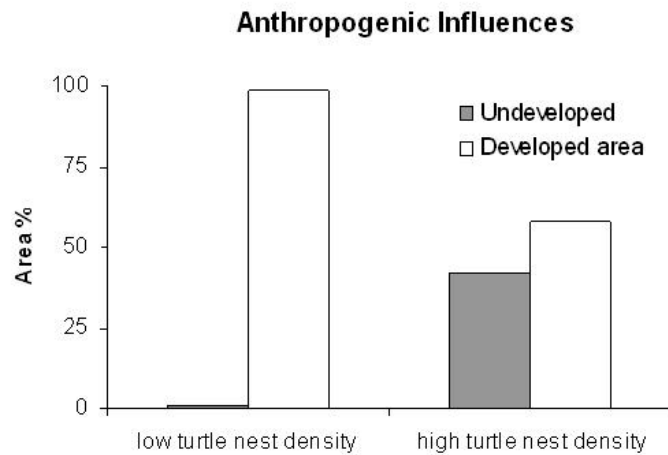


Figure 4: Anthropogenic influences are greatest in the area of low turtle nest density with over 98% of land in that area being commercially developed.

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THE NESTING BIOLOGY OF FLATBACK TURTLES IN THE TROPICS: SEVEN YEARS OF SURVEYS ON BARE SAND ISLAND, DARWIN, NORTHERN TERRITORY, AUSTRALIA *

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Introduction

The flatback turtle (*Natator depressus*) is the only sea turtle species not listed under the IUCN classification of threatened species. In Australia it is classified as vulnerable to extinction. Long-term data for flatback turtles in the tropics are limited. The aims of the project were to identify the peak in the nesting season; monitor nesting abundance between years; obtain morphometric measurements for adults and eggs; and identify threats to the population.

Methods

Nesting surveys were conducted at Bare Sand Island between 1996 and 2002. Bare Sand Island is located 50 km west of Darwin, Northern Territory, Australia. It is a small sand island sitting atop of ironstone lateritic rock and is located near the end of a chain of eight islands that extend 15 km from the mainland. It is 1.9 km in circumference and has sparse vegetation with only two trees. The survey periods varied in length between years and ranged from two to 16 weeks. A standard two-week survey period was conducted at the same time each year and began in the last week of June. Standard morphometric measurements of adults and eggs were taken (Limpus et al. 1981, Limpus et al. 1983). Only data from eggs measured in 2002 are presented in this paper.

Results

Flatback turtles in this region are winter nesters. They have an extended breeding season with nesting beginning in February and continuing until October. The peak nesting season occurs in June and July but this may vary depending on the season. A total of 553 individuals were tagged and 1548 nests laid on Bare Sand Island over the seven year period. For the standard two week survey period each year a mean of between 6.4 and 10.2 nests were laid each night. The nightly range was between zero and 20 nests. The total number of nests for the 14 day survey period ranged from 133 in 1996 to 79 in 2002. A trend line using seven years of data suggests a decrease in the population of 3% per year. Mean size of adult nesters was 86.43 cm CCL (sd = 2.97, range 67.0-96.9). The mean egg size was 4.78 cm (sd = 0.15, range = 4.50-5.01).

Discussion

The size of adult nesters and eggs is much smaller than those reported from other flatback nesting sites in southern Queensland (mean 92.3 cm CCL, range = 88.0 to 96.0 (Limpus 1971) and mean 93.70 cm ccl, sd = 2.867, range = 84 to 100.0 (Limpus et al. 1981)) but similar to Crab Island in the tropics with a mean of 89.6 cm CCL (sd = 3.80, range = 84.0 to 93.5) (Limpus et al. 1983). The size of eggs at Bare Sand Island was also smaller than those from SE Queensland (mean diam. 5.21 cm (Limpus 1971)) and than those from Crab Island in the tropics (mean diam. 5.06 cm (Limpus et al. 1983)). The decline in the number of nesting turtles over the past seven years could be real or an artifact of survey methodology. A real decline could be attributed to a number of factors: In the 1960's and 1970's the Royal Australian Air Force conducted practice bombing on Bare Sand Island and an adjacent island, the affect of which is unknown. Commercial fishing also has an unknown impact in the region. Set nets for shark and barramundi have caused numerous deaths of sea turtles in the past (Guinea and Chatto 1992). Since 2000 prawn trawlers are required to use TED's, but the impact on the nesting population prior to and after this date is unknown although sea turtle deaths have been linked to this activity in the region (Guinea et al. 1997). The perceived decline in the nesting population based on a standard two weeks of survey data each year begs the question of whether this is a long enough period to detect such population changes. If peaks in the nesting season are variable each year or at least in some years, then the standard survey period may need to be longer. With current data the decline of flatback turtles in the region must be considered real and further measures should be taken to identify and reduce mortality in this region.

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PHYSIOLOGY AND ANATOMY

ABNORMALITIES IN LEATHERBACK HATCHLINGS (*DERMOCHELYS CORIACEA*) DURING 2001 IN A HATCHERY ON PARGUITO BEACH, NUEVA ESPARTA STATE, VENEZUELA

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Introduction

The use of hatcheries for the marine turtles represents an important tool for the recovery of the populations of these animals. This practice in Venezuela has increased during the last five years, due to the benefits they appear to provide. Nevertheless, as a new tool in the country, there are still many unknowns that need resolving with regard to hatchling handling in Venezuela.

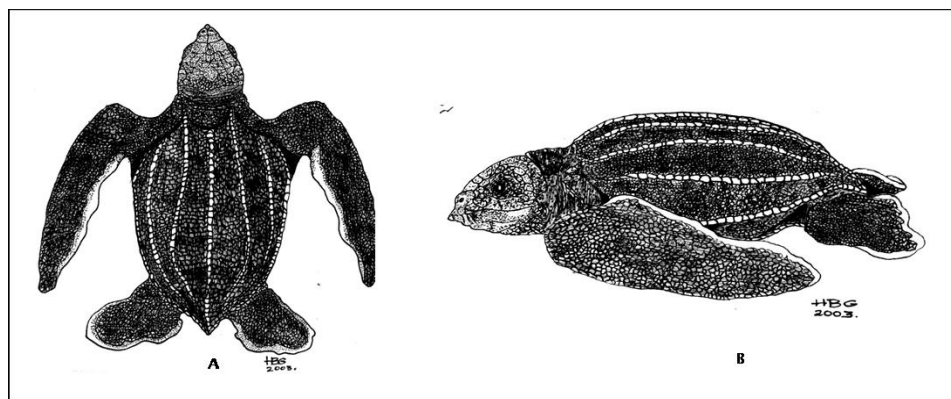
During the embryonic development of the sea turtles, environmental factors play a predominant role in the formation of the hatchlings, not only in the determination of the sex, but also in their growth and physiology. Past projects have referred to this type of phenomena, which can produce diverse effects such as congenital defects, contamination, decrease in the availability of oxygen inside the nest, and manipulation of the eggs, among others. During 2001 in the hatchery on Parguito beach, Nueva Esparta State, several anomalies were found in hatchlings of *Dermochelys coriacea*, from both natural nests and transferred nests. Among these anomalies were leporine lip, characterized by the presence of a deep split in the maxilla of the animal; micropodies, one or both flippers reduced in size; albinism, absence of melatonin in the skin; ‘guitar shell’ (with a deep constriction in the middle of the shell) and twins which shared a same one yolk and were not viable. These abnormalities were observed as much in natural nests as in artificial nests, therefore the abnormalities can not be attributed to incorrect manipulation of the eggs during the transfer stage.

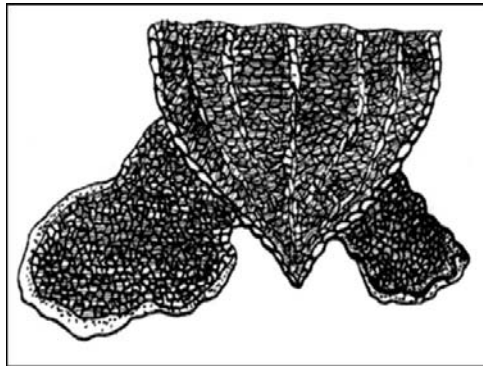
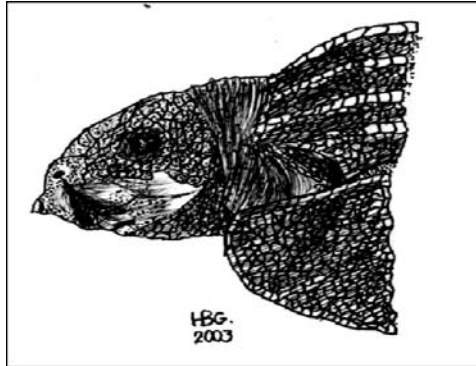
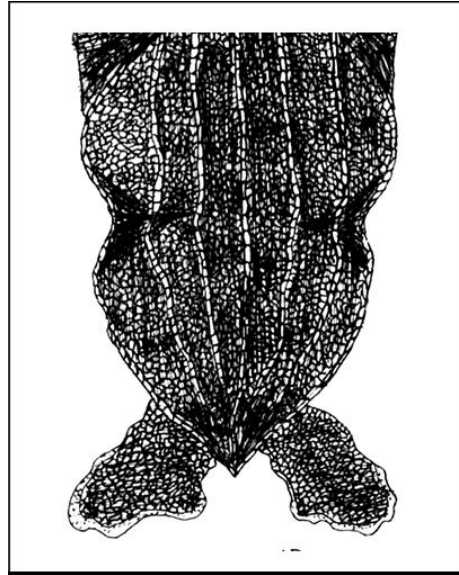
Phenotypic abnormalities of hatchlings scarcely have been documented, appearing generally as simple anecdotes or short notes reporting their presence (Rueda, et al. 1992), and suggested to be the result of an interaction of multiple factors such as contamination, decrease of the available oxygen inside the nest, congenital defects or possible erroneous manipulation of the eggs in the hatcheries (Carr, 1967; Fowler, 1979; Goodwin, 1981).

Methods

During 2001 in the “Antolín del Campo” hatchery on Parguito beach – Margarita island, carapace measures and external condition checks of hatchlings form part of the routine work by hatchery staff (Montiel-Villalobos & Barrios-Garrido; this volume), using “Mitutoyo” vernier calipers (300 mm) and taking photographs. Within these, several anomalous characteristics were observed as much under natural conditions as in the transferred nests, suggesting some phenotypic anomaly.

Results





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METABOLIC RATES, DIVE DURATION AND BUOYANCY REGULATION: WHY SEA TURTLES BEAT ANY OTHER DIVER IN BREATHOLDING *

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Sea turtles maintain a particular status among air-breathing diving animals due to their ectothermic biology and their bi-functional lung which serves as both an oxygen store and a buoyancy organ. With the aim of elucidating the interaction of these features we measured oxygen consumption rate (VO_2) in 9 loggerhead turtles, *Caretta caretta*, (body mass = 2 - 60 kg), kept at

ambient water temperature (T_w) from the Gulf of Naples (Italy) from Sep 2000 through Feb 2001 (T_w range = 15 - 27°C). VO_2 decreased drastically ($Q_{10} = 5.4$) while dive duration increased to a maximum of 1.5 - 2 h in the winter, when turtles were mainly resting. However, no correlation between VO_2 and dive duration was established for these winter resting dives. The aerobic dive limit (ADL) was calculated for various sized turtles and various T_w . Sea turtles, because of their low metabolic scope, have an aerobic diving capacity of up to 8 h (at $T_w = 15^\circ\text{C}$) which exceeds by far any previously reported ADL of marine diving animals, and also their own voluntary dive times. Additionally, the underwater weight (Muw) of 7 turtles was recorded while they were resting submerged on the bottom of the tank. Turtles were slightly negatively buoyant ($Muw = 3 - 7 \text{ gkg}^{-1}$), but their Muw increased during the apnoeic period. This was explained by pulmonary gas loss due to oxygen consumption. VO_2 calculated from these data corresponded well with expected VO_2 , based on the results from the preceding experiment.

ENERGETIC AND ENDOCRINE DYNAMICS IN BREEDING MALE GREEN TURTLES: IMPLICATIONS FOR REPRODUCTIVE TACTICS *

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Male green turtles lose significant body condition during their migration and courtship period. Concurrent with these physical changes, a metabolic shift from lipid-based to protein-based substrates is evident. In addition at the population level, migrant breeding males have a significantly smaller CORT response to the capture/restraint stressor compared to non-breeding males and that this decreased response coincided with the generally poorer body condition of migrant breeders. In contrast, plasma androgen levels decreased significantly in response to the capture/restraint stressor in migrant breeding males, but not in non-breeding and pre-migrant breeding males. For individual migrant breeding males, the magnitude of their CORT and androgen responses to the capture/restraint stressor was highly correlated with their body condition and body length, respectively. These results demonstrate that male green turtles exhibit complex interactions in their energetic and endocrine responses during breeding and that this variation is associated with individual differences in the males physical state. This interplay between energetic and endocrinal criteria is used as basis to examine how such state dependent processes could have important consequences for male green turtle reproduction, especially reproductive strategies used during breeding.

WATER, FAT, AND ACOUSTIC IMPEDANCE: SOFT TISSUE ADAPTATIONS FOR UNDERWATER HEARING IN TURTLES, SEABIRDS, AND MARINE MAMMALS *

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Remarkably little is known about underwater hearing in sea turtles. In fact, one of the most fundamental issues, how sound is channeled to the inner ear, has not been fully investigated. Turtles share a common problem with dolphins. Both lack conventional external ear canals. Nevertheless, turtles, birds, seals, and whales are believed to hear underwater and, possibly, as has been demonstrated at least for dolphins, to have good sensitivity and sound localization abilities. In this study, computerized tomography (CT) and magnetic resonance imaging (MRI) were used to explore underwater sound reception mechanisms through density analysis and mapping of tissues associated with the outer and middle ears of multiple species of dolphins, seals, turtles, and sea birds. The scans revealed well-organized bundles of coherent fatty tissues emerging from the middle ear in all species examined. The densities of these fats are similar across all species examined and are consistent with sound speeds of sea water. Three-dimensional reconstructions of the scan data showed that in turtles, the fats formed a discrete column fused to the tympanum. Seals and sea birds have distinct columns of fat that parallel an air-filled canal. In dolphins, the fats form three distinct bundles: two directed anteriorly with a third projecting postero-laterally. These findings suggest that all four groups evolved parallel soft tissue specializations that act as low impedance channels for underwater sound conduction to the ear.

Acknowledgements

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TRACE ELEMENTS (CD, HG, ZN, CU, SE) ACCUMULATION AND TISSUE DISTRIBUTION IN LOGGERHEAD TURTLES (*CARETTA CARETTA*) FROM THE WESTERN MEDITERRANEAN SEA (SOUTHERN ITALY) *

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Cadmium, total mercury, zinc, copper, and selenium were analysed from the liver, kidney and muscle of loggerhead turtles, *Caretta caretta*, from the South Tyrrhenian Sea (southern Italy). Cadmium and mercury exhibited a higher range of variation in the tissues than copper, zinc and selenium, likely due to some control by the turtle through a homeostatic mechanism. No differences were detected between male and female. The trace element concentrations in the liver were not influenced by size except selenium, which was negatively correlated with curved carapace length. Compared to marine mammals and seabirds, loggerhead turtles showed similar levels of cadmium but much lower levels of mercury (10.9-158.4 mg/kg dry weight and 0.14-8.76 mg/kg dw, respectively). The inter-specific variability was consistent with differences in biology and feeding ecology of these species. Copper, zinc and selenium exhibited the highest concentrations in the liver, muscle and kidney, respectively (17.6 mg/kg dw, 101.9 mg/kg dw, 15 mg/kg dw). Comparison with data reported in the literature showed small intra-specific variation in trace element accumulation that could be linked with the differences in the grade of local pollution or with the individual variability in trace element accumulation. Only for cadmium did a few individuals exhibit concentrations high enough to be cause for concern. However, a correlation between zinc and cadmium found in both liver and kidney could be linked to a protection mechanism based on metallothionein production. Mercury concentrations were always too low to be considered a threat for loggerhead turtle's survival.

WATER TURNOVER RATES AND METABOLISM IN FREE-SWIMMING FEMALE LEATHERBACK TURTLES (*DERMOCHELYS CORIACEA*) *

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Leatherback turtles (*Dermochelys coriacea*) nesting at Parque Nacional Marino Las Baulas, Costa Rica, nest on average 7-8 times in a season, with an interesting period of 9-10 days. It is not clear what activities turtles perform during the interesting period. The overall cost of migration to and from the nesting grounds, in addition to the cost of making multiple clutches and coming onto land to deposit them in the sand must be high, so quantification of the energy expenditure of the interesting period will clarify an important component of the leatherback energy budget for the complete nesting process. All published metabolic studies of sea turtles have been performed on animals during the terrestrial nesting process or while restrained. No study has quantified the metabolic energy expenditure of free-swimming sea turtles. Because the vast majority of a sea turtle's life is spent at sea, quantification of the metabolic costs of free-ranging activities for adult leatherbacks is crucial to understanding energetic requirements of these animals.

We determined the water turnover rates and metabolic cost of a typical interesting period for female adult leatherbacks nesting in Costa Rica by the doubly-labeled water method (DLW). Simultaneous with the isotopic measurements, we recorded the diving activity of the females, to describe relationships between diving patterns during the interesting period and field metabolic rates.

The water turnover rates of both turtles were within the range of published values for sea turtles, but because the study durations were 13 days for both turtles, the isotopes had been completely washed out of one turtle and nearly eliminated from the other. Therefore, we concluded that the dosage of DLW we administered was insufficient for the study duration and the relatively high water flux of adult female leatherbacks.

However, we did successfully obtain a field metabolic rate for one of the two turtles. The FMR for this interesting female leatherback fell at the lower cusp of the range of published resting metabolic rates for leatherbacks while nesting on land. This result indicates that this turtle was relatively inactive and therefore conserving energy during the interesting period and/or constant swimming was not costly for this animal.

Future studies corroborating DLW and diving activity will elucidate the energy budget of leatherback turtles during the reproductive process of their life cycle in order to understand how energetics influences leatherback physiological and behavioral ecology.

PUBLIC EDUCATION

SEA TURTLE CONSERVATION THROUGH COMMUNITY PARTICIPATION; AN INITIATIVE IN ANDHRA PRADESH BY COASTAL NGOS

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The killing of adult turtles for meat and poaching of eggs by coastal dwellers is one of the major threats to sea turtles in Andhra Pradesh. A large number of turtles also die as incidental catch in trawl and gill net fisheries. Most of the local fishermen in Andhra Pradesh are not aware of the status of sea turtles and their legal protection nor are they aware of fishing regulations that protect the rights of traditional fishing communities. With regard to trawler communities, extensive campaigning needs to be carried out to implement the use of Turtle Excluder Devices (TED). The involvement of local communities is critical to the long term conservation of sea turtles as well as coastal habitats of Andhra Pradesh. Non-government organizations create a good link between local community and conservation action.

In the past there was no or little awareness among the NGOs in Andhra Pradesh. Though a few organizations were involved in sea turtle conservation, a majority of coastal NGOs working on environmental and socioeconomic coastal issues were unaware of sea turtles. As a part of GOI-UNDP survey along the Andhra Pradesh coast, four NGOs carried out extensive campaigning in coastal fishing villages for sea turtle conservation awareness. Two workshops conducted in Andhra Pradesh also brought a wide cross section of people to a common platform for conservation and management strategies for sea turtles of Andhra Pradesh. This paper discusses the role of networking for sea turtle conservation.

KARUMBÉ EDUCATIONAL PROJECT: AN APPROACH TO FISHING COMMUNITIES

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Karumbé has been working since 1999 on the review and conservation of the sea turtles of Uruguay. The facts indicate that turtles are frequently trapped in fishermen's nets, and occasionally they are processed, eaten and their carapaces are sold. Taking this into account for protecting these ancient reptiles which ply our seas, we consider an educational programme essential. During 2002, Karumbé carried out a preliminary survey at twelve locations along the coastline, covering a total of 530 km (Río de la Plata estuary and Atlantic Ocean), working with children and fishermen of the most important fishing communities. Our objective was to make the local people aware of the present situation regarding sea turtles, as well as collecting the necessary information for designing an Educational Project for the critical areas. In this first evaluation, we discovered a great interest on the topic, both by children and adults. We also noted that some children do not attend school, but they are very receptive to learning about these animals, children who sometimes have seen the turtles alive or dead trapped in a net or as part of a meal. We consider it possible and necessary, based on our findings, to continue and extend the activities in critical areas, promoting the cooperative work with the fishermen and their families, with children transmitting the message of the pressing need for a new future for sea turtles.

TURTLE DAY: INTEGRATION OF THE COMMUNITY IN THE CONSERVATION OF SEA TURTLES IN THE GULF OF VENEZUELA

María Gabriela Montiel-Villalobos and Héctor Barrios-Garrido

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Environmental education is an indispensable tool for the protection and conservation of any species, integrating such diverse factors as basic needs, culture and of course, the development of the community. Only in this manner can really efficient strategies that guarantee the equilibrium among the man and the nature be developed. Based on this, the Sea Turtles of the Gulf of Venezuela Working Group (GTTM-GV) has as one of its main objectives implementing and executing environmental education plans directed at the community. Among these are an activity named the Turtle Day, a process that is carried out annually in various localities of the Gulf of Venezuela, and which includes educational chats directed to fishermen and children, interactive forums, plays, puppets and stories, all allusive to sea turtles and to their conservation. This year, the activity was carried out on Zapara Island with the help of 100 people, children and fishermen from the Zapara, the Maraca islands, San Carlos and Toas, and the main subject was the leatherback turtle (*Dermochelys coriacea*). Informative and educational posters were presented to the teachers of the schools to explain the situation and need for protection of sea turtles and 'Turtle Patrols' were developed for children between 8 and 17 years, to represent their communities as vigilantes of the welfare and conservation of the sea turtles.

ENVIRONNEMENTAL AWARENESS AND EDUCATION IN THE AMANA NATURAL RESERVE

Marion Rodet and Noemi Morgenstern

Natural Reserve of Amana, 270 av. Paul Henri, Awala-Yalimapo, French Guiana GF 97319

The Amana Natural Reserve, in northwestern French Guiana, South America, is one of the most important nesting sites for the leatherback turtle, and is an attractive for many people, local villagers as well as tourists. The Natural Reserve has a big environmental education component, especially sea turtle awareness for the public who come to watch the sea turtles nesting. The Natural Reserve works all year long with children at schools, students and teachers at university, tourists and local populations on site (beaches) and in a little museum and projection room in the House of the Natural Reserve.

REPRODUCTIVE BIOLOGY

PLASMA CATECHOLAMINES, LACTATE AND GLUCOSE LEVELS AT DIFFERENT NESTING PHASES OF THE GREEN TURTLE, *CHELONIA MYDAS* AT RAS AL HADD, OMANAbdulaziz Y.A. Alkindi¹, Aziz A. Al-Habsi¹, Ibrahim Y. Mahmoud¹, Saif Al-Bahry¹, and John L. Plude²¹ Sultan Qaboos University, College of Sciences, Biology Department, Al Khoud, Muscat OM 123² University of Wisconsin Oshkosh, Halsey Science, Oshkosh WI 54901**Introduction**

Sea turtles undergo exhaustive and difficult physical activities during nesting phases. After emerging from the sea, turtles must cope with the effects of unsupported body weight. One effect is compression of the thoracic region, making breathing a laborious process. Sea turtles on land exhibit a pattern of brief, strenuous, and exhaustive exercise, normally lasting less than 1 min, followed by a recovery period usually exceeding the time of exercise. This pattern of exercise-recovery prevails throughout the phases of nesting. Under these circumstances, the turtles, like some reptiles, appear to be intermittent breathers. After exercise, they appear to develop hypoxia and hypercapnia, characteristics of anaerobic respiration. In addition, when nesting, turtles frequently abandon several sites before choosing a place to lay eggs. Nest abandonment is usually related to unfavorable conditions such as lack of sand moisture, presence of obstacles or disturbance. Nesting may take between 2.0-3.5 hr depending on the number of nest abandonments a turtle makes. Thus, sea turtles are subjected to a high degree of stress, evidenced by high catecholamine levels during nesting exercise (Gleeson et al., 1993; Al Kindi et al., 2001). Moreover, sea turtles, like most other lung breathing reptiles ventilate intermittently (Shelton et al., 1986; Wasser & Jackson, 1991).

In this study, we report the changes in plasma levels of catecholamines, glucose and lactate during four nesting phases, which include emergence from sea, digging body or nest chamber, post-nesting and wandering. The physiological adjustments based on the data are discussed.

Materials and Methods

Blood samples were collected from their cervical sinuses within 3 min. of capture during four nesting phases. These were: (1) emergence from the sea, (2) digging of the body or nest chamber, (3) successful nesting (post-nesting) and (4) wandering (unsuccessful nesting). Plasma levels of adrenaline(AD), noradrenaline(NAD), dopamine(DP), lactate and glucose were subsequently examined.

Plasma CA Analysis: Plasma catecholamines were extracted onto alumina, washed, eluted and subsequently analysed using HPLC with electrochemical detection (Chromsystems reagents). Instrument conditions were 1.2ml/min, 600 mv, 10 nA FS.

Plasma Glucose and Lactate: The Beckman Synchron CX system was configured for amperometric detection of glucose via glucose oxidase production of O₂. Plasma lactate was measured following enzymatic conversion with lactate dehydrogenase to pyruvate, peroxidase addition for quinoneimine production and detection at 520 nm. A Mann Whitney nonparametric test was used to calculate significance at p = 0.05.

Results

Green turtles at Ras Al Hadd (Oman) were found to select 2.5 sites (avg.) before choosing a final nesting location. They also spent 2.1 hr. (avg.) on the beach before returning to sea.

The nesting phases (emergence from sea, digging body or nest chamber, post-nesting and wandering) were investigated in the green turtle *Chelonia mydas* relative to adrenaline (AD), noradrenaline (NAD), dopamine (DP), glucose and lactate. Adrenaline and noradrenaline plasma levels during post-nesting were significantly higher (P<0.001) than the other three phases. However, the plasma adrenaline and noradrenaline levels in the other three phases are about the same (Fig. 1).

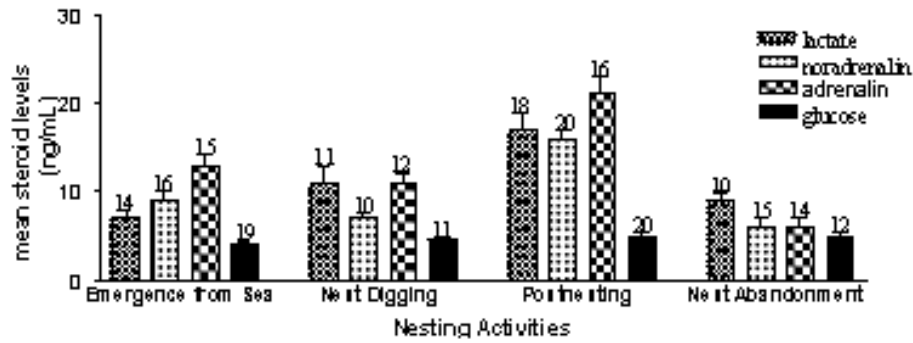


Fig. 1 Plasma steroid levels during different phases of nesting.
Numbers indicate sample size.

Dopamine plasma levels for emergence were barely significant compared with abandonment ($P=0.045$). However, the levels for the rest of the phases were the same ($P>0.05$). (Fig. 2). Glucose plasma values remained stable throughout the nesting exercise and there were no significant differences between the phases (Fig. 1). Lactate plasma levels during post-nesting were significantly higher ($P<0.001$) than those of other phases. Those for nest digging are also significantly higher than for either emergence or abandonment ($P<0.001$) (Fig. 1). The data reveal that catecholamines coincide with time spent on nesting grounds, which may indicate physiological adjustment.

Discussion

Behavioral changes during nesting activity caused some significant changes in plasma catecholamine values which may reflect physiological adjustments to combat stress. Under these conditions, the turtles may develop apnea accompanied by hypercapnia, and hypoxia which are primarily associated with anaerobic metabolism. These physiological 'stressors' cause the release of catecholamines into the blood stream. Catecholamines appear to facilitate breathing, O_2 uptake, increased heart rate and glycogen metabolism by stimulating glycogenolysis and/or gluconeogenesis. Catecholamines may play a major role in maintaining stable plasma glucose levels and removal of muscle lactate into the blood stream.

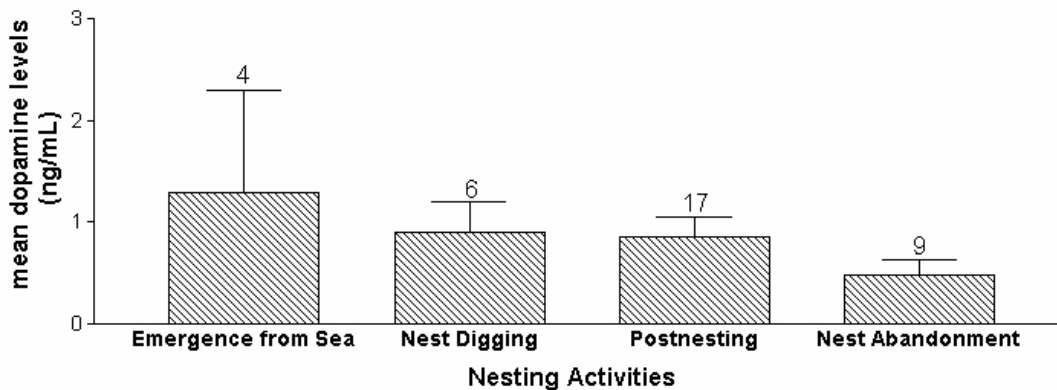


Fig. 2 Plasma dopamine levels during different phases of nesting.
Numbers indicate sample size.

The green sea turtles, like most other lung breathing reptiles, ventilate intermittently. During nesting exercise they undergo bursts of strenuous and exhaustive forceful breathing following by periodic recovery. We suggest that the catecholamines release into the blood stream occurs in "pulses" and the amount depends on the magnitude of the physical exercise and related physiological conditions. This suggestion is based on the fact that the present data reveal a wide variation in the catecholamine values among the individuals of the same nesting group. Pre-nesting green turtles demonstrated lower catecholamine values than nesting turtles. This is not surprising since the pre-nesting turtles did not undergo the strenuous exercise. The main source of catecholamines is probably of the adrenomedullary and autonomic nervous system.

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NESTING OF LEATHERBACK TURTLES, *DERMOCHELYS CORIACEA*, IN BARBADOS, WEST INDIES

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Low density nesting of leatherback turtles occurs in Barbados, primarily along the windward east coast of the island. A nest monitoring programme was initiated in 1997 and 192 nests were recorded between 1997-2002, with considerable inter-annual variation in numbers. Nesting occurs from February to August, with a detectable peak in May for some years. Inter-clutch intervals were used to estimate the size of the nesting female population from nest counts.

DETERMINATION OF THE SEX RATIOS OF LOGGERHEAD SEA TURTLE (*CARETTA CARETTA*, L.) HATCHLINGS PRODUCED ALONG THE SOUTHEASTERN ATLANTIC COAST

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The loggerhead population nesting along the western north Atlantic coast of the US is represented by several subpopulations based on mtDNA analysis. These subpopulations differ demographically. The smaller northern subpopulation is decreasing, while the larger southern subpopulation south of Cape Canaveral is increasing or stable. To meaningfully interpret and manage these subpopulations, accurate sex ratios of the hatchlings recruiting to the next stage must be determined. The purpose of this study was to empirically determine the sex ratios of loggerhead sea turtle nests from both major subpopulations using endoscopic analysis of gonadal morphology. Eleven study sites distributed along a latitudinal gradient (N to S) were sampled 3 times during the season. Hatchlings were raised for approximately 12 weeks to a minimum size of 120g and then their sex was determined. To verify the identification of the gonads, a subsample of the animals was biopsied: a small biopsy was taken of the anterior (cranial) end of one gonad for histological examination. Sex ratios for the southern subpopulation turtles were low (to date 13.5 % males: 86.5% females) and consistent with what temperature-based and incubation-based models might predict. The sex ratios of the northern beaches were significantly lower than expected producing maximally 39% males and 61% females. This very low output of males confirms the expected skewed sex ratio for loggerhead sea turtles. Additionally it provides additional support for action to rigorously protect the northern subpopulation because it is effectively producing 70-80 % of the males.

BIOMETRICS VALUES AND NESTING SEASONALITY OF OLIVE RIDLEYS (*LEPIDOCHELYS OLIVACEA*) IN MAJAHUAS, JALISCO, MEXICO

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Introduction

In the State of Jalisco, on the Mexican Pacific coast, nesting by four sea turtles species has been reported: olive Ridley's (*Lepidochelys olivacea*), greens (*Chelonia mydas agassizii*), leatherbacks (*Dermochelys coriacea*) and hawksbills (*Eretmochelys imbricata*), along with foraging loggerheads (*Caretta caretta*) (García & Ceballos, 1994, Márquez, 2000). The extensive legal and illegal exploitation over last 40 years have had critical consequences on the populations of these species on these beaches and their populations have diminished dramatically (Cliffton et al, 1995; Márquez, op cit; Mack, 1983). The Mexican Government in 1986 decreed a protected zone for nesting and breeding; and in 1990 approved laws for total protection of all sea turtles in Mexican littoral zones. But excessive predation continues on these beaches, many eggs are plundered, many turtles are killed to obtain skins and meat. All species are captured on the beaches but more frequently with nets at sea, when congregating to breed. In the Playón de Mismaloya area, the names and dwellings of people involved in the trade are well-known, but nobody reports them for fear of retaliation.

Majahuas Beach receives the highest number of nests each year, but nearly 40% of nests were plundered in 2002 and the number of turtles captured at sea in nets is in the region of 2,000. Nests are protected each season along nine km by students, volunteers and fishermen. All collected nests are relocated for incubation in a protected area. This is the first report of biometric values and nesting seasonality of females olive ridleys in Majahuas Beach. We found important differences with respect to other studies for this species on the Mexican Pacific coast.

Methods

Majahuas beach is located in the Eastern Pacific, on the west coast of Mexico, in Jalisco, Tomatlán (19°50'N, 105°23'W). Data were collected each day between July and November of 2002 on nesting olive ridley sea turtles. We patrolled the beaches using an ATV (and walking) usually three times per day between 22:00 and 06:00 hours (when environmental conditions it permitted). On nesting days we patrolled from 12:00-14:00 to 07:00 hours. We recorded Straight Carapace Length (SCL) and Curve Carapace Length (CCL) following Bolten (2000), as well clutch size, beach zone (n = 95); and data to estimate seasonality (number of nests collected per day) (n > 1500 nests).

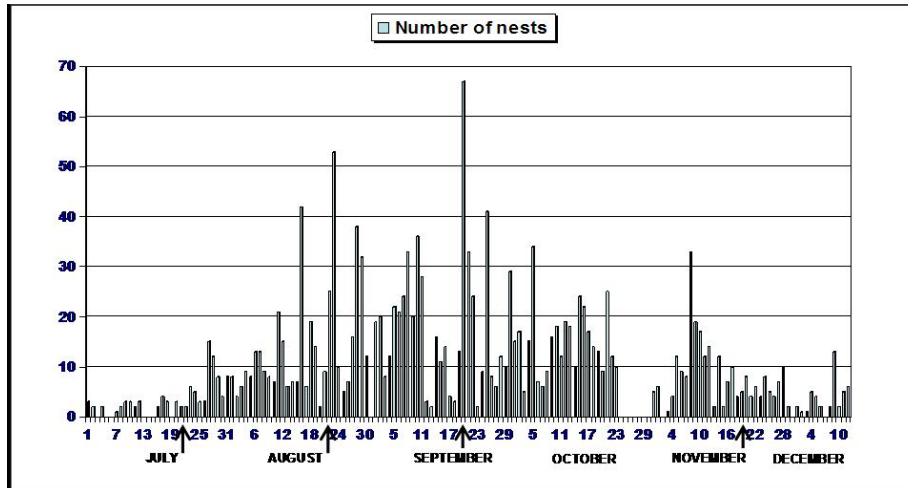
Results

We measured 95 olive ridley females with mean SCL of 61.24 cm and mean CCL of 66.48 cm; clutch size mean was 97.42. In July nesting levels were low increased by the last week, and significant increases were observed in August and September, decreasing slowly in October and November (Fig. 1). We did not sample between 24 and 30 of October because of a hurricane in the region.

Discussion

We found low mean sizes compared with other authors for this species, for example straight length (SCL): Honduras 65 cm (Pritchard, 1969); Mismaloya, México 63.14 cm (Godínez, 1989); Pacific Mexico 67.6 cm (Márquez, 1990, 2000); Oaxaca, México 60.6 cm; Nancite, Costa Rica 65.2 cm; Guyana 68.1 cm; Surinam 68.5 cm; Mozambique 65.4 cm; Madagascar 60.6 cm; Sultanate of Oman 71.5 cm; Gahimartha, India 64.3 cm; Colombia 63.1 cm (cited in Márquez, 1990); and Miller (1997) calculated 66 cm as a mean of means.

Clutch size was also very small compared with other studies. We think this population or group of olive ridleys females is composed of many young turtles, and only a few adult turtles. This could be the result of some great depredation in the past, followed by a protection programme in this area. New females were then incorporated to the nesting cohort. Clutch size is generally linked to size female, with small turtle laying small clutches. In future studies, we aim to take measures of a greater number of individuals, to estimate classes frequencies and to suggest a possible group structure. Seasonality was typical for the Eastern Pacific, especially the Mexican Pacific, for this species. In the future we also aim to analyze six years of data to search seasonality patterns.



Graphic 1. Seasonality, number of nests collected/day; (†) indicate full moon day.

Table 1. Carapace's values and clutch size, Olive Ridley females (*Lepidochelys olivacea*) in Majahuas Beach, Jalisco, México (Jul-Nov 2002, n=95).

	mean ± sd	max	min
Length straight (SCL)	61.24 cm ± 3.219	70.60	54.20
Length curve (CCL)	66.48 cm ± 2.674	73.50	59.00
Width straight (SCW)	56.67 cm ± 3.650	69.5	47.5
Width curve (CCW)	71.19 cm ± 2.917	79.00	64.5
Clutch size	97.42 eggs ± 20.71	135	40

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AVERAGE EGG COUNTS, WEIGHTS AND DIAMETERS FOR FIVE TURTLE SPECIES NESTING IN REKAWA, SOUTHERN SRI LANKA

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Introduction

Marine turtles lay two types of eggs: normal and odd shape eggs. Normal eggs are white, spherical cleidoic eggs with a flexible calcareous shell (3% of total weight), a capsule of albumen (48.5%), and a yolk (48.5%). Odd shape eggs may be very large multi yolked or very small yolkless (Miller, 1997). The eggs are laid individually or in groups of two, three or occasionally four. The diameter, shape and the weight of the eggs laid in one clutch varies slightly within the clutches laid by the same female. This variation is considerable within and between species (Hirth, 1980; Miller, 1997). Leatherback turtles lay the largest eggs among all marine turtles (5.3cm and 90g), while olive ridley and Kemp's ridley turtles lay eggs of similar size (3.9cm and 35g; 3.8cm and 30g, respectively). Flatback eggs are nearly the same size as for the Leatherback (5.1cm and 80g). Green turtles lay medium to large eggs (4.5cm and 48g), and Loggerheads (4.0cm and 36g) and hawksbills lay small eggs (3.8cm and 28g; Miller, 1997). Generally, large marine turtle species such as leatherback and green turtles lay large eggs and small species such as hawksbills and Ridelays lay small eggs.

A clutch is defined as the number of eggs laid into the nest, excluding the yolkless eggs. The mean number of eggs in a clutch varies among the species. The number of eggs in a clutch can be determined while the turtle is laying the eggs, or it can be counted when the eggs are to be moved and reburied (Miller, 1997; Miller, 1999). In most studies, ten eggs are chosen at random from each clutch and are measured for their diameter and individually weighed to establish the size of the eggs (Miller, 1999; Dobbs et. al., 1999).

Materials and Methods

The number of eggs was counted at the time of laying. If a turtle select an unsuitable place for nesting, then all the eggs in the nest were collected first and moved to a safe place. Then the eggs were reburied and during this time they were counted. Ten eggs were collected from each clutch for measurements. Each egg was cleaned using piece of cloth to remove the remaining sand, and then the eggs were weighed using a spring balance. In order to take the diameter measurements the egg was held by fingers tightly by gently pressing a finger against the shell to form a dimple (Miller, 1999). Using a plastic vernier caliper the diameter of the eggs was measured. The maximum and minimum diameter was measured and the average was taken. The eggs that were taken from the clutch during the time of laying was put back to the nest before the turtle covered the nest after taking all the measurements.

Results

The average egg count for each species of turtles did not vary greatly. The highest average egg count was recorded for hawksbill turtles (115.2) while the lowest was recorded for leatherback turtles (100.5 eggs). The average number of eggs laid by different species and the other egg parameters are presented in Table 1.

Discussion

The average egg count for the green turtles in Rekawa was 112.1 (range 10-195), close to a global overage of 112.8 for 24 green turtle populations (data extracted from Miller 1997). In comparison, the green turtles on Europa Island laid an average of 147 eggs and those in the Galapagos Islands laid an average of only 81 (Hirth, 1980). The average egg count for olive ridley turtles was 105.1 eggs (range 57-161) in Rekawa while it was 116 in Gahirmatha, India (Dash and Kar, 1990). The average clutch size for 11 olive ridley populations around the world was 109.9 (Miller, 1997). Olive ridelays in Sri Lanka laid smaller clutches, much like those in Playa Naranjo, Costa Rica (105 eggs: Hirth, 1980). Average egg counts for leatherbacks was 100.5 (range 29-140) while it was 115.2 (range 61-154) for hawksbills and 105.2 (range 90-119) for loggerheads on Rekawa. Miller (1997) reported the average egg count for 12 populations of leatherbacks was 81.5, and for 17 populations of hawksbills was 130. Another 19 populations of loggerheads averaged 112.4. The leatherbacks in Matina, Costa Rica laid about 80 eggs per clutch while in Tongaland, South Africa they laid 103.7 eggs (Hirth, 1980). Leatherback clutch size in Sri Lanka was higher and closer to the South African population. The hawksbills in Cousin Island, Seychelles laid an average of 182 eggs and on Seil Ada Kebir, Sudan, they laid an average of 73.2 (Hirth, 1980). When compared with populations in the world, the hawksbills in Sri Lanka laid average sized clutches. The loggerheads on Cape Romanian, South Carolina, laid an average of 126 eggs while in Masirah Island, Oman, they laid 101 eggs. Sri Lanka's loggerheads also laid a smaller clutches.

Table 1. The average egg count, egg weight and egg diameter for the five species of turtles nested at Rekawa beach.

Species	Average egg count	Range	Average egg weight (g)	Egg count range	Average egg diameter, (mm)	Range (minimum and maximum)
Green turtle	112.1 (x = 1985, SE = 0.71)	1 & 195	42.8 (n= 1905, SE = 0.09)	25.5 & 58.7	42.5 (n=1888, SE = 0.04)	34.6 & 50.2
Olive Ridley	105.1 (x = 30, SE = 5.02)	57 & 141	30.84 (n = 23, SE = 0.90)	18 & 37.4	38.1 (n=24, SE = 0.41)	31.5 & 40.7
Leatherback turtle	100.5(x =30, SE = 4.26)	29 & 140	79.6 (n =33, SE = 1.45)	63.4 & 94.7	53.2 (n=34, SE =0.54)	49 & 64.1
Hawksbill turtle	115.2 (x =6, SE = 14.77)	61 & 154	24.3 (n = 3, SE = 0.88)	20.5 & 27	35.8 (n=5, SE = 0.32)	34.4 & 36.3
Loggerhead turtle	105.2 (x = 5, SE = 5.49)	90 & 119	43.2 (n= 6, SE = 2.61)	31.1 & 48.6	42.6 (n=7,	39.4 & 44.1

n = number of samples (for a one sample ten eggs were taken from one nest) ,
 x = number of nests observed , SE = Standard Error

The average green turtle egg weight was 42.8g and average egg diameter was 42.5mm in Rekawa. The average egg weight was 46.1g for 10 populations and the egg diameter was 44.9mm for 17 populations around the world (Miller, 1997). In the French Frigate Shoals it was 50g and in Sarawak Island, 36g (Hirth, 1980). The green turtle population in Rekawa laid eggs of approximately the same size as those around the world. The average weight of olive ridley eggs in Rekawa was about 30.84g (range 18g and 37.4g) and average egg diameter was 38.1mm. The olive ridley turtles of Gahirmatha, India laid eggs of about 23.5g to 34g in weight with diameters between 34.5mm and 39mm (Dash and Kar, 1990). The average egg diameter for six other olive ridley populations was 39.3 mm (Miller, 1997). Therefore, the olive ridleys in Sri Lanka laid slightly larger eggs than those in India, and of the same size those in other places. The average egg weight for the four populations of leatherback was 75.9g and average egg diameter for nine populations was 53.4mm (Miller, 1997). The average egg weight for the leatherbacks in Sri Lanka was 79.6g and the egg diameter was 53.2 mm, which is similar to those in the other parts of the world. The average egg weight for the hawksbills observed was 24.3g and the egg diameter was 35.8 mm. According to the Miller (1997) the egg weight for five populations was 26.6g and egg diameter was 37.8 mm for one population. When compared with those populations the egg size of the hawksbills in Sri Lanka was similar. The average weight of loggerhead eggs laid in Rekawa was about 43.2g with an average diameter of 42.6 mm. According to Miller (1997) seven populations of loggerheads laid eggs with average weight of 32.7g and 14 population laid eggs of a average diameter of 40.9 mm. Therefore, the eggs laid by loggerheads in Rekawa were slightly heavier than global records.

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ESTIMATES OF GREEN TURTLE (*CHELONIA MYDAS*) NESTS ON TRINDADE ISLAND, BRAZIL, SOUTH ATLANTIC

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Trindade Island (20°30'S, 29°19'W) is the main nesting ground for the green sea turtle, *Chelonia mydas*, in Brazil. The Brazilian Navy maintains a 40-man garrison, the only local human population. Since 1982, Projeto TAMAR-IBAMA has been monitoring this area through expeditions with logistical support from the Brazilian Navy. A survey of nest numbers was carried out between December 7th 1999, and April 4th 2000. Nine beaches comprising 2,9 km were patrolled daily in the early morning and female emergences were counted. 90.92% of the total female emergences were recorded on four beaches, which were also patrolled once a week at night. During this period 10,417 female emergences were counted, resulting in an 4,808 estimated nests. These results suggest a nesting population of over 1,500-2m000 females per year at Trindade Island, a very important green turtle population in the South Atlantic.

SYNCHRONIZED NESTING OF OLIVE RIDLEY SEA TURTLES (*LEPIDOCHELYS OLIVACEA*) IN CHALACATEPEC, MAJAHUAS AND MISMALOYA BEACHES, JALISCO, MEXICO

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Introduction

In the State of Jalisco, on the Mexican Pacific coast, nesting by four sea turtles species has been reported: olive Ridleys (*Lepidochelys olivacea*), greens (*Chelonia mydas agassizii*), leatherbacks (*Dermochelys coriacea*) and hawksbills (*Eretmochelys imbricata*), along with foraging loggerheads (*Caretta caretta*) (García & Ceballos, 1994, Marquez, 2000). The extensive legal and illegal exploitation over last 40 years have had critical consequences on the populations of these species on these beaches and their populations have diminished dramatically (Cliffton et al, 1995; Márquez, op cit; Mack, 1983). The Mexican Government in 1986 decreed a protected zone for nesting and breeding; and in 1990 approved laws for total protection of all sea turtles in Mexican littoral zones. But excessive predation continues on these beaches, many eggs are plundered, many turtles are killed to obtain skins and meat. All species are captured on the beaches but more frequently with nets at sea, when congregating to breed.

The olive ridley nests each year with significant regularity compared with other species, although this population is not self-sufficient and is dependent of conservation actions. Reproductive synchronization is reported for *Lepidochelys* (in Spanish called "arribada" or "arribazón"), consisting of large groups of female turtles (100 or more) nesting simultaneously on a short area of beach (Eckrich & Owens, 1995). In Jalisco, the local people talk of the large numbers of females on the beaches 40 years earlier. Many authors have cited this past abundance in the Playón de Mismaloya (Municipalities of Tomatlán & Cabo Corrientes) was one of three major arribada nesting beaches for *L. olivacea* in Mexico (Cliffton et al, 1995; Márquez et al, 1976) with important "arribadas" each nesting season. The beaches of Mismaloya, Majahuas and Chalacatepec (all in the Playón de Mismaloya), we believe, are sites of ancient great nesting groups.

Methods

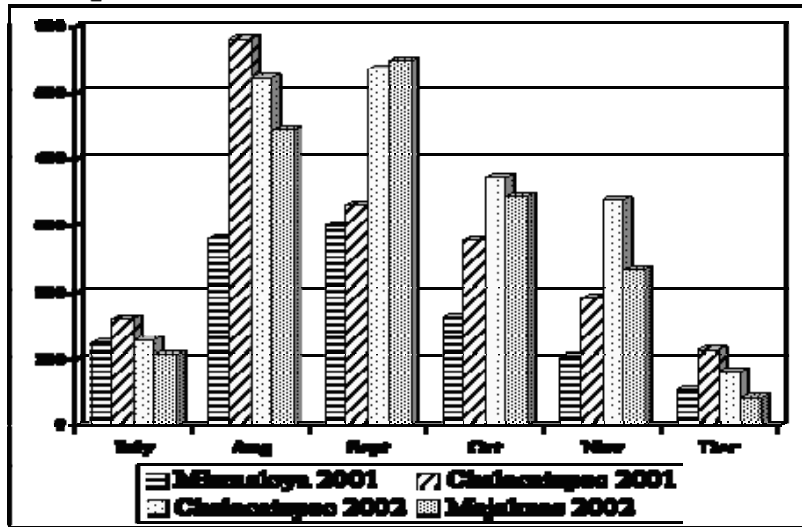
Surveys were conducted on Mismaloya, Majahuas and Chalacatepec beaches in Tomatlán, Jalisco, México (between 20°14'N, 105°36'W and 19°40'N, 105°15'W). Data were collected each day between July and the first half of December 2001 on Chalacatepec and Mismaloya. We patrolled the beaches using an ATV (and walking) usually three times per day between 22:00 and 06:00 hours (when environmental conditions it permitted). On nesting days we patrolled from 12:00-14:00 to 07:00 hours. We also sampled Chalacatepec and Majahuas in 2002. The major index for sea turtle nesting activity in Majahuas was the nests

collected for relocation, and in Chalacatepec and Mismaloya it was nests collected and the presence of nesting crawls of poached nests. Identification of sea turtles, nesting crawls and nesting pits followed Marquez (1990, 2000), and Pritchard & Mortimer (2000). As many nests as possible on each beaches were collected and relocated to protected enclosures.

Results and Discussion

Seasonal Distribution of Nesting Activity: In July nesting levels were low increased by the last week, and significant increases were observed in August and September, decreasing slowly in October and November (Fig. 1). We noted temporal synchronization in nesting activity associated with moon phases on each beach, and between two of the three beaches simultaneously, with increasing abundance with the progression of the moon phase. We did not find a definite pattern because the peak nesting period each year were associated with different moon phases. In Chalacatepec and Mismaloya 2001 season (Fig. 2), the peaks were on crescent moons in August and September (months with major nesting abundance). For the Chalacatepec and Majahuas 2002 season (Fig. 3), we founded synchronized nesting peaks during full moon in August and September, although there were also some other points of synchronization, for example three days after full moon in August and September and the crescent moon in October. Throughout September's new moon there were many turtles nesting on the two beaches. We believe these data suggest there may have been ancient arribada activity in this region because the beaches are 50 kilometres apart and nesting is coincident on many days. Further studies are necessary, but we think these results suggest a significant olive ridley's population or reproductive unit in need of restoration.

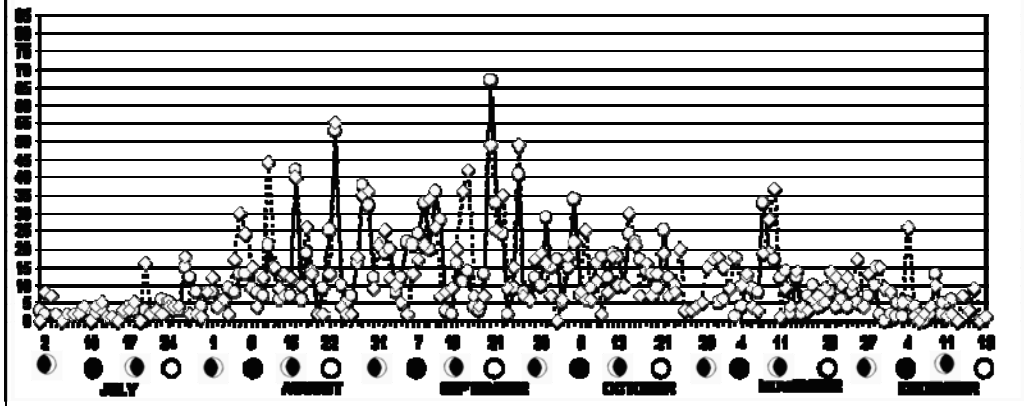
Graphic 1. Accumulative abundance of nests



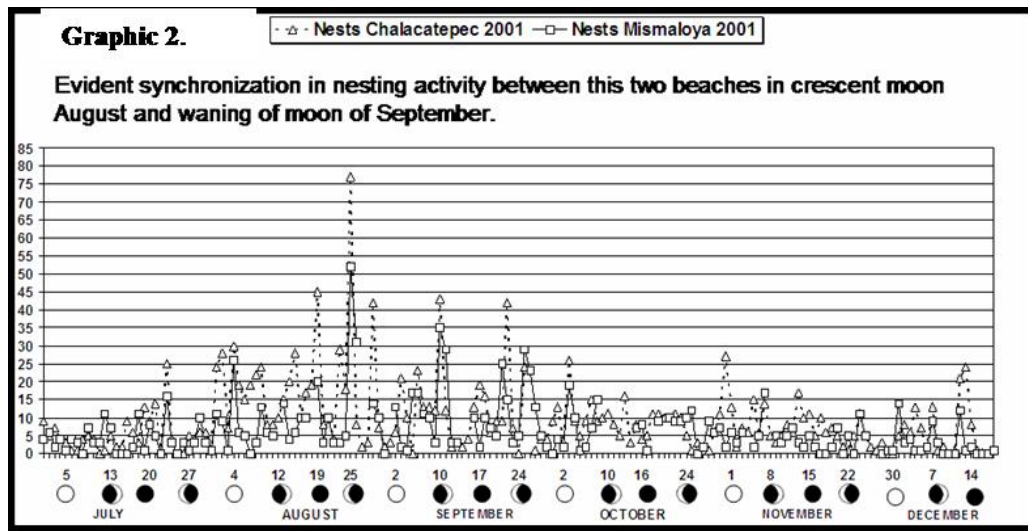
Graphic 3.

○—○ Nests Majahuas 2002 ◇---◇ Nests Chalacatepec 2002

Evident synchronization in nesting activity between this two beaches in full moon August and September, and crescent moon August and November.



Many studies have been focused to description of reproductive anatomy and physiology, but physiological and behavioural mechanisms for synchronized nesting activity “arribada” still remain mystery and have not been elucidated, other than on behaviour (Rostal et al, 1997). It is possible that in the future we will be able to better understand these functions and apply the knowledge to the recovery of endangered sea turtle populations across the globe.



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HAWKSBILL TURTLE NESTING AT MILMAN ISLAND, QUEENSLAND, AUSTRALIA: A TEN YEAR REVIEW *

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Hawksbill turtle nesting has been studied at Milman Island, Queensland, Australia, for ten summer seasons. The results show a decrease in the number of nesting turtles and in the number of clutches laid. The annually derived mean values for most other characteristics of the nesting population (Curved Carapace Length, adult weight, number of eggs laid, hatching success, etc) showed no significant difference among the years or showed the typical variation expected for the character in the species.

SEA TURTLE HABITATS

OBIS-SEAMAP: MAPPING GLOBAL SEA TURTLE DISTRIBUTIONS

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Relatively little is known about the extent to which the sea turtle distributions are influenced by seasonal, interannual and longer-term oceanographic variability. A thorough understanding of sea turtle distribution and abundance patterns are necessary foundations for their effective management and conservation. In particular, these spatial data may be particularly useful to guide fishery closures and marine protected areas designed to set aside important habitats (e.g., foraging areas, migration corridors) and to mitigate anthropogenic impacts (e.g., ship strikes, bycatch). As part of the Ocean Biogeographic Information System (OBIS), the SEAMAP (Spatial Ecological Analysis of Megavertebrate Populations) initiative is compiling geo-referenced data on sea turtle at-sea surveys, movements, strandings, and population counts into a coherent and standardized format. To facilitate the research applications of this global database, SEAMAP is also developing a web-based system equipped with data analysis and visualization tools. This publicly-available database will allow users to display, query, subset, and summarize data on marine vertebrate distributions in conjunction with environmental information. This presentation will showcase the SEAMAP database within the context of a novel data model designed to depict species distributions and animal movements in a fluid oceanic system. This dynamic global database of marine vertebrate distribution and abundance will enhance the understanding of the biogeography and the ecology of sea turtles by: (1) facilitating the study of potential impacts on endangered and threatened species; (2) enhancing our ability to test hypothesis about biogeographic and biodiversity models, and (3) supporting modeling efforts to predict distributional changes in response to environmental change.

MAPPING AND CHARACTERIZING FORAGING HABITAT OF IMMATURE HAWKSBILL TURTLES
(*ERETMOCHELYS IMBRICATA*) IN FRONT OF THE RÍA LAGARTOS BIOSPHERE RESERVE, YUCATÁN,
MÉXICO

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Introduction

The marine realm of the Ria Lagartos Biosphere Reserve (BRRL), Yucatan, Mexico harbors seagrasses beds and wide zones covered by Gorgonian octocorals. This marine landscape is an important foraging and development area for immature hawksbill turtles (*Eretmochelys imbricata*, Linnaeus 1766) in the Yucatan Peninsula, and was considered a priority for study (Frazier y Rodríguez, 1991; Maldonado y Garduño, 1999). The Yucatan hawksbill turtle population is considered the first to be increasing in size in the Caribbean (Meylan et al., 1997; Garduño et al., 1999a).

Ecological data may be expressed graphically to simplify evaluation and management of the ecosystems and the resources they harbor. Techniques such as geostatistics and GIS are being used to generate maps from field data and to manage them using algebraic and logic operations. The objective of this study was to characterize the marine benthic habitats in the area in front of the BRRL, Yucatan, Mexico, given it is a distribution area for immature hawksbill turtles.

Methods

The marine benthic habitats were characterized using two methods: submarine videotranssect (Aronson and Swanson, 1997), and spotcheck (Kenchington, 1978); both appropriate for wide marine zones. The combination of the techniques was based on logistics limitations. The survey sites were systematically selected along transects perpendicular to the coastline. During May and August 1999, 45 sites were surveyed: six using the videotranssect technique and 39 using spotcheck. Both videotranssect and spotcheck covers were standardized using a modified Brawn-Blanket scale (Bello, 1998).

We created a basic matrix data formed by six columns (variables), three biotic (sponges, seagrasses, gorgonians) and three abiotic (calcareous floor, sand, rubbish); and 45 rows (survey sites). This matrix was used with Geostatistics (kriging) and GIS techniques to create the bottom composition map (Figure 1). The map was groundtruthed using the checkpoint technique, and a global accuracy index (kappa) was calculated.

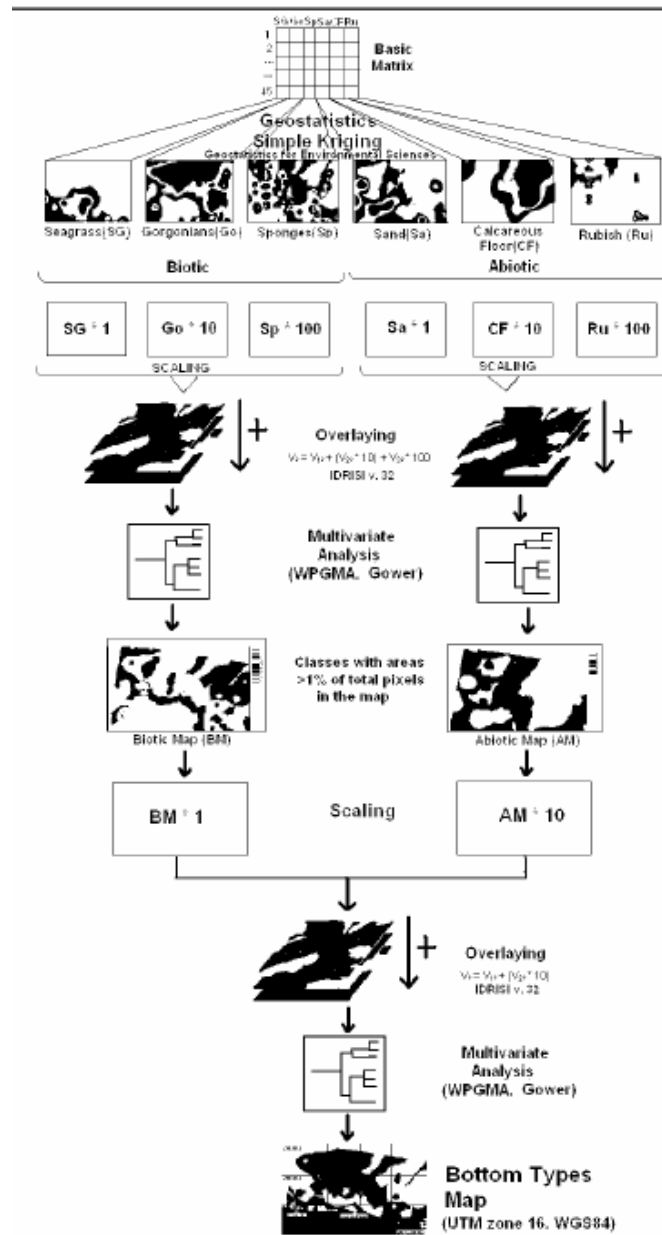


Figure 1. Summary scheme of the method used for the bottom type map elaboration using field data and geostatistics for the partial maps and GIS operations for the final map.

A sea turtle capture sites layer was added to the GIS so we could see in which bottom type they were resident. Also, based on an experimental work in this study area (Cuevas and Maldonado, 1999), their habitat ranges were also input into the GIS. A contingency table analysis was applied to determine if there was any dependence between the presence of the sea turtle and the different bottom types. Finally, Cuevas and Maldonado (1999) tracked one immature hawksbill turtle for 24 continuous to create a vector layer and understand the sea turtle's habitat use.

Results

A bottom composition map (Figure 2) of the marine zone in front of the Ria Lagartos Biosphere Reserve, Yucatán, Mexico, was developed (1:196,000, UTM, WGS84). During the ground-truthing, 25 (83.33%) of the 30 sites agreed with the bottom composition map, resulting in a global accuracy value (kappa index) of 0.76 (76%).

The ten sea turtle capture sites were as follows: one among sponges on a calcareous floor, one in gorgonians (> 20%, cover), five in gorgonians (20% - 40%, cover), two in gorgonians (40% - 65% cover) and one in gorgonian mix on calcareous floor. There were no significant differences in bottom type preferences for sea turtles (Chi-square = 1.53; df = 3; p = 0.676).

There were, however, differences between the bottom type used by the hawksbill turtle during the day and the night (Figure 3). Even though this was only for one turtle, the experiment gives us a rough idea of the hawksbill turtles' habitat use in the study area.

Discussion

We found hawksbill turtles foraging matter including *Chondrilla*, *Dictyota*, *Dictyopterus*, *Hypnea*, *Jania*, *Laurencia*, *Ceramium*, *Codium*, and *Gracilaria*. The study area fulfilled the four characteristics to consider it a development area: 1) Only immature organisms, 2) Shallow waters, 3) Organisms come in and out at specific sizes, and 4) Includes more than one single haplotype (see Meylan and Meylan 1998). The two bottom types with the highest potential density of immature hawksbills were those covered by gorgonians at 20 to 40% cover (some 2,000 organisms at 38 turtles/km²) and by gorgonians at 40 to 65% cover (some 1,500 organisms at 30 turtles/km²).

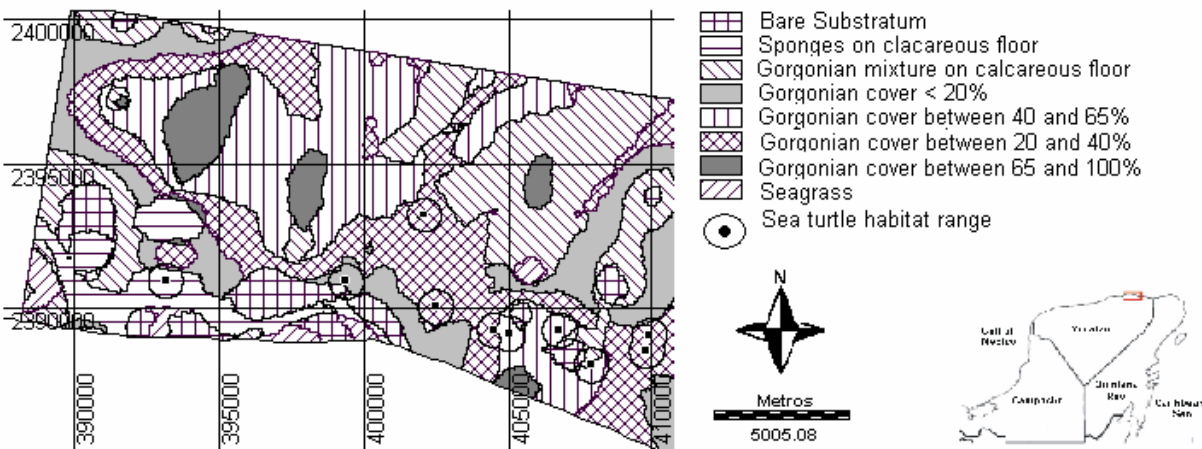


Figure 2. Bottom type map of the study area. In white color the Biosphere Reserve Ria Lagartos, Yucatán, México.

Garduño et al. (2000) reported a total population of 4,289 organisms in the study area and a density of 25.9 turtles/km², while León and Díez (1999) reported a density of 35.1 turtles/km² in Dominican Republic.

These results support the protection of this marine area because of the resources and processes occurring within it, besides its proximity to the Ria Lagartos wetland (Biosphere Reserve Ria Lagartos) with which it interacts.

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RELATIONSHIPS BETWEEN GROWTH RATES AND SIZE DISTRIBUTION OF THE HAWKSBILL TURTLE, *ERETMOCHELYS IMBRICATA*, IN SOUTH MALE ATOLL, MALDIVES

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The hawksbill turtle, *Eretmochelys imbricata*, is distributed in coral reefs. In this study, a total of 103 turtles were caught 206 times by SCUBA diving in the Maldives. All caught turtles were within 353 to 745mm SCL. The peak of the SCL frequency distribution was found to be in 500-600mm, which accounted for 53% of all captures, followed in decreasing order by the size classes 400-500mm (27%), 600-700mm (11%), and 300-400mm (6%). Since turtle captures in the 600-700mm class were less frequent than those in the 500-600mm class, it is thought that turtles move away to find new feeding grounds when they reach an SCL of approximately 600mm. Tagging of captured turtles yielded 92 growth rate data sets for 50 turtles. The rate of increase of SCL and body mass (BM) decreased with increasing turtle size. Turtles in the 600-700mm class were found to have much slower growth rates (2.2-3.7 mm/yr and 0.5-0.7 kg/yr, n = 7). Growth and population size of hawksbill turtles are thought to be affected by the standing crop and growth rate of sponges. The slow growth rate of the larger turtles indicates that the supply of sponges may be limited in this coral reef.

A CARIBBEAN JUVENILE HAWKSBILL AGGREGATION: LESSONS LEARNED FROM A 6-YEAR STUDY IN THE DOMINICAN REPUBLIC

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Introduction

Despite the poor conservation status of hawksbills in the Caribbean (Meylan 1999, Meylan and Donnelly 1999) and their continued exploitation in the region (Marte et al. 2002, Fleming 2001, Chacón 2002), few long-term studies have been conducted on their foraging grounds. In the spring of 1996, building on an initiative by Carlos Diez and Robert van Dam (from the Mona Island Hawksbill Research Project) and in coordination with Grupo Jaragua, a Dominican NGO, we conducted in-water surveys at Jaragua National Park (JNP) and Cabo Rojo. We soon identified a number of hawksbill foraging habitats and started an intensive hawksbill tagging and monitoring study.

Even though the six-year project is far from being considered a long-term study for sea turtles, the Dominican Republic hawksbill project is nevertheless one of the few multi-year projects conducting foraging area research for this species in the region (along with the Mona Island, PR and Buck Island Reef projects, USVI). In addition, the high density of hawksbills found in the Dominican study area (León and Diez 1999) has presented a unique opportunity to study a relatively large number of individuals. Finally, the project's consistency in methods through time and its comparability with other on-going efforts in the region allow us to draw conclusions from the hawksbill foraging area research. We have reported some of our project findings previously (León and Diez 1998, León and Diez 1999), and will here update some of this information as well as discuss new data concerning turtle residency, growth, population trends, and overall project lessons learned.

Methods

The western part of Jaragua National Park and nearby Cabo Rojo is the general study area. Since 2000 we have focused our efforts on only seven sites due to their proximity to shore and their more protected location with respect to prevailing winds and currents. Nineteen field trips were conducted to our general study area between May 1996 and August 2002 at different times of the year.

Turtle surveys consisted of one-hour long, daytime snorkeling censuses over hard-bottom and coral reef habitats with a depth of 15 m or less. Turtles were captured by hand following Diez and van Dam (1994) by four to five swimmers, followed by one other person on board a boat. All captured turtles were brought to the vessel for data collection. Turtles sighted (but not captured) were also recorded for each survey. Maximum straight carapace length (SCL) in cm was obtained for all turtles using a Haglof 60-cm tree caliper. To minimize measurement errors, the same observer (YML) took all measurements. Turtles greater than 25cm (SCL) were tagged on both front flippers using Inconel tags prior to their release. Additionally, we tagged all turtles with passive integrated transponders (PIT tags) inserted in their frontal right flipper muscle. We used an Avid Power Tracker IV reader (Norco, California) to detect the PIT tags. From 2000, we started applying plastic tags (Dalton Jumbo Rototag). However, due to their larger size, we only applied plastic tags to hawksbills greater than 35cm (SCL). The geographic position of each individual was obtained using a Garmin 12XL Global Positioning System (GPS) receiver without differential correction receiver. We also used this GPS data to calculate the distance between first and last capture(s).

Results

Hawksbill distribution closely followed the contour of hard-bottom areas (sparse-hard bottom and coral reef habitats). A total of 860 turtle captures were made, corresponding to 823 hawksbills and 37 green turtles. Of the hawksbill captures, 124 corresponded to previously tagged individuals. Hawksbills ranged from 18.1- 69.1 cm SCL, but the majority of turtles had between 25 and 35 cm SCL (mean = 30.8, SD = 7.2).

The time interval between hawksbill captures ranged from 23-1519 days (mean = 403.7, SD = 305.1). Distances moved from a previous capture ranged from 13 to 10,503m (mean 598.2, SD = 1316.3). Most displacements, however, were of less than 1000m, suggesting a high site fidelity for most individuals. Except for two individuals (IDs 1997-055 and 1998-090), all turtles were recaptured at the same site where they had been first tagged, despite the proximity of other hawksbill sites.

Growth: Growth rates calculated for captures over an interval greater than a year ranged from 1.7 to 9.5 cm/year (mean = 4.9, SD = 1.7, n = 64). No significant differences were found between size-classes in growth rates (one-way ANOVA, F = 0.91, p = 0.46, df = 4, a = 0.05). This could be due to the under-representation of larger juveniles in our sample. However, we detected significantly different growth rates according to site (one-way ANOVA, F = 5.96, p < 0.0001, between group df = 6, a = 0.05).

Turtles at Lanza Zó grew at a significantly greater rate than turtles at all other sites (mean = 7.0 cm/year, SD = 1.60, Duncan's multiple range test, $\alpha = 0.05$).

Abundance Trends: The overall mean number of observed hawksbills per unit of effort (OPUE) for 2000-2002 was 4.4 animals per hour (range 1-9.5, SD = 2.1). When plotting the OPUEs by site, certain sites had consistently higher OPUEs than others. However, this difference was not statistically significant when we analyzed data for 2000-2002 (one-way ANOVA, $F = 1.45$, $p = 0.26$, $df = 6$, $\alpha = 0.05$). Only 2000-2002 data were selected for hypothesis testing because it was only after 2000 that the length of our unit of survey effort was standardized to one hour. None of the observed OPUE differences could be attributed to a year effect in this data set either (one-way ANOVA, $F = 2.8$, $p = 0.09$, $df = 2$, $\alpha = 0.05$).

Discussion

The size-class structure presented in our earlier reports has remained unchanged: mostly juveniles (particularly small ones) have been found in our study area. At present, we can not explain the near-absence of large juveniles and adult-sized turtles. However, given the fact that size-class structure has remained constant for the past 6 years, it is probable that: 1) hawksbills are transient in the area and as they grow they leave, and/or 2) these turtles have low survival rates, and numerous small recruits keep reaching the area. Our detailed turtle distribution maps highlight the importance of hard-bottom areas for hawksbills. We believe that more marine benthic maps and inventories are needed to assist in detecting and monitoring other hawkbill aggregations in the region. Recaptured turtles showed high site fidelity. Similar observations of site fidelity in juvenile hawksbills have been reported by Limpus (1992) and van Dam and Diez (1998).

However, we also documented two individuals that moved over > 9,000m from Playa Norte and near-by Muelle Oeste to Bahía de las Águilas in the south. They suggest that at least some of these young turtles are capable of undertaking greater movements than what we had previously believed within or outside the study area. Also, the fact that both turtles moved south could indicate that the northwestern sites are transient habitats for these turtles as they recruit into the area. Only more recapture data can settle this question. So far, none of our tags has been recovered outside the study area. Limpus (1992) and Chaloupka and Limpus (1997) concluded that immature hawkbill growth in the Great Barrier Reef was non-monotonic, peaking at 50 to 60cm of curved carapace length. Similarly, Diez and van Dam (2002) detected increased growth rates for 34-35cm SCL in hawksbills from Mona and Monito islands. We failed to detect a class-size effect on our observed growth rates, however, this might be due to the under-representation of large juveniles in our data set. However, we were able to detect site-specific differences in growth rates, as Diez and van Dam (2002) have for Mona and Monito island hawksbills. This finding suggests that mean growth rates should be applied with caution for different sites.

In terms of OPUEs, more studies are needed to increase the statistical power of OPUE estimates in order to better assess abundance trends in the study area. Currently, we are in the process of applying capture-mark-recapture modeling to estimate population abundance and derive estimates of recapture, survival and recruitment probabilities. Finally, we would like to note that establishing a multi-year monitoring study has been a major undertaking. However, our work has been greatly facilitated by having reliable and well-trained local field assistants. Even though volunteers have been of great help, working with the same team has increased our efficiency. Investing in training and preserving these assistants has been paramount to the success of our project.

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SUMMARY OF 2002 COLD STUN TURTLES IN ST. JOSEPH BAY, FLORIDA

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Introduction

Temperature is one of the most important and influential factors when considering the ecology of many reptilian species. Unlike birds and mammals, reptiles depend on ambient temperature to regulate their body's core temperature. Reptiles have responded to this dependence on temperature with physiological and behavioral adaptations, which include hibernation and migration (McNabb 2002). These adaptations have allowed reptiles to survive in a variety of habitats and climates in which they would otherwise perish. Sea turtles are among those reptilian species that utilize these strategies in habitats with seasonal changes in temperature.

In temperate climates that experience seasonal changes in water temperatures, it is unclear how juvenile turtles respond to this potential threat. In January 2001, water temperatures in St. Joseph Bay dropped below normal, and 403 marine turtles were subsequently found stranded and cold-stunned. Ten Kemp's ridley, five loggerhead and 388 green turtles were collected, making this the largest stranding event ever documented in the United States (Blackwelder 2001). The presence of juvenile turtles in Northwestern Florida waters at this time of year suggests that these turtles were overwintering in this area and entered a torpid state once water temperatures decreased below an unspecified threshold temperature. Once the water temperatures dropped even further, to approximately 6°C (Foley pers. comm.), hypothermic stunning ensued and the turtles were perhaps not able to maintain their torpid state.

In 2003, northwest Florida again experienced unusually cold weather during the month of January, water temperatures dropped below normal, and sea turtles were again found cold stun within St. Joseph Bay. We summarize this cold stun event and the measures taken to ensure the survival of the stranded sea turtles.

Study Site

St. Joseph Bay (SJB) is a unique coastal habitat located in the northeastern Gulf of Mexico. It is the only sizeable body of water that is not regularly influenced by the flow of freshwater in northwest Florida (Stewart and Gorsline 1962). The bay encompasses just under 30,000 hectares along the coast of the Florida Panhandle in Gulf County (DEP 1997). The bay is approximately 21 km long with maximum width of 8 km, and opens north to the Gulf of Mexico. It has a mean depth of 7 m, the greatest depth being 13.3 m in the northern end and the shallowest in the south at a depth of 1 m. The bay is considered a lagoon primarily because it functions as a closed system, and currents do not have any impact at depths greater than 1.7 m (Stewart and Gorsline 1962). Tidal range is 0.47 m with one tide cycle per day. This bay is highly productive due to high organic content in its sediments (Stewart 1962). Sea grass beds cover approximately one-sixth of the bay and are most abundant in the shallow southern end (DEP 1997).

Methods

Florida Cooperative Wildlife Research Unit (FCWRU) personnel were alerted by local fishermen that approximately 10-15 sea turtles were seen floating in the Southern end of SJB and appeared dead. On 25 January, FCWRU personnel began searching this area of the bay by boat and stranded turtles were found and removed from the cold shallow waters. A thorough search continued with the addition of four agencies (U.S. Fish & Wildlife Service, Florida Department of Environmental Protection, and Florida Marine Research Institute) and numerous volunteers. A 17-foot Boston Whaler was used in deeper waters, while kayaks were used to gain access into shallow waters. Additional help scoured the shoreline for stranded turtles. At the end of each day, both

live and dead turtles were transported to Gulf World, a marine life center in Panama City, Florida. The live turtles were placed in a large swimming arena in which the water was gradually heated to allow for recovery.

On 27 January 2003, government agency staff and volunteers gathered at Gulf World to process the 28 live sea turtles. Turtles were weighed, photographed, measured and tagged. Tissue samples were obtained for genetic analysis. Measurements included straight carapace length (SCL), curved carapace length (CCL), straight carapace width (SCW), curved carapace width (CCW), plastron length, head width, and body depth. The turtles were checked for living tags, flipper tags, and Passive Integrative Tags (PIT). Inconel metal tags (Model No. 681, National Band and Tag Co., Newport, Kentucky) and PIT tags were attached when respective tags were not found. Dead turtles were also processed and transported to the Panama City National Marine Fisheries Service (NMFS) Laboratory located in Northwest Florida.

Results

A total of 42 stranded turtles were collected from St. Joseph Bay. Thirty-nine green turtles (*Chelonia mydas*), two Kemp's ridley (*Lepidochelys kempii*), and one loggerhead (*Caretta caretta*). Thirty turtles were found alive, while the remaining 12 were dead. One live turtle later died at Gulf World, and one turtle was euthanized by veterinary personnel at Sea World Orlando, FL. All turtles were juveniles. Seventeen of the 42 turtles (41%) were previously tagged during the SJB 2001 cold stun event, the FCWRU mark/recapture study in SJB, or captive reared by NMFS in Galveston, TX. Live turtles were kept at the rehabilitation center for 5-7 days from their initial capture date and then released into the Gulf of Mexico near Cape San Blas, Florida. The Florida Cooperative Fish & Wildlife Research Unit will necropsy the dead specimens, collecting both skeletal & soft tissue specimens for analysis.

Discussion

In temperate climates, adult turtles migrate across oceans to over-winter in warmer waters (Meylan 1995). However, juvenile turtles foraging in shallow coastal bays may face decreases in water temperatures that occur so rapidly they have little time to escape. It is unclear how juvenile turtles respond to seasonal temperature changes that result in decreased water temperatures. Green turtles along the Atlantic coast of Florida were found to enter a torpid state when water temperatures dropped below 15°C at Cape Canaveral, FL (Carr et al. 1980). Fishermen in the Gulf of California have reported a similar torpid state in Pacific green turtles (Felger et al. 1976). Entering a torpid state may be one way turtles survive seasonal changes in water temperatures. Cold-stunning events have been reported in coastal waters of New York (Burke et. al 1991, Meylan and Sadove 1986), Texas (Shaver 1990), and along the East Coast of Florida (Witherington and Ehrhart 1989). The occurrence of cold stunning events suggest that sea turtles overwinter in temperate climates by possibly entering a torpid state. However, this is only successful to a certain critical temperature. Once water temperatures drop below this critical level, turtles become unable to respond and cold stunning ensues.

Two recent cold stranding events in the northeastern Gulf of Mexico support this theory (pers. obs.). In January 2001, 403 sea turtles were stranded in St. Joseph Bay. In January of 2003, 42 sea turtles were found stranded when water temperatures dropped below normal. The presence of juvenile turtles in Northwestern Florida waters at this time of year suggests that these turtles were overwintering in this area and entered a torpid state once water temperatures decreased below an unspecified threshold temperature. Once the water temperatures dropped below a certain degree, cold stunning ensued and the turtles were perhaps not able to maintain their torpid state. The implications of cold stun events in the northeastern Gulf of Mexico have yet to be determined.

Acknowledgements

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CEUTA BEACH SAND PHYSICAL DESCRIPTION AS A EFFECT ON *LEPIDOCHELYS OLIVACEA* NESTING

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It is known that there are biotic and abiotic factors which are important in and affect organisms' behaviors. It is possible that when sea turtles *Lepidochelys olivacea* bury the muzzle into the sand when emerging, just before deciding where to lay eggs, they could be detecting some physical, chemical or environmental characteristic of the sand. It is thus important to characterize nesting beaches to understand variations in these properties (soil characteristics). Shoreline erosion results in the loss of the desirable habitat for turtles, and human interferences with natural processes through coastal development and related activities have generated accelerated erosion rates in some localities, along with the interruption of natural sand migration along the coastline. Tracks and compactation left by vehicles on the beach limit the ability of the hatchlings to reach the ocean; and when incubation sites are directly transited, the sand is compacted the emergence success decreases, and hatchlings can be killed in early development stages.

Based on this, the Sea Turtle Program at UAS has been characterizing nesting beach soils for apparent density, porous spaces, water retention capability, slope and sand compactation. Our results suggest that the soil characteristics in Ceuta Beach vary in over space and time, but that water retention and the slope appear to be the most important factors influencing nesting.

SOCIAL STUDIES AND SEA TURTLE-HUMAN INTERACTIONS

**DEFINITION AND REGULATION OF SUSTAINABLE USE IN INTERNATIONAL LAW –
THE CBD AND THE FSA ***

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A range of international conventions consider and regulate the sustainable use of living resources. Some of these are restricted to the marine environment but the bulk are designed for both aquatic and terrestrial environments. Equally are a group of treaties created to protect those species which can not sustain any substantial, prolonged or unanticipated take. Some agreements branch over the range of both protection and use, depending on the categorisation of the resource in relation to its level of endangerment.

Convention for International Trade in Endangered Species of Wild Fauna and Flora

The best known of these agreement, certainly in the sea turtle community but also in the wider public and governmental arena, is that of the Convention for International Trade in Endangered Species of Wild Fauna and Flora (CITES). Under this accord the issue of sustainable use first came to the fore in relation to the issue of the harvest and trade in products derived from African elephants. In regard to marine turtles, the sustainable use discussion revolves primarily around the well know "Cuban Hawksbill Issue". Briefly, this is a petition for a down-listing of what is claimed to be a Cuban population of hawksbill sea turtles, so as to facilitate the legal trade in hawksbill shell products called bekko to Japan.

Notwithstanding that CITES is associated with assigning strict protection for species, sustainable use and international trade, CITES does not contain an explicit definition of sustainable use. Instead it works through a listing process and regulations dependant thereon. Endangered species are listed under Appendix I, which contains all species of sea turtles, and for which trade is generally prohibited. At the other end is Appendix III, which primarily functions to assist countries in the reduction or management of domestic take in situations where some level of foreign trade in those products occurs. Appendix II contains those species that may become threatened with extinction and it is these species on which sustainable use is practiced. This provision does not prohibit trade, but rather trade is controlled through export permits, with certain conditions required to be met. Included is that trade must not be detrimental to the survival of the species in the wild, and it is this provision that effectively functions as a *de facto* measure of sustainable use.

Role and Position of the IUCN

The IUCN has a very specific role in providing advice to the secretariat and to member parties of CITES in particular in relation to proposed listings. Under the IUCN framework sits a Sustainable Use Specialist Group. IUCN first approved the "use" of wildlife within guidelines in 1990, and in 1996 a call was issued for a policy statement on sustainable use. This was adopted without change at the 2000 IUCN congress as Resolution 2.29. The Resolution contained statements to the effect that sustainable use:

- was both a consumptive and non-consumptive activity;
- was to be compatible with biodiversity conservation;
- should be undertaken in accordance with appropriate safe guards;
- that biological, social, cultural, economic factors influence the success;
- that if conducted in a sustainable manner then use is an incentive to conserve;
- that monitoring, including ongoing assessments of risk and uncertainty, was needed;
- that species and ecosystem productivity, resilience and stability were of great influence and importance in assessing if use could be sustainable; and
- incentives, penalties and implementation are necessary components of any sustainable use regime.

Though having a close relationship to CITES and government membership, the IUCN is a non-governmental body, and resolutions issued have no legal implications.

Other Accords

Notwithstanding the public awareness of the CITES accord, it is not the most explicit nor perhaps the most relevant of the sustainable use agreements. Two much more recent accords are the Convention on Biological Diversity and the Fish Stocks Agreement. The first of these is an agreement which extends beyond the species issue, and provides a possible framework agreement for conservation related arrangements (REF). The second, though designed to manage fish resources, offers a much more explicit consideration of the means for handling sustainable use issues.

Sitting outside of these accords are arrangements designed for traditional or subsistence use. Though these issues are included in environmental accords, they are given much more explicit attention in human and indigenous rights agreements. International arrangements are often purposefully ambiguous, and agreements in different forums may even be contradictory depending on the focus of the meeting and the likely lead governmental agency. Similarly, in terms of the wider community's view, personal priorities in regard to cultural and species imperatives and the perceived logistical needs often play a large role in decision making.

Convention on Biological Diversity (CBD)

The Convention on Biological Diversity (CBD) differs most noticeably from CITES in that it actually defines sustainable use. Under the CBD sustainable use is "the use of components of biological diversity in a way and at a rate that does not lead to the long-term decline of biological diversity, thereby maintaining its potential to meet the needs and aspirations of present and future generations." The CBD's objectives are the conservation of biological diversity and the sustainable use of its components. The CBD also includes in several of its provisions issues for the fair and equitable sharing of the benefits.

Throughout, the CBD uses the terminology of "conservation and sustainable use" (CSU). Preambular references to this include: that CSU of biodiversity is needed for food, health and other requirements of a growing world population; that CSU is instrumental in strengthened friendly relations and peace; and acknowledgment of the need to conserve and sustainably use biodiversity for present and future generations.

The CBD's basic regulation functions via overarching provisions that grant to States the right to exploit their resources pursuant to their own environmental policies, and provides them with a concomitant responsibility that State activities do not damage the environment of other States or areas beyond jurisdictional limits. These provisions are almost identical to provisions that are contained in the Law of the Sea Convention (LOSC) and the subsidiary Fish Stocks Agreement (FSA).

Article 6 of the CBD contains general measures for conservation and sustainable use. It requires, inter alia, that each Party shall, as far as possible: identify and monitor components of biological diversity important for conservation and sustainable use; and identify and monitor processes and categories of activities which do or may have significant adverse impacts on conservation and sustainable use of biological diversity. These provisions make reference to Annex I which acts as a mechanisms for prioritisation of identification and monitoring needs under the CBD. Annex I contains two sections, that on species and communities, and secondly on ecosystems and habitats. Several of these relate to sea turtles. Listed under the first of these are threatened species and communities, those that are of social, scientific or cultural importance and species and communities that are important for research including the example of indicator species. Under ecosystems and habitats are those with a large numbers of endemic or threatened species, or those that are required by migratory species.

Further regulation under the CBD in relation to CSU falls under Article 10: Sustainable Use of Components of Biodiversity. This includes directives to:

- integrate conservation and sustainable use of biological resources into national decision-making;
- adopt measures to avoid or minimize adverse impacts on biological diversity;
- encourage customary use in accordance with traditional cultural practices; and
- facilitate the involvement of local populations in the development and implementation of remedial action in degraded areas.

The Agreement on Highly Migratory and Straddling Fish Stocks (FSA)

After peaking in 1989, yearly global fish catches have steadily declined. Most commercially harvested fish species are either depleted or overexploited. By the 1990s the proportion of the world's fish catch that was taken from the high seas had doubled to 11% from 1980 levels, a level thought by the UN Food and Agriculture Organization to be unsustainable. High seas fishing had emerged as an international sustainability issue. Against this backdrop the Agreement for the Implementation of the Provisions of the United Nations Convention on the Law of the Sea of 10 December 1982 Relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks, commonly known as the Fish Stocks Agreement, was negotiated. It was initiated in 1992 as an outcome of the United Nations Conference on Environment and Development (UNCED). The output document, Agenda 21, contained Chapter 17 the Oceans Chapter. Within this, Programme Area C highlighted the inadequate management of high seas fisheries including: the over-utilization of resources; excessive fleet size; illegal, unreported and unregulated fishing and flag of convenience vessels; insufficiently selective gear; unreliable data-bases; and a lack of sufficient cooperation between States.

The Preamble to the Fish Stocks Agreement refers to assurance of the long-term conservation and sustainable use of straddling fish stocks and highly migratory fish stocks. Article 5 contains the General Principles of long-term sustainability and optimum utilization, whereunder subsection (g) requires that levels of fishing effort do not exceed those commensurate with the sustainable use of fishery resources. This form of arrangement, though directed to the management of fish resources, begets the question, if turtles were a fish could they be 'sustainably used' under the Fish Stocks Agreement?

Elements considered important in the Fish Stocks Agreement include the collection and sharing of accurate data, use of best available scientific evidence, and application of the precautionary approach, and the need to conduct scientific research and develop technology. The special requirements of developing States, interests of artisanal and subsistence fishers and need for cooperation between States are highlighted. It highlights the importance of considering the sum of all impacts on target stocks. The FSA directs that pollution, waste, discards, and ghost fishing should be minimized, and that biodiversity be protected, and overfishing and excess capacity eliminated. In addition the need for adequate monitoring, control and surveillance is highlighted.

Annex II of the Fish Stocks Agreement is entitled: Guidelines for the Application of Precautionary Reference Points in Conservation and Management of Straddling and Highly Migratory Fish Stocks. Annex II of the FSA states that the goals should be to maintain or restore populations. Precautionary reference points are used then to provide an estimated take value derived through an agreed scientific procedure. Elements to be taken into account in calculating precautionary reference points include:

- use stock/population-specific data
- reproductive capacity
- the resilience of each stock
- characteristics of fisheries exploiting the stock
- other sources of mortality and major sources of uncertainty.

These are a guide for fisheries management and reflect the international communities' view of the level and ways that resources can be sustainably used. Annex II contains two types of precautionary reference points: target reference points and conservation reference point. Target reference points are intended to meet management objectives. Conservation reference points set boundaries to constrain harvesting within safe biological limits wherein the stocks can produce maximum sustainable yield (MSY). They reflect the minimum parameters that must be met for harvesting to be allowed. When precautionary reference points are approached they are to trigger pre-agreed conservation and management action. If a stock falls or is at risk of falling below a limit reference point, conservation and management action should be initiated to facilitate stock recovery.

So ... IF TURTLES WERE A FISH COULD THEY BE 'SUSTAINABLY USED' UNDER THE FISH STOCKS AGREEMENT? Can the turtle stocks produce MSY? Does this take into consideration other sources of mortality? Can this be assured within a precautionary framework? If not then conservation management action should be initiated to facilitate stock recovery. That is ... sustainable use would not be approved under the FSA.

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THE SEA TURTLE IN MAGICAL-RELIGIOUS BELIEFS OF THE WAYÚU INDIGENOUS PEOPLE: VENEZUELA *

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The native Wayúu have lived since the very beginning along the Caribbean Sea, and their settlements are found along Colombian and Venezuelan coasts. Without a definite nationality, they are simply called the "Wayúu". Through their strong relation with the sea, the Wayúu have integrated many marine elements within their magical-religious beliefs. Among those elements are marine turtles, which are considered as 'gifts' of God (Maleiwa) and that they are envoys to compensate for the lack of water and fertile ground. There is a great cultural tradition referring to marine turtles and the fertility in all their life aspects. Within their beliefs several rituals stand out: the sacrifice of animals for diet, where only a fisherman and his wife can intervene; placing skulls of marine turtles upon the plants to accelerate its fruiting, as well as on the doors of cattle corrals to stimulate pregnancy and birth of their offspring, similarly the way they use the penis with alcoholic beverages as an aphrodisiac, or feeding their domestic animals the discards of turtles so that they be long-lived. The native Wayúu also utilize the shells of turtles to 'bathe' young natives girls during the first night of sexual maturity, by storing water under the light of the moon to promote the skin health and fertility. Many authors suggest that the Wayúu ethnic group descends directly from the more important indigenous groups of South America, that they migrated and settled in different localities, prompted by nutritional necessities of subsistence. Their predecessors were very much bound to mountains, nevertheless, after the pre-Columbian time their inclination towards the Caribbean Sea was greater and, arising from there, great histories and beliefs associated with the Sea and its biota.

15 YEARS LATER - LESSONS LEARNED FROM THE COMMUNITY-BASED TURTLE-EGG HARVEST AT OSTIONAL, COSTA RICA *

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15 Years ago, a small group of local villagers and a few biologists proposed and defended a controversial project to allow the entire village of Ostional, Costa Rica, to collect and commercialize eggs from the Olive Ridley turtle (*Lepidochelys olivacea*). This is only government-sanctioned commercial turtle egg harvest project in the world. The local population was unprepared for the changes that came with the commercial success and the biologists were unqualified to predict the political and environmental effects of this endeavour. The bittersweet lessons learned along the way will, hopefully, better prepare future projects.

THE EXPLOITATION OF MARINE TURTLES IN THE ROMAN SALTED FISH FACTORIES AT THE STRAIT OF GIBRALTAR REGION: NEWS FROM CEUTA, SPAIN

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We present an interesting archaeozoology discovery made in the Spanish town of Ceuta. During an archaeological excavation in the city center, the remains of the bone structures of a marine turtle, *Caretta caretta* were recorded. The discovery took place on the bottom of a rectangular pool designed for salting fish. This pool and the other related structures were part of a huge Roman salted fish factory, which started its activities in the middle of the 1st century BC and remained active until the end of the fifth century AD. Actually, the bones correspond to the final stages of this Roman industrial complex. The presence of these turtle bones in the factory can be related with some classical writings which mention the exploitation of marine turtle and cetacean meat as raw materials in the production of salted fish.

“Septem Fratres, or Roman Ceuta, was on the African shore, across the Straits of Gibraltar, as part of a powerful industrial complex with some other settlements and the Iberian Peninsula. The factory was set up during the 1st Century a surface of about 35,000 m² representing one of the biggest in size, and demonstrated the strategic location of Ceuta and its importance in the capture of Tunis. The smooth slope of the north bay beach was chosen instead of the rough south bay suggesting the area was chosen to facilitate unloading the fish catches and place them inside the factory. ... These pools have changed little from the original Roman model. Usually rectangular in shape and coated with a material made out of ceramic fragments called ‘Opus Sininum’, the bottom is concave in order to facilitate cleaning. The remains of a loggerhead turtles (*Caretta caretta*) were found, representing the first evidence in this period. Archaeological studies point to the 5th Century as the date this turtle was placed inside the pool.”

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EVALUATION OF POSSIBLE NESTING AREAS FOR MARINE TURTLES ON THE COAST OF MAURITANIA

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In Mauritania there are at least four species of marine turtles at sea, but little is known about nesting areas and the nesting season, with just some isolated data on nesting activities in some places around the coast. The present work presents the results from an expedition to Mauritania in September 2002 for the study of a coastal area to the south of the National Park Banc D'arguin, using informal interviews and night patrols to determine turtle activity. Through this we found interesting information on nesting activities of *Caretta caretta* and *Chelonia mydas* in a defined area of about ten kilometers in a totally deserted region. Based on the data obtained in this brief space of time, as well as the collated information from the people on nesting activities, the studied area could be an important nesting site, although further studies are needed to verify this over the coming years.

RELATIONSHIPS BETWEEN MARINE TURTLES AND COMMUNITIES ON THE COAST OF MAURITANIA

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In Mauritania a great part of the population inhabits the coastal areas. This population is comprised of local people and nomadic fishermen which inhabit the coast during specific parts of the year. For both, the main feeding source comes from fishing, more or less artisanal in nature, although the nomadic populations also fish as like part of an organized business that sends the fish toward Nouakchot, the capital, where it is marketed. In the present study we analysed some of the relationships between the marine turtles and the communities from the south of the Banc D'arguin National Park, through data gathered with informal interviews and site visits to the local communities and nomadic encampments. Among the relationships we found were accidental fishing, and subsequent consumption of turtles (mainly of juveniles), as well as the direct capture of mature individuals in the process of nesting, and consumption by local residents. It is presumed the turtles form the only nutritious resource other than fish in the area.

ARE MARINE TURTLES VIRGIN? DOES IT MATTER? *

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Introduction

It is widely known, and celebrated, that marine turtles are ancient animals; it is less commonly appreciated that humans have been interacting with these marine reptiles for millennia. Moreover, the significance of this inter-relationship is rarely contemplated. This study summarizes evidence for the antiquity and complexity of the human-turtle interactions, and reflects on its significance, in terms of both biological and conservation endeavors.

Summary of Evidence for Human-Turtle Interactions

Zooarchaeology: Remains of marine turtles have been described from archaeological sites from around the world. In the Middle East, particularly the western shores of the Arabian (or Persian) Gulf, there are records of over a dozen sites, ranging in age from Ubaid (5500-4000 BC) to Dilmun (2150-1000 BC). In at least half a dozen of these sites there are relatively large collections of marine turtle bone associated with human remains or past cultural artefacts: in at least one case the turtle bones have apparently been interred with human burials. Additional records from the region include a Bronze Age (after 4000 BC) site in Israel, and a

9th century AD site in the Comores. In some cases the bones show signs of burning or cutting, strengthening interpretations that the turtles were hunted for food (Frazier 2003; in press).

Records of zooarchaeological remains of marine turtles in the Western Hemisphere are also numerous, particularly in the Caribbean basin. In just the southeastern USA there are more than 40 sites, on Caribbean islands there are over 30, and more than a dozen sites are in the Yucatan Peninsula and Belize. Along the coasts of South America there are scattered records in Venezuela, Brazil, Ecuador, Peru and Chile. Unlike the remains in Arabia, those in the Americas are rarely older than 2000 years, and relatively few sites have produced large collections. Signs of burning or cutting are found on turtle bones from various sites in the region. There are several reports of the remains of entire turtles having been buried, apparently for ceremonial or religious purposes. Cultural items fashioned from marine turtle bone and scute are known from various sites in south-eastern US, and also the Caribbean. Tortoiseshell items were traded into the interior of the North American continent – particularly Hopewell sites – well before Columbus. Marine turtle carapaces seem to have been used for shields by the Maya (Frazier, 2003; in press).

It seems to be virtually a rule that any Pacific island on which there has been prehistoric human habitation, there are also archaeological remains of marine turtles. This includes Melanesia, Micronesia, and Polynesia; and there are likely to be scores of documented sites throughout the Pacific. As in the Americas, bones and tortoiseshell of marine turtles have been fabricated into items used by various Pacific societies; fishing hooks made of tortoiseshell are a prime example, as is traditional tortoiseshell money (Frazier, in press).

The numbers and locations of archaeological sites with marine turtle remains are far more than what has been reported in the literature. Relatively few, if any, sites seem to have been reported from Africa, Asia, the Mediterranean, or South America; and further investigation is certain to show wider occurrence throughout tropical and subtropical coastal regions around the world.

Cultural Artifacts: In addition to ancient remains of marine turtles in archaeological sites, there is a tremendous diversity of prehistoric cultural artefacts that depict these animals in various ways. Representations of marine turtles are found in several sites in the Middle East, at least as far back as the Dilmun period. These include seals and engraved cylinders, notably from Saar, Bahrain, and there are also Mesopotamian artefacts such as ceramic stamps and wall reliefs from palaces of erstwhile rulers. Representations of marine turtles were common in ancient Greece, being found on coins, ceramics, and statues (Frazier, 2003; in press).

Cultural artefacts from the Americas, especially the Caribbean basin, include a wide variety of items, such as turtle effigies, masks, and ceramics. Turtles were of remarkable importance to the Maya, who represented these reptiles in diverse media, including ceramics, carved figurines, stone alters, stucco, parchment, limestone cliffs, and so on. The Mayan representations take on central importance, including the rebirth of the all-important maize God through a turtle shell; the God Pauahtun (the sky-bearer or world-bearer) who wears a turtle shell; the constellation ak ek' seen as a great turtle in the sky; the K'an cross on the celestial turtle shell, which is interpreted as the precise site where creation began; earth platforms and central alters; the physical form of the k'atun wheel, representing a unique and central unit of time - 20 years; and singular architectural elements in the roofs of various sorts of buildings. Not all of these representations clearly depict marine turtles, but some of them do. In South America marine turtles are represented in ceramics, petroglyphs, and other items (Frazier 2003; in press).

In the Pacific, marine turtles are found in iconographic representations, myths, and probably objects that did not survive the test of time. Although not “tangible evidence,” myths about turtles, evidently marine species, are found in many parts of the world (Frazier, 2003; in press).

Ancient Historical Evidence: In addition to physical evidence in the form of turtle remains and cultural artefacts, there is noteworthy evidence of ancient interactions between humans and marine turtles in ancient historic accounts. Cuneiform tablets from the Late Uruk (3500-3000 BC) and Ur III (2100-2000 BC) provide information that is clearly about turtles, some of it evidently marine species. Ancient Greek authors wrote about observed and mythical events depicting marine turtles. For example, Agatharchides of Cnidus (about 300 BC) clearly describes the hunting and use of marine turtles by different peoples, apparently in the southern Red Sea. One of the most impressive ancient sources documenting wide-ranging trade in marine turtles is the Periplus Maris Erythrae, written about 50 AD. This, and other sources, shows that by the beginning of the Christian Era a well-established network for international trade in tortoiseshell was highly organised and very active throughout the Indian Ocean. Additionally, there are diverse, 10th century AD accounts in both Arabic and Chinese, again showing the importance of tortoiseshell in international trade, from East Africa to China (Frazier 2003).

Implications of Ancient Human-Turtle Interactions

Based on three lines of evidence – zooarchaeological, cultural artifacts, and ancient historic accounts – there is no doubt that human societies and cultures have interacted with marine turtles for millennia. This leads to questions of how humans were affected by these interactions, and also how marine turtles were affected.

Have Humans been Affected by Marine Turtles? There is no doubt that humans have been impacted by marine turtles; the cultures of different societies with zooarchaeological and cultural artifacts make this patently clear. This leads to other, more

profound questions. Did turtles provide critical resources for human survival? Were food resources limited, such as on remote islands or arid coastlines, marine turtles could have provided a critical source of sustenance that enabled people to survive, at least over a critical period. Indeed, there are accounts of stranded Polynesian sailors living off of marine turtles. Given the capriciousness of history, if those people who survived went on to have an important influence on the development of human affairs, then the turtles would have played a fundamental role in human history.

Where marine turtles or their products have been an essential component in a human activity, such as trade and commerce, a related question arises: Did turtles provide critical resources for institutional development? The international trade network that was well-established by the time of Christ depended on a variety of products, of which tortoiseshell was evidently one of the most important. Hence, the history and development of human societies may well have links to ancient interactions with marine turtles. In other words, access to marine turtles may have enabled certain societies to develop institutions, which have affected the course of human history.

Have Humans Affected Marine Turtles? This question is routinely asked in conservation circles, for it is commonly held that marine turtles have been subject to intense exploitation, globally and historically. Archaeologists working in various regions have concluded that with the arrival of the first human colonists, marine turtle populations declined, sometimes dramatically. Evidence since the arrival of Columbus shows that humans, in various parts of the world, have overexploited marine turtles, resulting in dramatic population declines or even local extinctions of the reptiles. Recent analyses have evaluated the effects of these reductions in population size, and concluded that they resulted in cascading effects of ecosystem change, which can be traced to resource problems for contemporary societies (e.g., Jackson et al., 2002). This, and many other studies have at their core the “pristine myth” – that much of the world was pristine until European or post-industrial societies arrived (Frazier, 2003; in press).

And, at the simpler, species level there are other questions. Has the biology of marine turtles been affected by millennia of impacts, selective forces, from humans? Aspects such as seasonal and diurnal timing of nesting emergences, timing and duration of mating behaviors, and timing and conspicuousness of feeding and respiratory behaviors are likely to have been affected by human selective pressures. As a consequence, adaptations may have occurred in social and density-dependent relations of these animals, as well as in aspects of their physiology and anatomy. In a nutshell, the question is: Are today’s marine turtles – their biology, behavior, ecology, physiology, genetics, and other manifestations studied by biologists – the product of generations of interactions with *Homo sapiens*?

Conclusions

Marine turtles and humans have interacted for millennia; in some cases relatively large numbers of turtles seem to have been exploited. Diverse cultural manifestations of marine turtles are found in many prehistoric societies, and ancient historic accounts further emphasize the significance of these reptiles to prehistoric and ancient societies around the world. Marine turtles may have been instrumental in sustaining certain human societies, and they were evidently fundamental in the development and maintenance of certain human institutions, particularly regional trade networks. The course of human history may well have been affected by interactions with marine turtles.

Clearly, humans have impacted marine turtles significantly through intense exploitation, and resultant population declines. However, little attention has been paid to other sorts of impacts that humans may have had on these reptiles over the past millennia. There has been an unquestioned assumption that because marine turtles are part of an ancient fauna, their biology and ecology is completely “natural,” or virgin. Yet, human activities have produced some of the most significant selective pressures on marine turtles, and it is necessary to evaluate the various ways that marine turtle biology may have been directly influenced by humans. Marine turtles, like nearly every other large animal on the planet, are not virgin.

This leaves us with two general questions: Is zoological study deceived by the pristine myth? Is domestication the norm and not the exception? Both biologists and conservationists must think more objectively about the intellectual and practical implications of sustaining the pristine myth, rather than simply assuming that organisms that we deal with are virgin.

Acknowledgements

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INCENTIVES FOR CONSERVATION AND THE HARVEST OF SEA TURTLES IN SOUTHEAST MADAGASCAR *

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Sea turtles are harvested in Madagascar onshore as they nest and as a directed catch or bycatch at sea. Such exploitation is illegal under national law but the law is not enforced. In the southeast, both WWF and Azafady run projects raising awareness about the need for conservation, but in the absence of enforcement and because of concerns about possible negative impacts of a turtle harvest ban on local livelihoods, Azafady Project Fanomena has combined awareness-raising with employment of local assistants as an externally-funded incentive for turtle conservation, and are piloting ecotourism as a sustainable alternative to the harvest. Both WWF Madagascar and Azafady Project Fanomena support community development projects to build capacity for sustainable resource management. As a result of these projects, some villages have made dina (traditional written contracts) to protect sea turtles. However, adherence to conservation agreements varies from village to village. Individual decisions on whether to harvest or respect local agreements depend on the balance of incentives to harvest and conserve. Incentives to harvest include financial returns, meeting nutritional requirements or preference for turtle products. Incentives to conserve are related to the probability and consequences of detection when an agreement is broken, financial and other benefits from maintaining the turtle population and expectations of future benefits. A livelihood questionnaire, interviews with coastal residents, and surveys of harvest and trade are being used to investigate the balance of these incentives in different villages in southeast Madagascar with the aim of developing recommendations for a local sea turtle conservation strategy.

SEX RATIO OF THE NORTH CAROLINA SEA TURTLE PROJECT

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Background

The North Carolina Sea Turtle Project is a network of several hundred people dedicated to monitoring all sea turtle occurrences along the state's >500 km coastline. Activities include monitoring nesting beaches, excavating emerged nests, and salvaging dead or injured sea turtles. Although some federal and state employees work on the Project, particularly through state and federal protected areas, the majority of participants are local volunteers. Casual observation by the project coordinators (MHG and WMC) suggested that there were more women participants than men. We asked the following question: Are participants in the North Carolina Sea Turtle Project more likely to be women than men? We investigated the sex ratio of the participants of the project

Methods and Materials: We investigated the sex ratios on several different scales of the project. On a larger scale, we segregated the application forms submitted by volunteers each year into men or women. Overall, there were 116 applications from women, and 54 from men, a 68% female bias (Figure 1). On a finer level, we looked at a single volunteer group responsible for all turtle activities on Sunset Beach, in the southern end of the North Carolina coast. The overall ratio of women to men participants is 50:16, a 76% female bias (Figure 1). Because not all participants in the NC Sea Turtle Project are volunteers, we also looked at the beach coordinators (there are 22 management beach units in NC, each with a coordinator). Of the 22 coordinators, 15 are women (68% female sex ratio) (Figure 1).

Discussion and Future Directions: The results presented here are preliminary, and there are several factors not taken into account that could alter our results, such as actual hours worked by men and women. Nevertheless, using three different measures, we found that the sex ratio of participants is biased (68% female or more, depending on the scale). Note that the overall sex ratio for the whole state of North Carolina is 51% female (US Census Bureau, 2000 data). Therefore, we suspect that there are underlying social factors driving more women than men to become involved in sea turtle conservation.

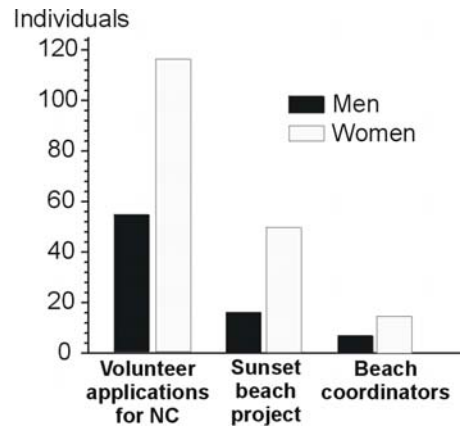


Figure 1. Gender ratio of volunteers

To further investigate the relationship between gender and conservation (Czech and Krausman 1999; Kellert and Berry 1987), we invite social scientists to investigate this interesting situation (as biologists, we lack training and expertise in this type of research). Other points of interest for investigation include variables such as age, race, employment, and familial relationships.

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WHO IS THE SEA TURTLE VOLUNTEER?

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Many sea turtle conservation projects around the world rely on volunteers for funding and labor. Conservation volunteers, particularly those that pay for their experience, are considered to be a specialized form of ecotourist. Although much has been written about ecotourists in general, very little attention has been paid to conservation volunteers. It would therefore be beneficial to better understand who the ‘turtle volunteer’ is, both to improve the ability of turtle conservation projects to attract volunteers and to enhance volunteer satisfaction. This presentation will explore the characteristics, motivations, expectations, experiences, and perspectives of a group of turtle volunteers. Results are based primarily on semi-structured interviews conducted with 17 volunteers (7 male, 10 female) working with Asociación ANAI in Gandoca, Costa Rica, from June to August 2002. Themes to be considered include environmental education, cost, integration with the local community, and cultural aspects such as communication.

MEASURING USE AND ITS IMPACTS IN THE REPUBLIC OF PALAU: SOCIAL AND BIOLOGICAL INTERACTIONS *

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Consultations with various stakeholder groups in Palau were conducted to explore important sea turtle use and management issues. Basic findings were that Palauan sea turtles are a highly valued, increasingly commercialized, and rapidly declining natural resource. Women reported that hawksbill turtle shell money (*Toluk*) is noticeably smaller in size than those produced in previous years, a possible indication of population decline. While subsistence and cultural uses remain important aspects of harvest of sea turtles in Palau, there is a perception that turtles are being hunted increasingly for economic benefit. Fishermen indicated the growing market for green turtle meat and turtle shell makes it very difficult for them to ignore the opportunity for quickly-earned cash. Concern was expressed about the increasing frequency and number of green turtles being transported from remote nesting areas to commercial centers for informal commercial sale. Tourist gift and jewelry stores now carry a wider array of hawksbill turtle shell products than ever before. While sea turtle resources are highly valued in Palau, long-standing management approaches have proven inadequate in terms of providing effective, sustainable management, and use of local sea turtle populations. Contributing factors to this condition include weak national interest to pursue stricter measures for sea turtle management, inherent difficulties with enforcement, and other problems linked to inhibiting social contexts. Despite these obstacles, there exist positive elements in contemporary Palauan society that may influence responsive and precautionary measures required to contribute to the recovery and the sustainable management of local turtle populations.

PROGRESS OF COMMUNITY-BASED TURTLE CONSERVATION INITIATIVES IN SRI LANKA

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Five of the world's seven species of marine turtle come ashore to nest in Sri Lanka. They are the green turtle (*Chelonia mydas*), the olive ridley (*Lepidochelys olivacea*), loggerhead (*Caretta caretta*), hawksbill (*Eretmochelys imbricata*) and leatherback turtle (*Dermochelys coriacea*). Despite the protection of sea turtles through government legislation since 1972, sea turtles are still being exploited by Sri Lankan fishermen for their meat and eggs. Coral mining, destruction of coastal vegetation (such as mangroves and sea grass beds), coastal erosion, non-scientific hatchery practices, uncontrolled tourism, some coastal development activities and accidental by-catch are the other key threats for sea turtles in Sri Lanka.

The Turtle Conservation Project (TCP) was established in 1993 to address the issue of marine turtle conservation through research, awareness, and community participation. TCP has initiated and conducted many community based conservation activities along the coastal belt of Sri Lanka in order to address marine turtles and their habitat issues. Major programmes such as community environmental education programmes, mangrove rehabilitation programmes, model medicinal garden and free herbal drink programmes, community library programmes, free English teaching programmes, nature trail programme, turtle watch programme, rural medical clinic programme, primary school programmes, school lecture programmes, environmental film show programmes have been successfully initiated between Kalpitiya (North west) and Kirinda (South east) of Sri Lanka with community participation. TCP continues its education and awareness programmes and is expanding the coastal sites, which were earlier not accessible due to LTTE separatist's movements.

THE HISTORICAL RELATIONSHIP BETWEEN PEOPLE AND TURTLES IN SEYCHELLES

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Historically, sea turtles have played a critical role in the economy and traditions of the people of Seychelles since the islands were first discovered in 1609 and permanently settled in 1770. They have always been appreciated for their nutritional value, but also as an important source of foreign exchange. Since the 17th century, hawksbill shell was exported to Europe and since the 1960s to Japan. Green turtle calipee was exported in quantity to Britain during most of the 20th century. Since 1994, however, the Seychelles has provided complete legal protection to her turtle populations, and now values live sea turtles as a source of foreign exchange by providing a natural tourist attraction.

AN ASSESSMENT OF THE TRADITIONAL HARVEST OF TURTLES IN THE DAMPIER PENINSULA REGION OF WEST KIMBERLEY, WESTERN AUSTRALIA *

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Marine turtles play an important cultural, spiritual and economic role in the lives of coastal indigenous people in northern of Australia. As an action in the draft recovery plan for marine turtles in Australia, this study examined the extent of the indigenous take in the Broome / Dampier Peninsula area of the West Kimberley, Western Australia. Community members were consulted from 10/01 to 09/02 and provided information on the number of turtles taken, species, size, sex, number of families involved and the hunting time, tagged turtles and information on egg harvests. At least 209 turtles were taken by the four major communities. This is probably underestimated as there are several smaller communities and family groups that reside on the Peninsula that were not included in this survey. Two thirds of those turtles taken were female *Chelonia mydas*. Over half were taken by members of the One Arm Point, the largest indigenous community on the peninsula. Six tagged turtles were taken during this period, confirming that turtles being exploited in this area nest throughout the north-west shelf green turtle stock range.

We will extend this study to other parts of the north-west and Kimberley coasts and the larger indigenous communities, to get a better understanding of the total extent of traditional harvest in Western Australia, to be put into perspective in relation to indigenous harvest across the remainder of northern Australia and other causes of mortality, and as an integral part of any modelling undertaken of green turtle stocks in Western Australia.

BELIEFS AND PERCEPTIONS ASSOCIATED WITH SEA TURTLE PRODUCTS IN THE DOMINICAN REPUBLIC

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Introduction

The conservation of biological species is known to be intimately linked to cultural aspects. The motivations for the consumption, veneration, or rejection of certain species are often rooted in beliefs and traditions of local people. Sea turtles have a particularly long history of use in Hispaniola (the island currently shared between the Dominican Republic and Haiti). Before the arrival of the Europeans to Hispaniola, sea turtles were a prominent element in the existing native cultures, namely the Taíno.

The use of sea turtles has continued to this day in the Dominican Republic, particularly of hawksbill turtles, which are utilized for their meat, eggs, shell, and other products. Recently, Stam and Stam (1992), Dominguez and Villalba (1994), Fleming (2001), and Marte et al. (2002), have documented the on-going (albeit illegal) sea turtle trade in the Dominican Republic. Preliminary information revealed that certain sectors of Dominican society attributed medicinal and magical powers (for santería practices) to sea turtle parts and products. The objective of the present study was to go beyond the mere documentation of trade by attempting to understand the motivations and beliefs held by locals and foreign tourists that are responsible for sea turtle demand, particularly that of hawksbills products.

Methods

Three types of surveys were developed for data collection, these were aimed at 1) tourist souvenir shop managers and shopkeepers, 2) knowledgeable or key informants about sea turtle trade, and 3) college students. A fourth survey instrument had been developed for foreign tourists, but could not be implemented, given the limited amount of time tourists spend in the shops (particularly cruise-ship tourists) and the intense competition of salespeople to attract their attention. Instead, tourist preferences for tortoiseshell products were assessed via informal conversations with two experienced tourist guides. Twenty souvenir shops were surveyed in the Colonial City area and at Mercado Modelo, the main crafts market in Santo Domingo. The collected data included the presence of tortoiseshell items, preferred items, prices and buyer nationality. In addition, we conducted 15 interviews with knowledgeable informants comprising fishermen, traditional herbs and potion shops' salespeople, lawyers, biologists, anthropologists, and a taxidermist, among others. To assess popular knowledge about hawksbills in young people (products and parts used, purpose, and associated beliefs), we interviewed 49 college students at Universidad Autónoma de Santo Domingo. Eighty-two percent of the college students were younger than 20.

Results and Discussion

Tortoiseshell items were found in 85% of the shops surveyed. The most commonly found articles were jewelry boxes, bracelets, hair combs, rings, handbags, earrings, picture frames, serving trays, necklaces, souvenir spoons and forks, and cigarette boxes. No dissected specimens or whole carapaces were seen on display. However, we were able to spot a dissected hawksbill head (possibly sold as a book end) in a box being packaged by a store employee.

Most souvenir shop employees did not want to talk openly about tortoiseshell demand, even though it is prominently displayed. However, in six shops we were told that the most popular items were handbags, followed by bracelets, and jewelry boxes. In general, souvenir shops stated that most of their sales came from items made with larimar stones, amber, haitian paintings, ceramics and wood figures. With respect to the nationality of the majority of tourists that purchase tortoiseshell, we also received very few answers. Puerto Ricans were mentioned twice, followed by Spaniards (1) and Italians (1). One interviewee said that in the past, Japanese tourists used to be the main group.

Many shopkeepers said that they had been forced to lower tortoiseshell prices because it was illegal, and that they were allegedly phasing out this merchandise. Some were also aware of the fact that many of these items are confiscated upon arrival to the tourist's country of origin. In spite of this, they said that there is always a supply of raw shell for making more crafts. Many of them expressed rage at sporadic merchandise raids done by the Dominican Navy and/or the Ministry of the Environment. During our surveys, a popular Dominican TV host appeared on a national entertainment award ceremony (the Cassandra awards) wearing a dress made entirely of tortoiseshell pieces. The dress and its origin received considerable media attention, and the authenticity of the shell has not been well established (after an initial statement that it was real carey pieces, the designer has lately said it was made of plastic imitation). In any case, many shop keepers expressed anger at this woman for stirring up the authorities interest on controlling tortoiseshell again.

Informant surveys revealed that the hawksbill's meat, eggs, penis, blood, fat/oil, shell and heart have a known history of use in the Dominican Republic. The meat is particularly regarded as great-tasting and nutritious. Commonly, fishers refer to it as a "red meat", constituting a welcome variant in their almost exclusive diet of fish. In the South, sea turtle meat is still often cured in salt and dried by adding ashes to it. Sea turtle eggs were commonly mentioned, and are also considered to be very nutritious. Raw eggs are sometimes taken with honey to "strengthen the brain" and to combat anemia. In addition, sea turtle eggs in general are considered as aphrodisiacs. Both meat and eggs appear to be consumed locally in coastal towns and villages.

Besides tortoiseshell, the hawksbill's penis was the main hawksbill trade product mentioned. Allegedly, it is dried and grated or chopped up to be introduced in a rum drink known as mamajuana or damajuana. Mamajuana bottles are sold in many craft markets, and they include other leaves and dried spices that can be used on repeated occasions to flavor rum after it sits in the bottle for some time. The addition of hawksbill penis is optional as an "extra" for aphrodisiac purposes. Informants said that hawksbill penis is sold by the inch, at approximately RD\$100 (about US\$5). Recently, a newspaper article also revealed that grated dried hawksbill penis can be added to cocoa, beer or juices to "heighten both male and female sexual potency" (El Día 2003). However, it is probable that currently, given the depletion of hawksbills in the country, the market is flooded by fake hawksbill penises. Certain fishers have confessed substituting dried bull penis or snook's swim bladder for hawksbill penis to cure sexual impotence, because most people could not tell the difference (pers. comm. to YML, 1995). Nevertheless, the strong aphrodisiac beliefs associated with the hawksbill penis are of concern.

Sea turtle fats and oils are used in the manufacture of skin lotions to eliminate skin marks and wrinkles, “calm nerve pains”, arthritis, fatigue and the common cold. Hawksbill blood is also believed to cure arthritis among some fishers. The use of the hawksbill’s heart seems to be restricted to fishers from the Pedernales Province (in the southwest). These fishers believe that if they eat this organ (raw or boiled), their own heart will beat faster when a new hawksbill will come out to nest, and therefore they will have a lead into where and when this happens so they can catch it. Tortoiseshell is not only used in ornamental crafts, but is also utilized in making spurs for cock fights, guitar picks, and santería (magical-religious practices) rituals. For santería purposes, hawksbill carapaces are placed in altars with lit candles on top. An informant expressed that tortoiseshell can also be grated and added to mamajuana bottles.

With regards to green and leatherback turtles, informants declared that their meat, fat and eggs are utilized, however, unlike the hawksbill, their penis is not an aphrodisiac. One informant added that leatherbacks are infrequently harvested at present, because the large amount of meat produced (over 600 pounds) cannot be easily hidden from authorities. No data was obtained this time on the local use of loggerheads, however, one of us (YML) had heard in 1995 that their eggs were highly desirable, although their meat had a “funny taste” that was not favored by fishermen.

From our conversations with tourist guides, it seems that foreign tourists are not actively intending to buy tortoiseshell items. They explained that, in the past (allegedly 20 years ago), Spaniards used to buy a lot of tortoiseshell items, but not anymore. Puerto Ricans were another group mentioned, particularly seeking mamajuana bottles containing hawksbill penis. The tour guides indicated that foreign tourists know that tortoiseshell and black coral are illegal, and therefore do not buy it. On occasions, they are said to act offended when such merchandise is offered to them, because they don’t like the killing of animals. A tour operator specializing in German tourists said that these visitors are given a list of illegal items, which includes tortoiseshell, and they are very careful not to buy any of it. Most students surveyed agreed with statements saying that tortoiseshell crafts were attractive to buyers because it was beautiful, different, and exotic-looking. The majority knew that tortoiseshell came from sea turtles, however some (3) said it came from a seashell, while others (6) did not know the source (note: this is not as evident as it may seem, since in Spanish, carey, the name for tortoiseshell crafts, does not indicate that it comes from a tortoise or turtle). A similar confusion in the origin of tortoiseshell was manifested to one of us by a Spanish tourist, whom expressed the belief that her carey necklace was made from a Dominican seashell (YML pers. comm., 1998). But most importantly, many students seemed unaware of the poor conservation status of hawksbills in the region. Fifteen students believed that it was an abundant species, while 16 did not know.

The recent assessment of sea turtle trade in Central America (Chacón 2002) provided a wonderful comparison framework for our results in Dominican Republic. Many striking similarities were found between Chacón’s findings on popular beliefs associated with sea turtles and those of our study. For example, in both studies the use of hawksbill meat, fats/oil, carapace, tortoiseshell, eggs and penis was widespread among the local population. The shared popular belief that the hawksbill turtle’s penis (mixed with rum) and sea turtle eggs have special aphrodisiac powers, was also noteworthy. Also, both studies report medicinal powers for the oils and fats derived from sea turtles. These findings indicate that local beliefs associated with sea turtles, and particularly hawksbills have strong roots in the region, which share a common Afro-caribbean ancestry. These widespread popular beliefs may constitute a greater obstacle for sea turtle conservation than it was previously believed. From our limited souvenir shop interviews, it seems that foreign tourists are not currently buying many tortoiseshell items. Thus, it is possible that the shops are over-stocked with old material; many shop owners complained that tourists nowadays are only interested in t-shirts and inexpensive souvenirs. However, Marte et al. (2002) found large quantities of raw shell in many of the shops’ storage rooms. Even if shopkeepers are not buying raw shell anymore, it is possible that it will take a few years for their stocks to deplete. Given the relatively high price of tortoiseshell items, even if sales are low, it might still be profitable for shops to continue carry them.

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THE TRADITIONAL, CULTURAL USE OF SEA TURTLES BY THE YOLNGU/DHIMURRU ABORIGINES OF NORTHERN AUSTRALIA

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Sea turtles have long been an important natural and cultural resource to the Aboriginal people (Yolngu) of north east Arnhem Land in northern Australia. Western science dates Aboriginal occupation of northern Australia as far back as 40 000 or even 100 000 years, while Aboriginal people believe they have occupied the land since the creation beings first formed the landscape and bestowed law and knowledge. Regardless of differences in interpretation of the past, the association between Aboriginal people and turtles is a long one and has led to a rich culture of law, ceremony, oral history and detailed traditional ecological knowledge about turtles. Looking after sea turtles through the management of hunting and egg collection and the practice and performance of rituals, dances and songs remain an important aspect of contemporary environmental management by coastal Aboriginal people.

Yolngu have initiated a sea turtle (*miyapunu*) project that combines traditional knowledge and law with contemporary scientific methods to develop a miyapunu management strategy. Yolngu view the cultural conservation of turtles (the songs, stories, hunting and ceremony) as inseparable from the biological conservation of turtles. Through the miyapunu project and engagement in numerous national and international conservation and management fora, Yolngu play a vital role in the development of a marine turtle management strategy for northern Australia.

BEDAWANG NALA: TURTLE SUSTAINER OF LIFE ON EARTH *

Putu Liza Kusuma Mustika, Ngurah Mahardika, and Windia Adnyana

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For centuries sea turtles have inspired many coastal communities on Pacific Islands, Africa, America, and Asia, and Indonesia. Ancient Balinese in Indonesia represented sea turtles in the form of Bedawang Nala or Kurma Avatar, God Vishnu's incarnation as a giant turtle supporting the world. The creature is placed in the base of main temple shrines in the Island of Gods. Philosophically, turtles are considered to be sustainers of Life on Earth.

In Bali, the sacred aspect of sea turtles is raised as one of the key messages in consumer campaigns, aiming to raise their awareness and participation in sea turtle conservation on the island. WWF has included the mythology in several traditional art performances such as bondres (traditional comedy-satire), arja (traditional opera), and wayang Bali (Balinese puppet show). It has been proven many times that these communication channels have been effective in spreading conservation messages. Some Balinese artists have adopted turtle conservation as a way of life. They have been actively spreading the turtle conservation message by means of traditional performances with or without formal cooperation from WWF.

This paper describes and discusses the indigenous values of sea turtles among Balinese and Hindu followers in Bali. It will explain also the role of local artists and Hindu high priests in promoting sea turtle conservation issues in the Island of Gods.

**THE PERCEPTIONS OF LOCAL COMMUNITIES ON MARINE TURTLE CONSERVATION IN EAST AND WEST
NZEMA-GHANA**

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Marine turtles thrived in the topical and sub-tropical oceans from the time of the dinosaurs more than 1,000 years ago until present. Today, they are found in warm and temperate seas throughout the world. There are only five species of marine turtles occurring on the Ghana coast. Out of these only three species visit the coast regularly: *Lepidochelys olivacea*, *Chelonia mydas* and *Dermochelys coriacea* all of which are listed as endangered on the IUCN Red list. However, almost all the species are hunted for food and other traditional purposes in Ghana. In this paper we present the perceptions of local communities living in the Amanzuri area of the Nzema East and West districts of Ghana on the conservation of the species vis-a-vis the local needs.

**POPULAR BELIEFS ABOUT SEA TURTLE PRODUCTS AND METHODS OF HAWKSBILL CRAFT
PRODUCTION ON THE CENTRAL AMERICAN ISTHMUS**

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This study was carried out in the Central American region between 2000 to 2002. The first inhabitants of this tropical region showed great interest in and gave special importance to sea turtles. At present, much of the cultural heritage involving sea turtles is based on oral story-telling; that is, tales and legends passed down from one generation to the next. The most notable themes emphasize aphrodisiacs and luck qualities, protection against evil and culinary merit.

Meylan (1999) notes that indigenous people of Yucatán Peninsula (Mexico), Gulf of Honduras, and the Misquito Coast of Nicaragua hunted hawksbill turtles with observations based on data from 1517, 1666 and 1722. The hawksbill population in Central America has declined and one of the most harmful impacts is the hunting for turtles to obtain the keratin plates of the carapace, primary materials in the handcraft industry, and to export these illegally to other countries (Chacón 2002).

During this study it was possible to document the ancient techniques that the local villagers used to produce the hawksbill handcraft and particularly the specific powers that everyone attributes to each turtle shell piece. The whole production process is presented using pictures from a 40 years experience local artisan in Bocas del Toro, Panama.

The data indicates for the first time in the region all aspects of the production and the local trade in hawksbill products, with an emphasis on Central America, including the types of items and their respective prices in different countries of the region.

ASSESSING THE SOCIO-ECONOMIC VALUE OF MARINE TURTLE USE IN THE UK OVERSEAS TERRITORIES IN THE CARIBBEAN: METHODOLOGICAL CHALLENGES *

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Multidisciplinary, participatory, and regional approaches are all components of 'new' conservation. Turtles in the Caribbean Overseas Territories (TCOT) is a UK Government funded project using multidisciplinary and participatory approaches to assess the status and exploitation of marine turtles in the UK Overseas Territories in the Caribbean, and to make recommendations for improved policy and management. It is undertaken in response to the CITES Hawksbill Turtle Range State Dialogue process. As part of TCOT, levels of use (consumptive and non-consumptive), the role use plays in local economies and cultures, and stakeholder views on management options are all being assessed. The methodological challenges for doing so in a comparative manner across six different territories, through diverse in-country partner organizations and individuals (including field scientists, administrators, NGO's and enforcement officers), and with a multidisciplinary research team are considerable. Based on a one-week workshop with representatives from all OT partner organisations to develop research tools, and on preliminary fieldwork in Turks and Caicos Islands and Anguilla, this paper discusses the challenges of participatory, multidisciplinary research in a diverse region, and the implications of this approach for the accurate assessment of levels and values of use. In doing so, the opportunities and challenges associated with 'new' conservation in general are considered.

ARTISANAL AND SUBSISTENCE USE OF GREEN TURTLES IN COASTAL ARABIA- IMPACTS AND IMPORTANCE *

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An artisanal fishery for green turtles around Masirah Island, Sultanate of Oman, was monitored between 1978 and 1981. Collection of eggs of both Green turtles and Loggerheads was also recorded. The cultural justifications for this activity are complex and relate to seasonal patterns of agriculture and fishery activity. The impact of this use on sea turtle populations was judged to be negligible but the nutritional importance of this activity to local people was significant. A conservation program, including complete protection of nesting turtles and reduction of egg harvest was successfully developed at this location. The incentives, benefits, costs and structural requirements to balance human needs and sea turtle population conservation are discussed.

SEA TURTLES AND THE INDIGENOUS CULTURE OF PALAU *

Bilung Gloria Salii

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The Republic of Palau comprises the western-most Micronesian islands lying seven degrees north of the equator equidistance between Papua New Guinea, Guam, and Mindanao (Philippines). Despite one hundred years of colonial rule, Palau retains a strong cultural tradition. It is a matriarchal, matrilineal society in which women are the guardians of the clans and responsible for selecting and supporting chiefs. Sea turtles (hawksbill and green turtles) play a special cultural significance distinguishing them from other sea creatures. Sea turtles feature prominently in Palauan songs, dances, chants, and myths. In pre-contact times, turtle flesh was the only source of red meat available and turtle eggs were also a greatly prized food. The hawksbill shell is traditionally

carved into shallow bowls called ‘toluk’ circulated during cultural events by and among women as “women’s money”. Their exchange brings social status to giver and recipient alike. Parts of the shell not suitable for toluk are carved into highly valued ornaments. In another important ritual, the Paramount Chief of Palau (the Ibedul) washes his hands in the blood of a turtle before assuming his title.

Traditionally sea turtles were recognized to be both a special and scarce resource. Chiefly permission was required before their harvest. Permission was granted only for special occasions and thus our islands enjoyed a high turtle population. Today, hunters no longer seek chiefly permission before hunting turtles. While turtles are still consumed communally at cultural events, they are also killed for household food consumption. Their flesh and shell are sold in urban shops to locals and tourists. As a result, turtle numbers have declined. Fearing local extinction unless action is taken, the chiefs and women of Palau are working closely with the Palau Conservation Society to educate the community about sea turtle conservation. New management strategies are being enacted to ensure that our children’s children will continue to practice our cultural traditions that so prominently feature sea turtles.

MARINE CHELONIAN ILLUSTRATION: A SHORT HISTORY OF *ERETMOCHELYS*

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Illustration has always played an important role in biological documentation, even serving as type specimens as Gray’s *Chitra indica* as that species’ neotype. With photography, fewer illustrations are drawn, but it remains an important teaching/documentation tool, more easily reproducible than photographs. From cave art onward, it is an art form with styles and techniques undergoing evolutionary phases. Woodcuts advanced to copper and later steel engravings. Hand-coloring progressed to chromolithography (true color printing). Other media was likely utilized, but the earliest surviving zoological illustrations are first seen on cave walls and later in Babylonian clay seals or Egyptian palettes/tablets. Images do not always document scientific fact and may be exaggerated or enhanced. While sometimes inaccurate, interpretation of organisms is equally important. Early images sought appeal with symmetrical unrealistic poses and contexts. Particular designs were dictated as religious mores provoked stylized models. Not all early works were inaccurate, but the 1800s were a turning point in zoological illustration, scientific method being coupled with vivid realism and hand-coloring. Images were widely plagiarized (detail deteriorating in subsequent appearances) or drawn from descriptions rather than living specimens - giving credence to inaccuracies, myths and errors. The late 1800s saw more works written for public appeal with common animals seen new and differently. Marine chelonian illustration’s evolution can be seen from Gesner (1617) to Sowerby and Lear (1872), whose turtles perhaps represent the pinnacle of chelonian illustration. This study includes *Eretmochelys* alone (with some early non-species specific images) to allow marine chelonian illustration’s evolution to be easily followed and contrasted. Wide distribution and interest in “tortoiseshell” focuses additional attention on this genus in natural history texts.

1600: The first illustrations of marine turtles are found in cave art (Rodriguez, nd), some being incredibly lifelike. Other early depictions are found in Babylonian clay seals (Olijdam, E. 2001). But the art form gained wide distribution in the woodcuts of the earliest printed natural history works. Gessner’s work (1620-1621) was illustrated with hundreds of woodcuts and both volumes contain herpetological sections. Considered the father of modern zoology, his work laid the foundation for scientific terminology standardization, listing the equivalent names of animals in a dozen languages. He combined classical and medieval literature, added his own observations to those of correspondents, and organized the entirety in a precise systematic manner. With the added dimension of woodcuts, he produced the first illustrated work covering the entire animal kingdom, providing animal models that would be copied for centuries. Its influence was to continue for two centuries through the numerous reprinting and translations (Adler, 1989). The art advanced to copperplate engravings in the great encyclopedias of the 1600 and 1700s. Some of Linnaeus’s new species were based on the works of Jonston (1660) although both his and Aldrovandi’s descriptions were largely based upon Gessner. Comparative anatomical works had begun at this time with the work of Redi and his student Caldesi (1687) who published an work on turtle anatomy. He distinguished the two auricles in the heart, and included finely engraved plates with detailed illustrations of the external and internal anatomy of marine, freshwater and terrestrial turtles.

1700: Seba (1735) brought the art to a new level with a work including a series of stunning folio and double folio natural history prints. These copper engravings, often hand-colored, are the most dramatic natural history prints of this time, produced with as much concern for their aesthetic appearance as for their scientific accuracy. Seba, like others of his time, was a collector of curiosities, which were illustrated in his work. In 1712, Mark Catesby, an English-born artist-naturalist embarked on two scientific expeditions to the southeastern U.S. that would ultimately result in the first major work on North American zoology.

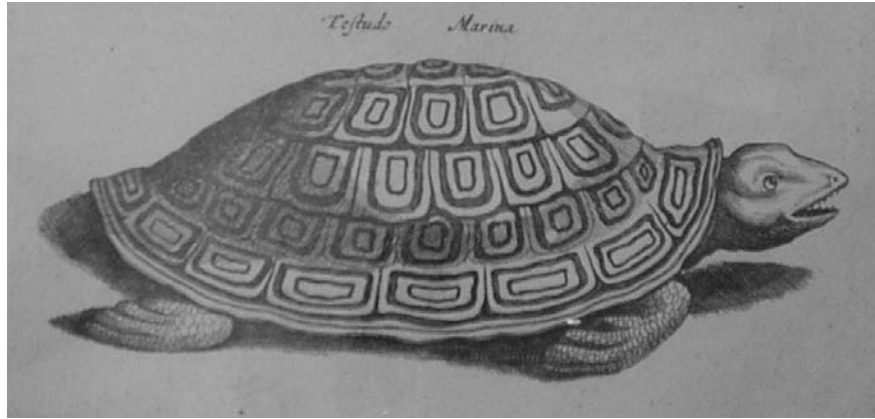


Fig. 1. Jonston (1660)

Lacking funds to hire engravers, Catesby (1743) personally translated his watercolors into 220 plates. He included descriptions of plants and animals in English and French, providing Europe with first glimpses of the New World. Linnaeus used many of Catesby's drawings, specimens and text in *Systema Naturae* 10th edition (1758) which laid the foundation for today's system of binomial biological taxonomy. Edwards (1748) produced his impressive volumes almost single-handedly, accomplishing the illustrations upon which the prints are based, writing the text, etching and coloring the plates of colored editions. It's interesting to note that Catesby taught Edwards to etch the copper plates for his own natural history books. Edwards incorporated some of Catesby's style in his drawings and text. The trend of copying older illustrations found new outlet in the new popular natural histories, evident in Anon (1754), which clearly was heavily influenced by Edwards, a trend which continued into the 1900s. Knorr (1760-1773) was an important intermediate between the natural history "cabinet" collectors and those using these specimens for identification, assembling one of the illustrated German natural history books of its day with plates hand-colored at publication. Drawings were made after actual specimens rather than from memory or plagiarism. The extraordinary quality of the plates represents the continuation of Dürer's scientific investigations.

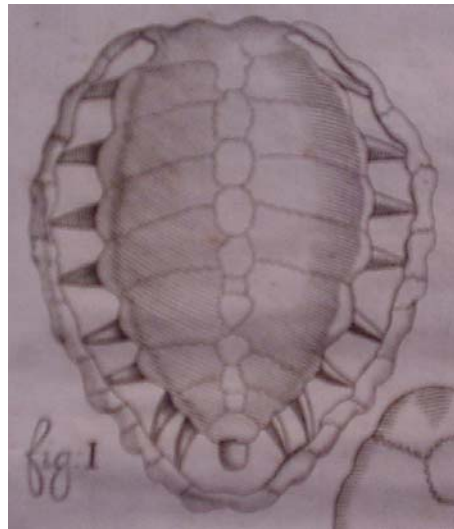


Fig. 2. Caldesi (1687)

The Comte de Lacépède was professor in zoology (reptiles and fishes) at the Paris Museum of Natural History. Accepting Buffon's invitation to contribute to his series, Lacépède (1788) added to substantially by writing the chapters on what would become his major herpetological opus (Adler, 1989). He compiled the work of a number of other authors including Gmelin and Bonnaterre utilizing woodcuts and copper engravings. Subjects were depicted in their "natural surroundings" such as the temples, pyramids and landscapes, (after artist De Sève). Early editions were uncolored copper engravings with later enlarged editions often hand-colored. Bonnaterre (1789) made major contributions to this art and science. The German polytechnical movement led Bertuch (1798) to produce teaching materials, stressing the usefulness of natural history for non-naturalists. This popularization,

reflected in his plates, propagated the sciences for systematic and methodical nature study, opening it to a wide range of participants who could contribute to and benefit from the production of knowledge.

1800: Academic endeavors also proliferated during this time, especially in France. The 15th to 18th century voyages of discovery brought Europe vast numbers of specimens of new species and Paris remained the center for herpetological studies into the 19th century. Daudin (1801) was the most comprehensive of those works (Haines, 2000). He produced an extensively illustrated (colored & uncolored) herpetological work, on which his reputation rests. It was the standard herpetological reference of its day (Adler, 1989), due primarily to his personal examination of triple the specimens examined by Lacépède. Latreille (Sonnini & Latreille, 1801) primarily wrote the text, which covered herpetofauna worldwide in the Déterville edition of Buffon's encyclopedia, with 54 hand-colored plates. Its importance justified a new edition in 1826 (Adler, 1989). But Cuvier (1827) was the most influential exposition of the typological approach to animal classification to date; representing the greatest body of zoological facts yet assembled. It served as the standard zoological manual for most of Europe during the first half of the nineteenth century (colored & uncolored steel engravings). In Germany, Buhle (1829-35) and Schinz (1855) presented extensive works with lavish illustrations in colored and uncolored editions. In the U.S., Holbrook (1840) completed the first real treatment of American herpetology with highly detailed hand-colored engravings. Shaw (1802) represented the first global English

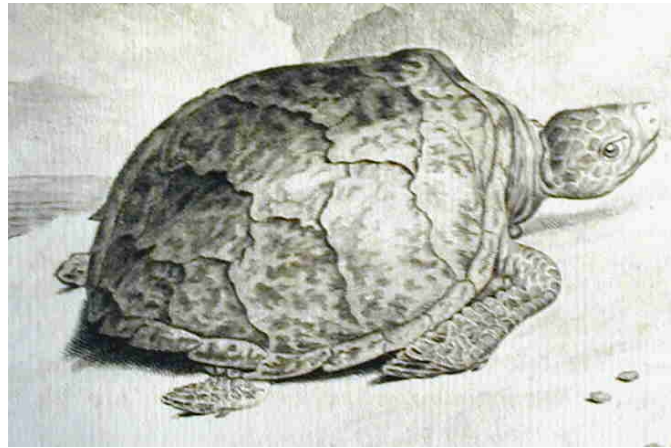


Fig. 3. LaCepede (1788)

herpetological review. A founder of the Linnean Society in 1787 and one of the most prominent and prolific naturalists of the late-18th - early-19th centuries, he was curator of the British Museum's zoological collection, beginning a long tradition of herpetology there, where he worked for much of his life. His work is a development of Gmelin's system, augmented by species taken from Bloch and Lacépède (Pietsch, 1995) with most figures copied from them. And Gray (1870) began the trend toward monographs and order specific (chelonian) works. The epitome of chelonian illustration was arguably represented by the unfinished work begun by Bell and completed (in graphical form) by Sowerby and Lear (1872). Regional works (Boulenger, 1890) relied heavily on accurate scientific illustrations. Although Goldsmith's first edition appeared in London in 1774, illustrated with copper plates, (many used in later editions), it gained greater acceptance in numerous reissues. It sought to draw together all that was known about the world, its plants and animals described from a biological perspective. He drew most of his information from other naturalists' work, first planning to translate Pliny's Natural History and then, after reading Buffon, deciding to write from his own feelings and to imitate nature. Lacépède (1832; 1836) too, re-emerged many times during the 1800s, with engravings of wood, copper and steel or lithographed, and often hand-colored or finished. Reissues of these works paved the way for the trend toward popular natural histories begun by Bertuch. Some even listed the original writer as author (Goldsmith, 1825) or in the title (Monlau, 1854). Popular natural history encyclopedias (Rees, 1820; Hutton, 1821; Bromme, 1867; Figuier, 1869; Meyers, 1885; Brockhaus, 1885) appeared at this time. But perhaps the most prolific of these are attributed to Brehm (1878) and Kingsley (Kingsley, 1885; Kingsley and Breck, 1890;) and Lydekker (1896) who produced a variety of editions and reissues, sometimes including similar or entirely different plates between and amongst themselves.

1900: Popular natural histories (Haeckel, 1904) continued into the 1900s. Brehm and Lydekker continued to revise and reissue utilizing a mix of earlier technologies and styles including wood, steel and copper engraving, lithographs and chromolithographs and the new technology of photography. Regional works also continued with Smith (1931) updating the earlier work of Boulenger (1890) in India and Deraniyagala (1939) in Ceylon. Some regional works dealt with a single order (Bourret, 1941) capitalized both on engravings and photography.

Conclusion

Early works were general in nature including simple illustrations, over time evolving in complexity. Accordingly, as the images became more detailed, textual material did the same with a greater number of monographs and regional works appearing. With

the advent of photography, fewer “artistic” illustrations were produced in popular publications, the very venue which drove this process initially. Although photographs became more important to scientific works, line drawings never diminished in value or frequency. The process has come full circle with line drawings being utilized as explanation for photographs in Wyneken (2001).

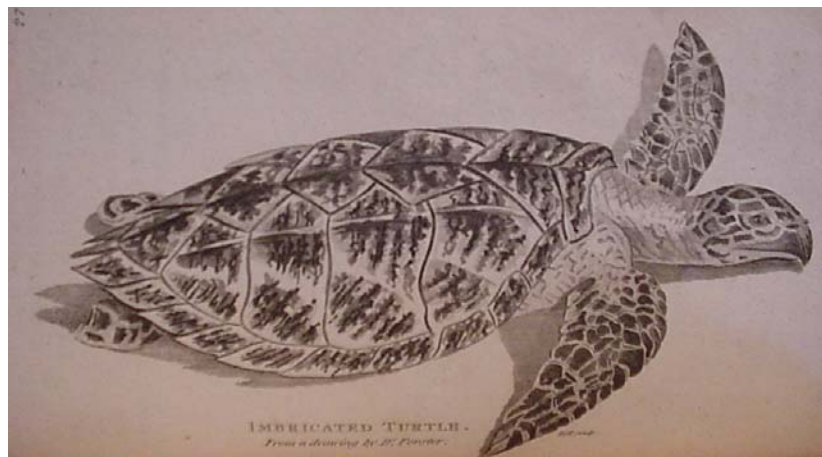


Fig. 4. Shaw (1802)

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SEA TURTLE TRADITIONS IN SERI CULTURE: PAST AND PRESENT *

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The Seri, or Comcaác, of the Sonoran coast and islands of the Gulf of California, Mexico, are one of the last groups able to withstand integration into western-derived cultures. The tribe has traditionally relied on sea turtles as both the food and cultural foundation of their communities. The center of the Seri territory is the Canal Infiernillo, a narrow channel separating Tiburón Island from the coast of northwest Sonora. Populations of sea turtles, particularly green turtles, were historically abundant and the focus of organized turtle hunts and traditional ceremonies. Such events served to strengthen the cultural bond within Seri communities and provided opportunities for the teaching of traditional knowledge to the younger generation. Over the last four decades, however, sea turtle populations in this region have experienced tremendous declines. The result has been a gradual shift away from reliance on sea turtles. Today, Seri-sea turtle interactions are complex: turtle-based ceremonies and tribal activities that embrace sea turtles continue on occasion, but the problem of illegal capture for sale to outside markets has grown. A recently formed Seri Turtle Group is currently working toward preventing these illegal activities. Further, the Group works with scientists on ongoing research and monitoring projects in the Seri territory. This presentation details the Seri-sea turtle interactions starting from pre-Columbian times to present day and discusses the successes and failures of conservation efforts that have been undertaken in the region.

TURTLES ARE OUR FRIENDS *

Yalap Yalap

Palau Conservation Society, P.O. Box 1811, Koror, Koror PW 96940

The Palau Conservation Society undertook a ‘A Uel a Sechlid’ (Turtles are our Friends) conservation education campaign modeled after the RARE Center for Tropical Conservation methodology of promoting protection through pride. The process conducted stakeholder meetings and gathered notes on biological facts, traditional use and local knowledge from hunters and fishermen young and old. A survey was conducted to assess knowledge of existing regulations, behavior and attitude. A consortium of related agencies worked together in visiting all 27 primary and secondary schools in Palau. Interactive presentations were made with puppet shows, turtle costumes, children singing turtle songs and distribution of fact sheets, posters, stickers and badges to a total of 4027 students. Of all the students, 57% or 2295 signed a petition to the National Congress calling for a moratorium on sea turtles in Palau. Following the school visits, community visits to all 16 States were undertaken. There were a total of 24 presentations, modified depending on the village. Fact sheets, stickers, and posters were distributed again. Local villagers’ knowledge was reviewed and related to known biological facts. Local villagers agreed that sea turtles, especially hawksbills and greens, were declining in numbers. A consensus from most villages urged the halt on turtle take. A resolution from the 9th Annual Women’s Conference in Palau was passed to the National Congress calling for the moratorium on sea turtle take, and the Council of Chiefs is in the process of imposing a traditional moratorium through the Office of the President.

STRANDINGS AND FISHERIES

STRANDING, FORAGING AND MIGRATION OF *CARETTA CARETTA* IN THE NORTH-WESTERN COAST OF MOROCCO

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The northwestern coast of Morocco extends 160 km from Asila city to Oued Laou village, and fronts the Atlantic, the Gibraltar Straits and the Mediterranean. This area does not favour *Caretta caretta* nesting because it has no protected areas and the majority of the coast has been developed over the two last decades. However, this zone constitutes a very significant area for foraging and migration of *Caretta caretta*, and numerous strandings are reported. Observations of the area over the last decade and investigations carried out with fishermen during the last three years (2000-2002) indicated significant sea turtle interactions with fisheries, large turtles at sea, and stranding of several turtles at many localities such as Sebta, Marina-Smir, Martil and Mdiq. These resulted mostly from accidental captures of juveniles turtles. The observations of large turtles at sea and strandings on the northwestern coast of Morocco and the high content in fish, mollusks, and shellfish suggest this is a significant foraging and migration corridor for *Caretta caretta*. The migration of turtles between the Atlantic and the Mediterranean can be made only through Gibraltar Strait and the observations of large turtles in this Strait support this hypothesis. Strandings observed in this coastal zone might also be explained by oil pollution, plastics or accidents with boats. Consequently, sea turtle conservation in Morocco should be treated within a greater framework of marine biodiversity conservation.

DEAD WITHOUT A TED: TURTLES DROWNING IN U.S.-CERTIFIED SHRIMP NETS *

Randall Arauz

Sea Turtle Restoration Project, Costa Rica

On February 11, 1997, Costa Rica presented a formal request to the United States for permission to modify TEDs by shrimpers in Costa Rican waters to allow an 8 inch bar spacing. This request was supported with shrimp trawl fishery observer data gathered by the Sea Turtle Restoration Project's Office in Costa Rica. In July 2000, Costa Rica was allowed to use a 6-inch bar spacing on a temporary basis for two years, after which a report needed to be submitted with observer data proving the modification did not represent a threat to sea turtles. A six month observer program was carried out from February to July 2002 on commercial vessels of the Costa Rican shrimp fleet. Nevertheless, it was not possible to gather sufficient information on the performance of six inch TEDs, as the devices were either removed or sewn shut during more than 50% of the total observer hours (2700 hours). The effectiveness of a 6-inch bar spacing TED, or for that matter any TED design, is meaningless if fishers do not use them. Countries obtain a certification by the United States as a TED-using country by having TEDs installed one day a year when the US Fishery inspectors carry out their ANNOUNCED inspection. Sea turtles are DEAD without a TED, and the US government continues to certify countries that do not use them.

TRAWL GUARD, A SUBSTITUTE TO THE TED?

Chitta Behera

Project SWARAJYA, Ganesh Ghat, Bakharabad, Cuttack, Irossa, India 753002

Notwithstanding the vigorous campaign for TEDs, the Indian trawlers are still hesitant to use them. The TED was designed basically for exclusive shrimp trawling, and they argue it is unsuitable for the mixed catch they invariably target. Other than TEDs, any device would be acceptable provided it does not critically hamper their mixed catch. At this critical juncture of the ill-fated TED in India, a ray of hope is now visible, with the emergence of a new device: the Trawl Guard, claimed by its inventors to contain the virtues of TED minus its vices. The new device, a brain-child of two Oriya coastal fishermen, seems to be a fool-proof mechanism for disposal of all large-size objects including turtles, while allowing both shrimp and fish into the net. Originating in the aftermath of Orissa Super-Cyclone 1999 and in response to the vexing problem the trawlers experienced from obstructions by big logs that accumulated on the seabed, the device not only protects trawl-nets from accidental damage by such obstructions but also disallowed inadvertent movement of turtles while retaining the full mixed-catch of shrimp and fish in the net. Unlike the metallic TED, fitted ingeniously at the throat of a bifurcated trawl-net, the inexpensive Trawl Guard is made of roughly 4 kg of nylon rope only and fitted at the mouth of net. Any average fisherman can prepare, install and maintain it with ease. Trawl Guards, if promoted further, might solve the long-drawn-out TED tangle, at least for Indian trawlers.

MONITORING OF SEA TURTLE INTERACTIONS WITH FISHERIES IN THE NORTHWESTERN COAST OF MOROCCO

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The studies that were focus on the Atlantic-Mediterranean marine turtles of Morocco are rare or non-existent. For this reason conducted an investigation with the fishermen of the northwestern coast of Morocco in order to determine the importance of this zone for the loggerhead *Caretta caretta*. The fishermen noted that during June, July and August 2002 there were indeed sea turtle interactions with fisheries and accidental captures of *Caretta caretta* juveniles along with fish in their nets (in the past the fishermen brought these turtles to the market but currently they do not bring them given recent legislation), and thus sea turtle conservation policies along the northwestern coast of Morocco need to be considered within an overarching framework of marine biodiversity conservation.

LOBSTER TRAMMEL NETS AS THE MAIN SOURCE OF INCIDENTAL CATCH OF LOGGERHEAD TURTLES (CARETTA CARETTA) IN THE BALEARIC ISLANDS (WESTERN MEDITERRANEAN)

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Turtle by-catch during 2001 off the Balearic islands was assessed through a questionnaire-based survey and an observer program on board fishing vessels. According to fishermen, both turtle sightings and catch increased in the summer. Observers reported catch per unit effort values matching those declared by interviewed fishermen, hence validating their answers. Both were combined along with declared fishing effort to produce a total catch estimate of 373 loggerhead incidental captures for 2001. Most of the turtles were taken by lobster trammel nets (196) or drifting long-lines (102). Although catch per unit effort was much lower for trammel nets than for drifting long-lines, total catch was much larger due to the larger size of the fleet. Loggerheads

caught by lobster trammel nets were always dead, while no immediate mortality was observed in animals caught by drifting long-lines. Turtle bycatch in long-liners from southeastern Spain moving seasonally to the Balearic Islands have not been included in the calculations, so the number of by-caught turtles in the area is expected to be larger than numbers reported here.

RECENT TRENDS IN SEA TURTLE STRANDINGS (1993-2002), NORTH CAROLINA, USA

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The objective of this analysis was to examine sea turtle strandings for North Carolina, USA, to help illustrate any trends that have occurred over the past 10 years. Sea turtle stranding data will be analyzed each year for characteristics such as inshore vs. offshore locations, numbers of adult turtles, and frequency of strandings for each species. Other analyses will include types of injuries noted, such as boat strikes, entanglement, or emaciated turtles. Trends will be examined temporally by month, as well as spatially by county.

These analyses have never been done before to this extent and over this long a time frame for North Carolina. Illustrating any patterns in sea turtle strandings will help state wildlife personnel recognize where and when problems occur. In addition, programs designed to help alleviate these problems or to further examine them can be established.

ORGAN WEIGHTS OF GREEN TURTLES STRANDED IN THE HAWAIIAN ISLANDS

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Introduction

Fibropapillomatosis (FP) is a neoplastic and debilitating transmissible disease of green turtles (*Chelonia mydas*) that has emerged as a serious threat worldwide, including the Hawaiian Islands. Previous studies of FP in Kaneohe Bay on the island of Oahu have shown severe tumor affliction as having a significant impact on green turtle growth rates (Balazs *et al.*, 2000). Many turtles with severe FP also have poor body condition. In Hawaii, stranded turtles debilitated with FP are evaluated for possible rehabilitation. If prognosis for survival is deemed poor by two independent veterinary exams, turtles are humanely euthanized and a thorough necropsy is performed. During previous necropsies of severely tumored turtles, the liver and spleen showed gross evidence of shrinkage. We set out to quantify the degree of internal organ shrinkage by weighing organs and relating organ weights to degree of tumor severity.

Methods

Reports from the public, as well as from county, state, and federal personnel on six major inhabited Hawaiian Islands (Kauai, Oahu, Maui, Molokai, Lanai, and Hawaii) form the basis for initiating a response to collect a stranded turtle and acquire relevant data (Murakawa *et al.*, 2000). Once collected, the turtles are measured, weighed, and assigned an overall subjective tumor score of 0 (no tumors), 1 (lightly), 2 (moderately), or 3 (heavily tumored) based on the size and number of tumors on the animal (Work and Balazs, 1999). In March 2000 we began weighing the major organs during necropsies of stranded turtles evaluated as euthanasia cases (n = 58) or freshly dead turtles considered to be viable for histopathological analysis (n = 16). The heart, liver, lungs, kidneys, spleen, and brain were each weighed separately using an electronic scale. Organs with tumors were omitted.

Analysis of variance was conducted to compare mean organ weights among tumor scores using the SAS System for Windows v. 8.02. In cases of significant differences, pair-wise comparisons were done using t-test comparisons with an alpha of 0.05.

Results

Tumor score 2 and 3 turtles had significantly lower liver, kidney, and spleen weights than turtles with tumor score 0 and 1 (Figures 1a-c). Heart weight was significantly lower for tumor score 2 animals versus tumor score 0 and 1 (Figure 1d). No significant difference in weights existed between the four FP groups for the other organs (lungs and brain).

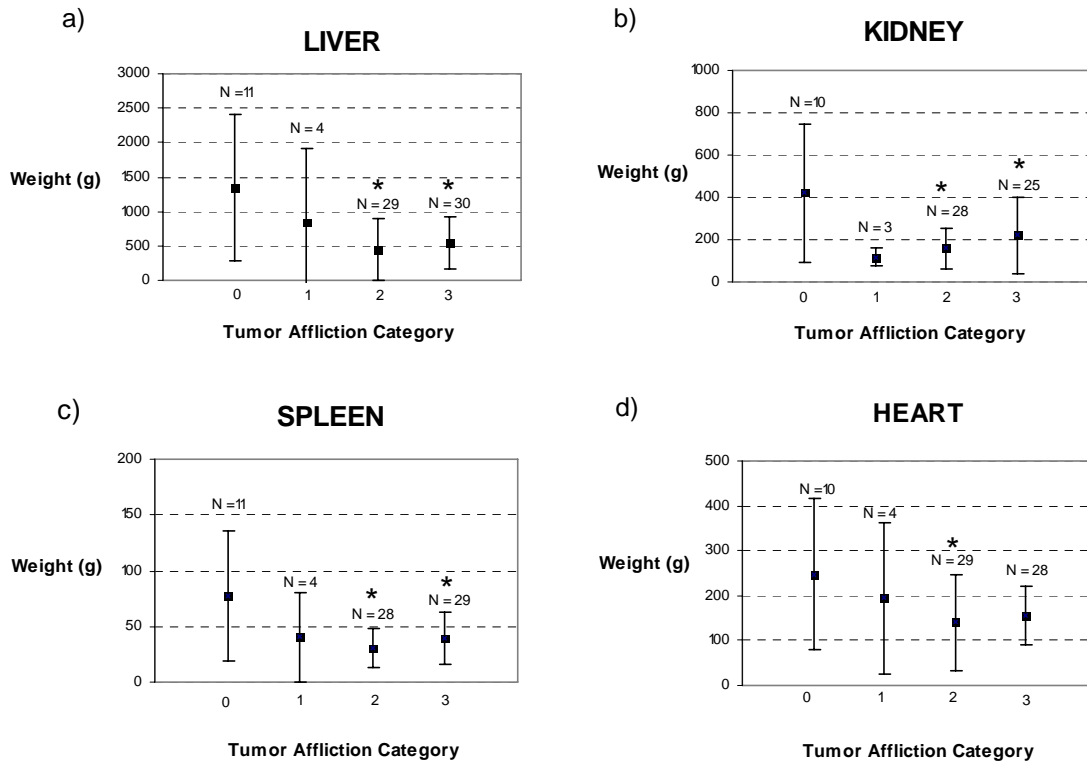


Figure 1a-d. Mean weight of organs for each tumor affliction category for liver (a), kidney (b), spleen (c), and heart (d) respectively. Standard deviations are shown as bars from the mean and sample sizes (N) are shown over each data point. * = Significant difference at alpha = 0.05.

Table 1. Mean body percentage of organ weights for non-tumored green turtles, N=11.

Weight class	Mean weight	Heart	Liver	Lungs	Spleen	Kidneys	Brain
10.0 - 29.9 (kg) N=5	16.6 (kg)	107 (g) 0.6%	361(g) 2.2%	235 (g) 1.4%	24 (g) 0.1%	91 (g) 0.6%	2 (g) 0.01%
50.0 - 69.9 N=2	62.8	391 0.6%	1456 2.3%	987 1.6%	132 0.2%	484 0.8%	6 0.01%
70.0 - 89.9 n=2	81.8	407 0.5%	2431 3.0%	1162 1.4%	98 0.1%	568 0.7%	7 0.01%
90.0 - 109.9 n=2	93.2	350 0.4%	2591 2.8%	1415 1.5%	140 0.2%	867 0.9%	6 0.01%

No significant difference existed between the mean straight carapace length and the four FP tumor score groups examined. Of the 74 turtles necropsied, 11 turtles (15%) ranging from 10.5 to 93.2 kg were non-tumored and showed little to no change of organ/body weight ratios with increasing size (Table 1).

Discussion

In Hawaii, green turtles with severe fibropapillomatosis are often debilitated due to primary and secondary effects of tumors. Aguirre et al. (1995) and Work et al. (2001) concluded that turtles with severe FP were stressed and immunosuppressed based on hematology, blood cortisol levels, and white cell function assays. The likelihood of turtles becoming bacteremic with increasing FP reinforces the hypothesis that FP causes immunosuppression (Work et al., 2003). In addition, the presence of oral tumors in Hawaiian green turtles tends to impair normal breathing and feeding ability thus leading to greater debilitation (Aguirre et al., 2002). With all of these factors affecting turtles with FP, it is logical to conclude the internal organs could be affected as well. Our study reveals that liver, heart, and kidney weights were significantly lower for tumor score 2 and 3 animals versus tumor score 0 and 1. Not only does the liver aid in metabolic functions of carbohydrates and proteins, but it also plays a role in the removal of toxins from the blood. The spleen contributes to immunological activity by acting as a blood filter and providing a source of immune cells, while the kidneys function to excrete metabolic wastes. Overall, each of these organs either contributes to the excretion of toxins and wastes within the body or plays an important role in immune status.

There is also evidence that many turtles with FP are in very poor body condition. Atrophy (shrinkage) of liver and spleen are common sequelae to severe emaciation in wildlife and would explain our finding in liver and spleen. It is likely that the kidneys would also respond similarly. Heart weight was found to be significantly lower for tumor score 2 animals versus tumor score 0, 1, and 3. Given that the heart weight was closely tied to body weight rather than FP score, it is likely that lower weight of this organ was simply a reflection of body weight. Although the body weight did not show a significant difference for tumor score 3 as compared to non-tumored turtles, the lower trend in body organ weights in tumor score 2 and 3 animals suggested that FP had an impact on the internal organs of turtles in these two tumor categories. Additional studies could focus on the correlation between emaciation and organ weights to gain a greater perspective on the relationship between tumor severity and body condition.

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INCIDENTAL CAPTURE OF A LEATHERBACK TURTLE (*DERMOCHELYS CORIACEA*) BY ARTISANAL FISHERMEN OFF VALIZAS, URUGUAY

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Despite the fact that Uruguay is not a nesting area for the leatherback turtle (*Dermochelys coriacea*), individuals are observed throughout the year, summer (January to March) being the season of maximum rates of occurrence of leatherbacks near the coast, coinciding with the presence of great banks of medusas.

While juvenile green turtle *Chelonia mydas* are the most frequently caught species by artisanal fisheries in Uruguay (López-Mendilaharsu et al., 2003), this is not the first case of a leatherback getting entangled in artisanal fishing gear. There are two reports of leatherbacks incidentally caught by artisanal fishermen in coastal waters of Río de la Plata estuary (Fig. 1, Fallabrino et al., 2001). Also, we have received many reports from fishermen of different coastal villages in Rocha about leatherbacks incidentally caught in their gill nets. There are also reports of leatherbacks incidentally caught by Uruguayan longliners (Domingo et al., 2002), and trawlers (Laporta & Miller, 2003).



Figure 1: Incidentally caught leatherbacks by artisanal fishermen in coastal waters of Río de la Plata estuary.

At a regional scale, Studzinski (1999) reports the incidental capture of a leatherback turtles by artisanal fishermen from the southernmost Brazilian state of Rio Grande do Sul, which borders with Rocha, at the easternmost extreme of Uruguay. The same year, Albareda (1999) reported similar cases in Buenos Aires Province (Argentina), observed during the summer at less than 3 miles from the coast.

On May 11th, 2002, a leatherback turtle was incidentally caught at 34°13,8S, 53° 32,2' W (about 15 miles from Valizas) (Fig. 2), by an artisanal fishing vessel out of Valizas, a small coastal village in Rocha. The turtle was found entangled in a bottom gillnet (intended to catch *Mustelus* spp, a small shark), which remained underwater for 12 hours at a depth of about 15 meters. The nets are 70 meters long by 2.5 meters height, deployed contiguously in groups of 7, in a way that a coverage of about 500 meters is obtained. The turtle was already dead when found, and no tags or tag scars were found. Curved Carapace Length and Curved Carapace Width were measured following Bolten (1999), and were 142 and 105 cm respectively. The turtle was identified as an adult female. Many specimens of *Cirripedia* sp. were found on the carapace. A necropsy was conducted and stomach contents were collected, as well as some muscular tissue samples for genetic studies. At the date of the capture, there was an abnormal occurrence of large quantities of medusas, ranging from few centimeters to almost half a meter in diameter. This lead us to believe that the specimen might have been feeding in the area.

The World Conservation Union IUCN (Hilton-Taylor, 2000), lists the leatherback turtle as “Critically Endangered”. To prevent the local leatherback population from reaching the same dramatic situation as the Pacific leatherback turtle population (Spotila, 2000), Karumbé Project is developing a conservation programme and continuing gathering data about incidental capture. Once this data is analyzed, we will have information to better estimate the impact of the artisanal (as well as trawl and longline) fishery fleets on leatherbacks, and to study the potential existence of important feeding areas in Uruguay.

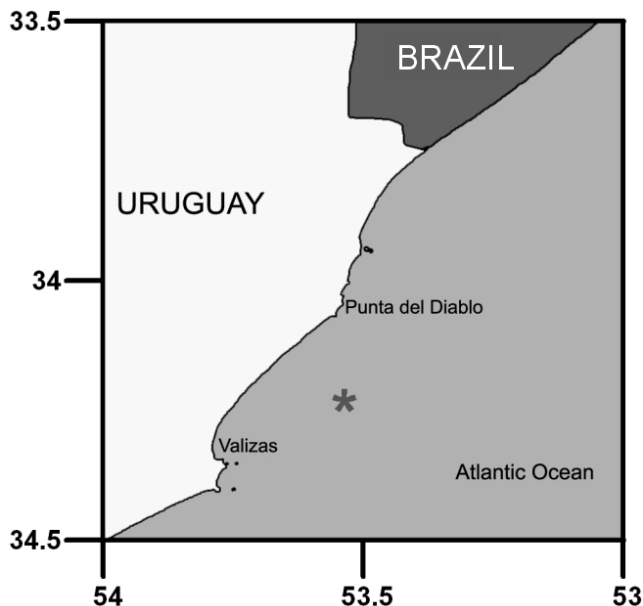


Figure 2: Location of incidental leatherback capture (about 15 miles from Valizas)

Acknowledgements

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CONDITIONS AND MORTALITY FACTORS OF LOGGERHEAD TURTLES (*CARETTA CARETTA*) CAPTURED BY LONGLINERS: OBSERVATIONS FROM THE RESCUE CENTRE OF LAMPEDUSA (ITALY)

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Longlines, especially drifting longlines, are known to capture high numbers of sea turtles and are a cause of great concern for the survival of turtle populations worldwide. This is because, although a relatively low mortality is observed during gear retrieval, a much higher post-release mortality is suspected. Unfortunately, only meagre data are available at present to give an estimate of this mortality rate.

During 2001 to 2002, data were collected on 230 *Caretta caretta* specimens incidentally caught by longliners from Lampedusa island, Italy, central Mediterranean. Turtles were brought to the harbor by collaborating fishermen and then treated at the local sea turtle rescue center. Usually the hook was removed, except when it was in the lower esophagus or deeper in the body.

The hooks in these 230 specimens were found in the mouth (32.6%), higher esophagus (part of the hook visible; 33.9%), lower esophagus or deeper (hook not visible; 33.0%), and limbs (0.4%).

Of the 94 turtles caught in 2002, six died before they could be operated on, while 21 were kept under observation without operation (deep hook) and periodically radiographed to follow possible movements of the hook. Of the latter group two died from the branchline and seven from the hook, while the others were released (after 17-62 days) with the hook still in the original position (n = 5), expelled (n = 1) or moving as to be expelled (n = 4), or with undetermined final hook position (n = 2). This total of 15 dead specimens out of 94 provides an estimate of mortality of 16%, which should be considered as a minimum, since a) other specimens could have died if not operated on, b) in the rescue centre the turtles have the branchline cut as short as possible, so reducing this mortality factor. It is interesting that in two out of 14 specimens in which the hooks were not lethal (see above), the branchlines were 96 and 130 cm long, probably because the turtles swallowed them before they were cut short. The sub-sample of turtles with hooks deep in the body (n = 21) can be used to estimate the mortality rate induced by hooks only (not considering branchlines) experienced by turtles with deep hooks at 33.3%.

Necropsies were performed on 24 specimens which were captured by longlines during 2001-2002 and eventually died. Twenty-one died from the hook in the stomach (n = 14), intestine (n = 1), esophagus (n = 4), and heart (n = 2) (parts easy reachable surgically are underrepresented). The other three specimens died from the branchline which cut (n = 1) or induced invagination of the intestine (n = 2). It should be stressed that usually branchlines were cut short by fishermen or personnel of the rescue center, so that the above proportion (21 hook vs. 3 branchlines) cannot be used as indication of the relative importance of these two mortality factors.

Generally, branchlines are poorly investigated as a mortality factor, because they are usually cut at minimum during rescuing operations, but they seem to induce problems easily when present. While lethal hooks perforate blood vessels or the digestive tract, e.g. the stomach, usually in the short period (0-9 days; mean = 2; n = 9), lethal branchlines act more over the long-term, for they cause compression and invagination of the intestinal tract, eventually breaking it or, disabling digestive functions, debilitating the specimens to death. Two turtles brought in by fishermen died 12 and 32 days after the capture, while three specimens found afloat (thus captured before then) died one, 43, and 44 days after arriving at the Centre. This long-term action is probably the reason why branchlines are the main mortality factor in specimens found afloat or stranded: of 13 specimens on which necropsy was performed, two died for hooks, six for branchlines, and five for causes not related to interaction with longline. Branchlines which caused death in specimens found afloat or stranded ranged between 70 and 160 cm (n = 5). It is also worth reporting that of 11 turtles found with a branchline coming out from the cloaca, only one was released alive after the complete expulsion of the branchline. So, it seems that turtles released with even relatively short branchline tracts might experience high mortality, if they survive the hook.

DERMOCHELYS CORIACEA STRANDINGS ON THE NORTH AFRICAN COAST IN THE STRAIT OF GIBRALTAR *

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Leatherback turtles are, among all the marine turtles, undoubtedly the most mysterious; so every data point related with this species always draws remarkable scientific interest. That is why any stranding or sighting of this species becomes such an important event for the scientific community. The main opportunity to study *Dermochelys coriacea* properly is with females on the nesting beaches, but this is still insufficient since males are excluded.

In the last two decades, the North African shores of the Strait of Gibraltar (both Morocco and Ceuta) have experienced an unusual number of strandings (even a massive one) and an unusual seasonal distribution pattern. In this presentation we provide information to contribute to the overall knowledge of the migration behavior of these turtles in our geographical context and also some insight into causes of mortality.

During the seasons when jellyfishes occur in the form of “blooms”, the number of turtles increases, often traveling together, as can be deduced from two mass strandings, one of them with 11 turtles (García y Chamorro, 1984), and several observations of traveling groups across the Strait of Gibraltar (Salvador, 1985). This suggests a trophic migration and indicates how important the benthopelagic ecosystem is for the feeding ecology of turtles in general and the leatherback in particular.

With regard to mortality, trawling nets and fixed arrowhead fish traps are easily the main causes for turtle loss (Ocaña y De los Ríos, 2002) which can be minimized by a conservation plan where by the nets are monitored and cleared on a daily basis.

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OLIVE RIDLEY TURTLE RESCUE AND TAGGING PROGRAM IN GULF OF MANNAR, NORTH WEST OF SRI LANKA

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Olive ridley turtles including mature and immature animals belonging to both sexes use the Gulf of Mannar off Sri Lanka. Sri Lankan fishermen in Gulf of Mannar accidentally catch many of these turtles during the flying fish season, which occurs between September and March. This project was carried out between September 1999 and March 2001. Objectives of this program were to tag 1000 olive ridley marine turtles, establish the geographical range of olive ridley turtles caught in the Gulf of Mannar by Sri Lankan fishermen, and to publish reports on findings of the tagging programme.

During the flying fish season in the Gulf of Mannar, the TCP hired fishing boats and the fishermen were expected to fish as normal. TCP checked the fishing nets for accidental by-catch and entanglements. If any live olive ridley sea turtle entangled in fishing nets, they were brought aboard measured, tagged and then released.

A total of 278 olive ridley turtles were released including 57 adult males, 29 sub adult males, 105 adult females, 52 sub adult females and 35 sex unknown juveniles. Therefore, it can be assumed that this region provides an important breeding and foraging

habitat for the all sizes of olive ridley turtles in the Northern Indian Ocean. It can be concluded that the Sri Lankan fishermen catch all available sizes and sexes of olive ridley turtles as incidental by-catch. If target flying fish catch does not arrive for a given season in the Gulf of Mannar, olive ridley by-catch will be dramatically reduced.

INCIDENTAL CAPTURE OF SEA TURTLES BY THE TRAWL FISHERY FLEET IN THE SOUTHWESTERN ATLANTIC, URUGUAY *

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Introduction

This is the first study on the incidental capture of sea turtles by groundfish trawlers operating in the Southwestern Atlantic. Most of the studies regarding the interaction between sea turtles and trawling activities have been directed towards shrimp and flounder fisheries (Anonymous 1992), and the implementation of TED's in the Gulf of Mexico and the Southeastern U.S. coast (Graham 1995; Harrington 1995; Kennelly 1995; Perret 1995). In Australia, efforts have been conducted to implement TED's and BRD's in the Northern prawn trawl fisheries (Robins 2002).

In Uruguay, shrimp are not caught with trawl nets, and all trawling efforts are directed at fish and mollusks. There are few studies about interactions between fish-targeting trawlers and sea turtles, notably Laurent et al. (2001), who published the results of their research on the interaction between trawl fisheries directed at fish and interactions with sea turtles in the Mediterranean Sea.

All Uruguayan fishing vessels operate in oceanic and estuarine zones yearround (Fig. 1). As the target species are distributed throughout the water column, there are different types of trawling fisheries. Coastal fisheries target three species, the Croaker (*Micropogonias furnieri*) and Seatrout (*Cynoscion guatucupa*) (Arena & Rey 1994), and the fine snail (*Zidona dufresnei*) (Riestra & Fabiano 2000). This fishery operates at depths from four to 20 meters in the case of fish, and from 30 to 60 meters in the case of snails. Trawling operations within five nautical miles of shore are prohibited. High sea fisheries are directed at the Argentine hake (*Merluccius hubbsi*) (Norbis 1999) and squid (*Illex argentinus*). Depth ranges at the fishing ground vary from 50 to 400 meters. There are 45 coastal fishing vessels operating in the country, of which 33 are target fish. These last ones have an average 25 meters LOA and 126 GWT, and a crew of 10 (DINARA 2003). Most of the vessels use Montevideo as base home port. The net dimensions are 2.5 meters vertical aperture, 77 meters horizontal aperture, and the length from the opening to the cod end is 97 meters. The minimum legal mesh size at the cod end is 100 mm. The vast majority of these fishing vessels operate as pair trawlers, and just a few operate as otter bottom trawlers. The haul duration is estimated at an average of four hours, but when the capture is scarce the haul may extend to up to 10 hours. The speed during haul is between 3 and 4 knots.

Among the non-target species that interact with these fisheries are juvenile green turtles (*Chelonia mydas*), juveniles and adult loggerhead turtles (*Caretta caretta*), and adult leatherback turtles (*Dermochelys coriacea*). The objective of this work was to describe and have a preliminary understanding of the interaction between sea turtles and the Uruguayan trawl fishery fleet.

Materials and Methods

In order to obtain good quality information, it was decided to work with information provided directly by the fishermen and onboard scientific observers. They are the ones who are in direct contact with the day to day interaction with sea turtles. First, the main task was to get acquainted with the fishermen, therefore different ports were visited and personal contacts were established in order to gather preliminary information about the situation regarding sea turtle interactions with the fishery. This approach was also very useful in obtaining information on fishing methods and data regarding the fishing fleet. This was achieved by interviewing fishermen on the dockside, asking them about the fishing maneuvers and the characteristics of the fleet, and the occurrence of sea turtle incidental captures.

At the same time, we visited the Technical Maritime School, where fishermen with many years of experience attend special courses as legal requisites. A couple of workshops with videos and slides were given to the fishermen, in order to explain our project and finally they were asked for their support and collaboration. Most of these seamen showed interest in the project, and were therefore instructed on the necessary skills to obtain scientific data on board their vessels. To recruit more volunteers, we used the same criteria as Robins et al. (2002), asking the volunteers to recruit other fishers who found the project interesting and wished to take part in it.

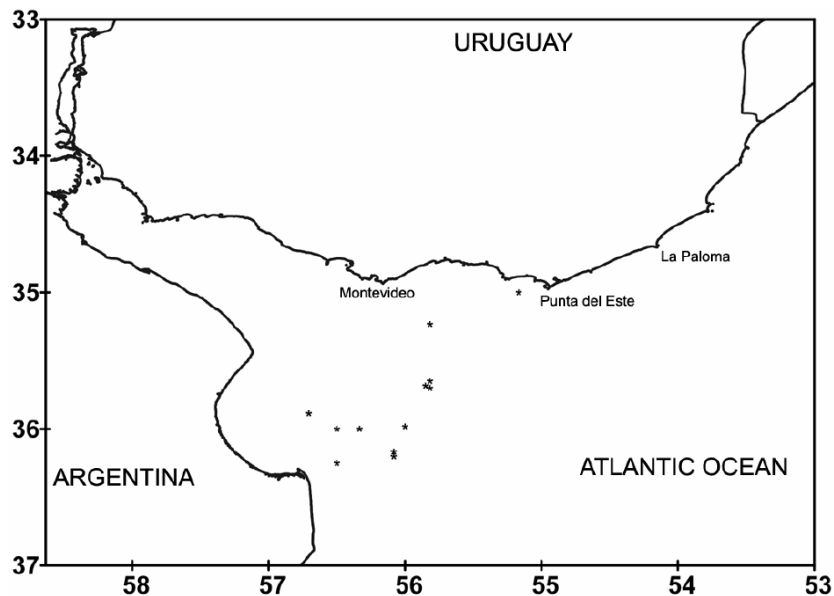


Figure 1. This map shows the position where incidental capture of sea turtles was observed. * indicates an incidental capture event.

The fishermen were trained and equipped to collect the following information: species identification; biometric measures; tagging; skin tissue sample collecting; tumors and epibionts sample collecting. Other training consisted in reanimation techniques for comatose turtles, and photo identification. These trained fishermen are now the foundation and first members of our “Onboard Tagging and Data Collection Programme” which started in November 1st, 2002, with just three equipped fishermen.

Results

Observations started in April when the first volunteer reported a sea turtle recapture, after which 12 sea turtles were captured by two coastal fishing vessels and a research vessel from the National Direction of Aquatic Resources (DINARA). One volunteer, who started when the Programme was launched, did not observe any sea turtle incidental capture to this date. As the three volunteers working to this date are onboard coastal fishing vessels and no observations could be attained from snail or hake fishing vessels, the data is restricted to the coastal trawl fishery fleet.

Of the 12 captured turtles, 10 were tagged and released alive successfully, the remaining two individuals died on the deck.

This preliminary work is not intended to be a quantitative analysis of sea turtle incidental capture. In order to perform such a study, we would need to collect several other data sets, which was beyond the original objective of the project. We chose to limit data collecting in order to identify how, where and when are sea turtles were incidentally caught by trawler nets. Although this is a very conservative figure, based on data obtained from just one single fishing vessel over a period of 11 consecutive months, we estimate a probable incidental yearly catch of 288 turtles by the entire 33 vessel fleet.

An interesting finding was that the volunteers indicated that when a leatherback turtle has to be disposed from the deck, it is winched and swung overboard, hitting the gunwale many times. This helped us to comprehend why so many of the stranded leatherbacks had the skull cracked and a tight knotted rope in a posterior flipper.

Discussion

The “Onboard Tagging and Data Collection Programme” has been a success since its inception and implementation. Our relationship with all the volunteers is excellent. They show great commitment to the Programme, and they are generating good quality information. They are also respectful with the incidentally caught sea turtles.

Based on the preliminary results of this on going research, we believe it is extremely urgent to expand the number of trawler vessels and crew members participating in this project. This will allow collecting more data, which will help us to better understand the magnitude of the impact caused by this fishery in the sea turtle populations. As soon as this is achieved, we will be in a better position to suggest measures, such as geographical and/or temporal fishing bans, and the implementation of a device, similar to the TED’s utilized in shrimp trawls, which could help to mitigate this impact, thus helping the conservation of sea turtles.

We also strongly suggest the utilization of a suitable device to lower without problems the leatherback turtles into the water. We are at present developing a backpack-style device which could help to safely return the leatherbacks back to water with the aid of the winch.

Acknowledgements

This study would not have been possible without the volunteer fishermen Andres Vidal, Gustavo de Leon and Ernesto. We also would like to thank Luis Barea, Yamandu Marin, Fabrizio Scarabino and Julio Chocca at National Direction of Aquatic Resources. This work was possible thanks to British Petroleum Conservation Programme, and National Fish and Wildlife Foundation. Special thanks to David and Lucile Packard Foundation for the travel grant. Scientific and Collect Permit: N° 270/01 (General Direction of Natural Renewable Resources).

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LOGGERHEAD TURTLE (*CARETTA CARETTA*) STRANDINGS AND REGIONAL DIFFERENCES IN SIZE DISTRIBUTION IN JAPAN

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Strandings of the loggerhead sea turtle in Japan (1996-2001) were compiled. Many strandings were found, especially around the mouth of Ise Bay, where a new type of pound nets (which have top nets obstructing surfacing turtles) is becoming popular, and intensive trawl fisheries for anchovy post larvae operate. Among all the reported strandings, 275 turtles were measured. The Mean, Minimum and Maximum SCL were 74.1cm, 12cm and 134cm, respectively. Considering that the minimum size of nesting loggerheads in Japan is 70cm, turtles with an SCL less than 70 cm can be considered premature, and the distribution of premature turtles around Japan was previously unknown. More than sixty percent of the strandings found in Chiba, Ibaraki, and Fukushima (the northeastern district) were of premature size, while only about 20% were premature size turtles in the other parts of Japan. The guts of most strandings found in the northeastern district were full of crustaceans. These results suggest that this area is major foraging ground for premature loggerhead turtles, in contrast with the East China Sea for matured turtles.

SEA, SHRIMP, AND SEA TURTLES - CASE STUDY OF A SOLUTION APPROACH USING TEDS IN TRAWL NETS IN ORISSA

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Extremely large numbers of olive ridleys (some 15-20,000) get killed along the coast of Orissa, India every year during the breeding season. The incidental capture during shrimp trawling has been identified as a major reason for this wanton killing of sea turtles in Orissa. While the trawl operators are still reluctant to agree to the fact that trawl fishing is indeed a major cause of sea turtle mortality, they are also reluctant to use TEDs. Their apprehension that a significant degree of catch loss will result if TEDs are used in trawl nets is not based on empirical data. To substantiate the efficacy of indigenously designed CIFT-TED on turtle exclusion and level of fish catch loss, experimental trawling with and without TEDs was conducted in the coastal waters off Orissa during November 2001 to March 2002. A total of 51 trawls carried out in 6 to 13 fathoms in the stratified study zones with TEDs resulted in 21 turtle captures and 100% escape. Another 21 trawls carried out in 12 to 35 fathoms without TEDs resulted in 5 turtle captures. The data reveals that most turtle captures occur within 5 km of shore and below 10 fathoms, emphasizing such marine habitats need to be safeguarded. The fish catch loss in the study zones with TEDs ranged from 2.3 to 10.3%. Further non-invasive TED demonstrations and an extension program are proposed as strategies to gain acceptance of TEDs as a solution for shrimp trawling and sea turtle interactions among fishmenn in Orissa.

THE UK MARINE TURTLE REHABILITATION MANUAL

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Introduction

Five of the world's seven species of marine turtle have been recorded in UK waters, including the leatherback (*Dermochelys coriacea*), the loggerhead (*Caretta caretta*), the Kemp's ridley (*Lepidochelys kempii*), the green (*Chelonia mydas*) and the hawksbill turtle (*Eretmochelys imbricata*). Although the olive ridley (*Lepidochelys olivacea*) occurs in the Atlantic, this species has not yet been recorded in UK waters.

In 1999, and with UK Government support, Marine Environmental Monitoring (MEM) compiled a database of contemporary and archived marine turtle sightings and strandings in UK waters. The 'TURTLE' database now holds approximately 1000 records, most of which were recorded since 1980, although some archived records date back to the 18th Century (Penrose, 1999).

In recent years, MEM has received several reports of live-stranded and cold-stunned marine turtles and has solicited the help of public aquaria to assist in the rescue, rehabilitation and eventual release of these stray turtles. These rehabilitations have been carried out with varying degrees of success, by inexperienced public aquaria staff with assistance from coastal veterinary practitioners. Until now, UK public aquaria and coastal vets have not had access to a specific and dedicated technical reference for marine turtle rehabilitation. They have relied on liaison with marine turtle husbandry experts overseas as well as trial and error during marine turtle rehabilitations.

Marine Turtles Grouped Species Action Plan

In 1999, the UK Government published the Marine Turtles Grouped Species Action Plan in recognition of the need to enhance the conservation of marine turtles in UK waters and the UK Overseas Territories. The Action Plan, which can be viewed at www.ukbap.org.uk, outlines 26 priority actions, including:

- the dissemination of 'information ...for conservation agencies, veterinary surgeries, relevant public bodies and other organisations, to help deal with enquiries relating to stranded marine turtles'
- the introduction of 'a code of practice for the repatriation, where necessary, of cheloniid (hard-shelled) species which are occasionally stranded live on UK shores'

MCS is a joint lead partner of the Action Plan and coordinates a coalition of UK institutions committed to its implementation. MCS has produced the UK Marine Turtle Rehabilitation Manual as contribution to the Action Plan. The Manual is the first dedicated technical reference produced to advise UK aquaria staff and veterinary practitioners on the successful rehabilitation and repatriation of live marine turtles stranded on British shores.

The UK Marine Turtle Rehabilitation Manual

The Manual has been compiled, using relevant literature, as well as the experiences of UK public aquaria personnel and experienced overseas marine turtle rehabilitation experts. It provides comprehensive, UK-specific guidance on rehabilitation and repatriation of stranded, hard-shelled species and includes guidance on dealing with live leatherback turtle strandings. The text is split into the following six chapters:

1. Introduction: Biology and conservation status of the marine turtle species recorded in UK waters, Marine Turtles Grouped Species Action Plan and relevant legislation.
2. Marine turtle rescue: The collection, transport and initial health assessment of live stranded and entangled marine turtles, as well as health and safety.
3. Rehabilitation: Accommodation guidelines, external and internal examinations, primary treatment and stabilisation. Feeding and supplementation, monitoring, diagnosis and treatment of hypothermia, hypoglycaemia, flotation abnormalities, parasitism, gastrointestinal obstruction, constipation, trauma, petrochemical/oil contamination, fibropapillomatosis and captivity related conditions. Guidelines for retaining debilitated turtles in captivity and euthanasia, disposal of dead turtles.
4. Repatriation: CITES, legal and health implications of repatriation. Transportation by air, container specifications and documents required.
5. Case studies of successful rehabilitation: Case studies describing the successful rehabilitation and repatriation of juvenile Kemp's ridley (*Lepidochelys kempii*), loggerhead turtle (*Caretta caretta*) and green turtles (*Chelonia mydas*) stranded in the UK.

6. Veterinary section: Euthanasia techniques, chemical restraint, therapeutics, analgesia and surgery.

The Manual is illustrated with over 50 colour photographs and diagrams. Template patient admission sheets and monitoring sheets are included as appendices. There is also a comprehensive bibliography as well as contact details of the relevant authorities and organisations in the UK. The Manual has been reviewed by a panel of vets, aquaria staff, UK Government Agencies and marine turtle experts and will be distributed free of charge to all UK public aquaria and coastal veterinary surgeons.

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PREDICTING THE MAGNITUDE OF COLD-STUNNING EVENTS IN CAPE COD BAY, MASSACHUSETTS USING CLASSIFICATION AND REGRESSION TREE MODELING *

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Previous studies of sea turtle cold-stunning events have been primarily descriptive accounts, or focused on proximate factors operating at short temporal scales and local geographic extents (Burke et al. 1991; George 1997; Morreale et al. 1992; Schwartz 1978; Witherington & Ehrhart 1989), including sea-surface temperature, wind speed and wind directions that are typically associated with cold front storms that ultimately drive torpid sea turtles ashore. While informative, these studies did not address the factors that may influence the magnitude of these strandings. Using Classification and Regression Tree models, we demonstrate that the magnitudes of sea turtle cold-stunning events in Cape Cod Bay, Massachusetts are predicted by a variety of confounded factors with differing temporal and spatial scales. Summer and fall sea-surface temperature dynamics in the northwestern Atlantic, as well as turtle hatching success two years previous at Mexican nesting beaches greatly influenced the magnitude of cold-stunning events in Cape Cod Bay between 1984 and 2001. By the time cold front-induced storms begin to roll across the region in late October, the magnitude of the cold-stunning events in Cape Cod Bay during November and December has been predetermined by these landscape extent dynamics. Using our models, the magnitude of the coming season's cold-stunning event can be predicted, thereby facilitating recovery efforts for cold-stunned turtles.

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A NEW CURE CENTRE FOR MARINE TURTLES AND THE FIRST CASE

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Introduction

For many years the coast between Sacca di Goro and the mouth of the Reno River has been extensively studied because of the presence of loggerhead turtles *Caretta caretta* (Vallini, 2000, Vallini et al., 2000; 2001). Through a research project carried out until 2002 with CHELON's Marine Turtle Conservation and Research Program, attention was focused on the study of the interaction between the fishing methods most frequently used in these waters (bottom trawls and midwater pair trawls) and the loggerhead turtles. The analysis was performed on healthy live animals, on animals with any kind of problems preventing their release into the sea (hosted by the Fondazione Cetacea di Riccione), and stranded animals, both dead and alive. Since 2000 the Ferrara section of Istituto Zooprofilattico Sperimentale of Lombardia and Emilia Romagna has offered its support to the protection of marine turtles that frequent the waters of Lidi Ferraresi. In 2002 IZSLER proposed and obtained the approval from the Ministry of Health and "Politiche Agricole e Forestali", as a center for receiving and assisting turtles injured or in difficulty, and providing shelter in those cases where objective or logistical problems did not allow the sheltering in specialized centers or for uncomplicated cases requiring a subsequent short-term housing.

Materials and Methods

Anamnesis - On July 13th, 2002 the Coast Guard harbour office of Porto Garibaldi got a report of a turtle in difficulty, close to the breakwater cliffs, by guests of a camping resort. The large turtle was taken to the beach and appeared to be in severe shock, but did react to eye reflex. We arrived in less than 30 minutes during which, by phone, we indicated some emergency actions to be taken in order to limit the stress to the animal.

Clinical Signs

The clinical examination indicated debilitation, marked malnutrition, dehydration, and a weakly sensory state. Moreover, we observed the absence of cloacal reflex, (but uninterrupted presence of eye reflex), an anemical mucosa, and respiratory difficulty. Three big continuity breaks were detected on the carapace, due to some traumatic event, probably propeller damage. The central break (Fig.1) was of concern due to its seriousness and size (19,2 cm x 2.5 cm), from the XII right marginal to the V neural. The animal also presented a ventral dermaskeletal fracture at two different points (Fig.2). Under closer examination the wounds were deep and necrotic, and covered with various epibionts and barnacles including *Lepas anatifera*, *Chelonibia testudinaria*, *Platylepas hexastilus*, *Caprella acanthifera*, *Nereis* sp., *Ozobranchus* sp., *Serpula* sp., and *Mytilus galloprovincialis*.

With the locomotor apparatus we found an anatomo-functional alteration of the right anterior and posterior flippers. Because of the serious debilitated state and the big size of the animal (Male, CCL max: 83.5 cm; CCW 76.4 cm, weight 58.9 Kg) we preferred an intervention in place until the next morning in order to avoid movement during the night. Anti-shock therapy was immediately administered with the administration of 5% glucose solution (1 lt) and dexamethasone (0,2 mg/kg) subcutaneously. In addition, an antibiotic coverage was provided by administering a wide-spectrum antibiotic by phlebotomy (200 mg ciprofloxacin total). An accurate cleaning and a first curettage of the wounds were also performed. The turtle was then moved to the veterinary clinic. From July 15 the subject was maintained in an external brickpool (cm 167 x 148 x 40) at IZSLER. In the beginning the water level was kept low, with 494 liters of water, in order to favor respiration and wound healing. Subsequently, the water level was increased to 676 lt. From September 2002, the turtle was housed indoors, in a pool made of fiberglass (165 x 165 x 102) containing a mechanical and biological filter (240 lt.), and 800 liters of artificial salt water.

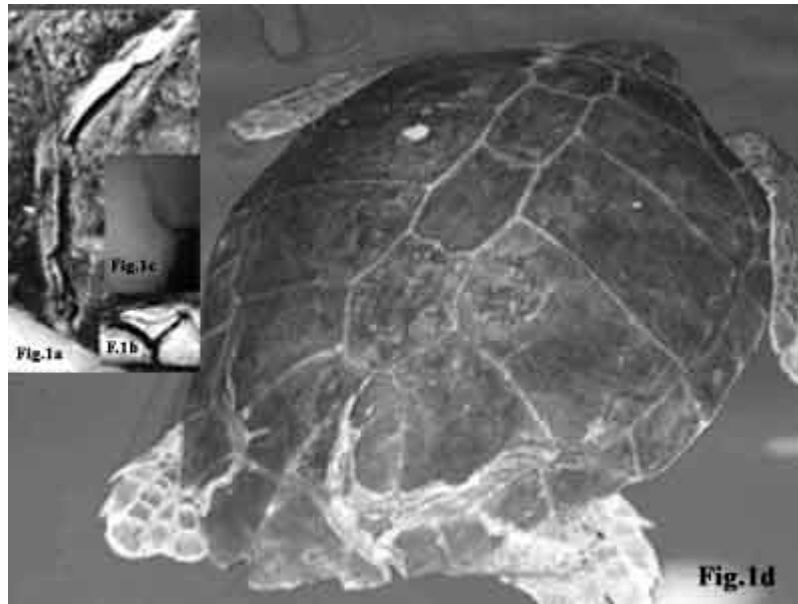


Fig. 1a: The biggest wound; 1b: The fracture in the ventral position of carapace; 1c: Dorsoventral radiography projection view of 1a; 1d: The loggerhead turtle now.

Collateral Examinations

Radiographical examination - Radiographical exams were performed with a portable radiological apparatus at high frequency 80 kv-20mA. Several dorsoventral projections were performed at different time intervals. Carapace (frequency: 66 kv-2,5 mAs), right anterior flipper (frequency: 64 kv-2,5 mAs), right posterior flipper (frequency: 58 kv-2,5 mAs).



Fig. 2a: First exam: right front flipper dorsoventral view; 2b: First exam: right post flipper dorsoventral view.

Laboratory tests - A parasitological exam of fecal samples and culture from blood samples were performed by IZSLER. The media used in these analyses were blood agar (5% sheep erythrocytes), TCBS (Thiosulphate Citrate Bile Sucrose) e BHI (Brain Heart Infusion) broth, all incubated for 24 hours at 30°C.



Fig. 3a: Second radiography front flipper; 3b: Second radiography post. flipper.

Therapy

Medical Therapy - At the time of hospitalization, a preventive therapy was designed, because of the severe condition of the subject and the condition of the carapace. This consisted in the administration of a wide spectrum antibiotic containing enrofloxacin (11,6 mg/kg) over the following 23 days. Through culture tests and by antibiotic assays we detected the presence of a kanamycin-sensible bacterium, therefore a kanamycin-based therapy was chosen to replace the previous antibiotic. The antibiotic was given by intramuscular injection at dose of 20 mg/kg for the following 22 days. At the end of the treatment the culture test was negative. The animal was not capable of autonomous feeding and also showed signs of apathy, anorexia and general weakness, therefore we administered a glucose solution (500 ml s.c. twice a day) and saline solution (500 ml s.c. twice a day). After four days the treatment was reduced to 125 ml/day of saline solution and was maintained during the all period of antibiotic therapy in order to decrease any cytotoxic effect. From day nine onwards, the turtle underwent forced feeding based on minced fish and crustaceans. Three weeks after hospitalization it started swimming autonomously in the pool and one month after hospitalization the turtle started to eat fish and whole preys. The medical therapy was supplemented with polyvitaminic solutions (toldimfos, vit B1,n vit B2, vit B6, vit PP and calcium pantothenate) in order to stimulate and sustain the metabolic functions.

Surgical Therapy - The curettage of the wounds included the removal of the all necrotic tissue down to the live tissue. The wounds were then disinfected with an iodopovidone solution, antibiotic ointments and penicillin.

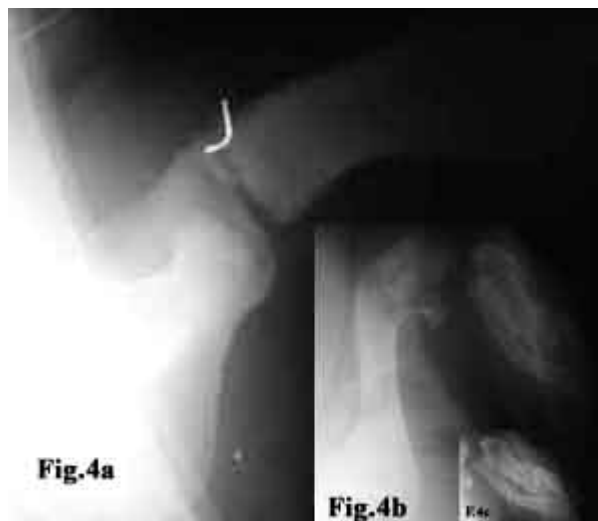


Fig. 4a Third exam front flipper; 4b,c: Third exam post. flipper (b) and particular of fig.4b (c).

Results

Radiography exams - First exam - Carapace dorsoventral projection: fracture of carapace without damages to the coelomatic cavity (Figure 3). Right front flipper dorsoventral projection: complete composite fracture between third median and third proximal humeral diaphysis (Fig. 4). Right posterior flipper dorsoventral projection: multiple fracture with fragment of the distal epiphysis and metaphysis portion of femur, complete decomposed fracture with fragment of third median of diaphysis of fibula and tibia, with contraction and superimposition of fractured fragments.

Second exam (after 22 days) - Front right flipper: fracture with indirect scarring in progress due to light distortion of fragments of fracture but keeping the bone segment alignment; bone callus in formation that is knitting almost half of fracture line. Posterior right flipper: the fracture fragments of the distal epiphysis and metaphysis of femur show zones of indirect bone cicatrization; the diaphysis fracture of tibia and fibula do not yet show bone scarring.

Third exam (after 41 days) - Front right flipper: we can see a bone callus expansion that now immobilizes 2/3 of fracture zone. Posterior right flipper: the metaphysis and epiphysis distal fracture of the femur shows many areas of calcifications of internal callus; the diaphysis fracture of the fibula shows an internal and external callus with good level of calcification, but a bad alignment of fragments remains; on the other hand the diaphysis fracture of tibia show bones callus on the fracture line that is expanding toward the parallel fragment.

Fourth exam (after 5 months) - Front right flipper: the bone callus extended on all the surfaces of fracture which is creating good front flipper stabilisation. Posterior right flipper: (58 kv- 2 mAs): the bone callus of distal portion of femur is homogeneous and expands to all the lesion; the fibula diaphysis shows an exuberant bone callus but it is justified by the two fracture fragments bad alignment; while even the tibial diaphysis shows an exuberant callus, here due to a superimposition of the bone fragments cicatrization.

Laboratory Exams - The parasitological exam of the fecal sample was negative. From all the blood cultures we isolated a bacterium belonging to the *Aeromonas veronii* and *Biovar sobria* species; this bacterium was submitted to an antibiogram exam with the following results: sensible to: kanamycin, neomycin, sulfadiazine, sulfonamide, cephalosporin, tetracycline, flumequine and enrofloxacin. Resistant to: nalidixic acid, oxolinic acid, apramycin, bacitracine, ampicilline.

Discussion

During the eight months of hospitalization the turtle showed a significant improvement of general conditions that was almost unexpected. After a first period of forced feeding by intubation or whole prey, the animal started to eat autonomously any food that was given and prey that were left in the pool. Both right side flippers restored correct functionality and in particular the anterior flipper is now able to acquire the correct swimming position; both flippers restored the capability of opposing strength to the traction. The wounds demonstrated a good level of scarring, with the dermaskelton margins approaching each other to within about half a centimeter. Considering the present improvement, the team is planning to perform additional radiographical examinations and laboratory analysis in order to check the recovery rate three months from now, and to free the turtle into the sea as soon as conditions stabilize.

The bibliography reports only *Aeromonas hydrophila* as a causal agent of septicemia in reptiles among the bacterial species belonging to *Aeromonas* genus, but does not refer to *A. veronii* and *Biovar sobria*. As reported in the literature, *Aeromonas* spp causes extraintestinal infections and diarrhea in humans and can produce many virulent agents. We are now investigating whether the germs isolated from the turtle were capable of producing any form of virulence.

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TELEMETRY AND MIGRATION

INTER-NESTING MOVEMENTS OF LEATHERBACK TURTLES IN PAPUA NEW GUINEA

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Leatherback turtles nesting on beaches in Papua New Guinea have long been an important part of local cultures and traditions. Declines have been apparent to local villagers in many areas, but conservation and protection is hindered by a lack of knowledge of turtle movements following local nesting. As part of a multi-national partnership between local villagers, conservation organizations, and sea turtle researchers, twenty female leatherback turtles were sampled and tagged with satellite transmitters after nesting on beaches near Lababia Village, Morobe Province, Papua New Guinea during December 2001, and February 2003. The leatherbacks were documented to nest repeatedly, approximately every 5-7 days, both on beaches near the tagging site and at several distant locations to the north and south in Papua New Guinea. One turtle track suggested re-nesting on beaches of Bougainville Island, 800 km away. Two tracks revealed long-range movements to the southeast, past New Caledonia and towards southern Australia or New Zealand. Satellite telemetry was instrumental in documenting beach use, inter-nesting intervals, variability in nest site selection, and migration patterns of post-nesting female leatherbacks in Papua New Guinea. Inter-nesting tracks indicate that the Huon Gulf, Papua New Guinea, is an important area for female leatherbacks between nesting events.

MOVEMENTS OF MARINE TURTLES NESTING IN GUANAHACABIBES PENINSULA, CUBA, INFERRED FROM TAGGING RESULTS *

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Marine turtle nesting activities on Cuban beaches is still being researched. One of the nesting areas, which is intensively monitored is located at the western tip of the Cuban main island: Guanahacabibes Peninsula. Since 1998, the Marine Research Center from Havana University has been heading and conducting, the 'University Project for Study and Conservation of Marine Turtles in Cuba' in the Peninsula de Guanahacabibes Biosphere Reserve and National Park. Three species of marine turtles nest on the beaches located along the south coast of Guanahacabibes (*Chelonia mydas*, *Caretta caretta* and *Eretmochelys imbricate*, in order of arrival nesting magnitude). The nesting season spans from May to September, during which volunteer teams (mostly Havana University students) conduct intensive night patrolling out of six turtle camps. A tagging program in four out of the seven monitored beaches commenced in 2002. Self-piercing inconel tags, type 1005-681, from National Band & Tags were used, and results indicated, among others, that individuals nested in alternating years. Nesting females were very much phylopatric, even when some migrations between beaches occurred. Re-nesting intervals varied from 6 to 22 nights, with mean of 12 nights. Nesting females nested four times on average per season with minimum of one and maximum of six times. Clutch size showed an increasing trend by the 5th nest. Results from the saturation tagging methods during 2002 suggest an effective population size at Caleta de los Piojos beach of some 72 nesting females.

**IDENTIFYING ORIGINS OF LEATHERBACK TURTLES FROM PACIFIC FORAGING GROUNDS OFF
CENTRAL CALIFORNIA, USA**

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Little is known about migratory behavior or stock origins of leatherback turtles on North Pacific foraging grounds, but this information is critical for evaluating impacts of incidental catches throughout the Pacific Ocean. Leatherbacks that commonly forage off central California, USA, from July to October have been suspected of belonging to eastern Pacific nesting populations. Past telemetry studies were limited to post-nesting movements of females from beaches in Mexico and Central America, and all of these turtles migrated southward into areas along the equator and in the southern hemisphere, rather than northward. This study combines genetic analyses with satellite telemetry to test the hypothesis that leatherbacks foraging off California may belong to western Pacific stocks. Further, the study provides a first look at the behavior and migration patterns of foraging adult leatherbacks away from nesting areas. We sampled and attached satellite transmitters to 13 adult leatherbacks, including three males, captured at sea in Monterey Bay, California during September 2000-2002. Following release, most turtles moved rapidly southwest along similar tracks. One turtle tagged in 2000 was tracked for 18 months as she crossed the Pacific to the Mariana Trench, north of a major nesting beach in northern Papua. Results of genetic analyses indicated that sampled animals were from western Pacific nesting stocks, most likely Papua or the Solomon Islands. The results have implications for conservation of Pacific leatherbacks and demonstrate the utility of combining two analysis techniques to determine population and stock boundaries of highly migratory sea turtle species.

**INTERESTING DIVE PATTERNS OF LEATHERBACK SEA TURTLES (*DERMOCHELYS CORIACEA*) AT PLAYA
GRANDE, COSTA RICA**

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We conducted a study of the dive patterns of leatherback turtles at Playa Grande in Guanacaste, Costa Rica during the 2002-2003 season. We placed Lotek LTD1021A data loggers on 19 turtles after oviposition while the turtles were on the beach. The data loggers measured time, depth, light and water temperature. We retrieved data loggers from the turtles during subsequent nestings on the beach. Data Analysis indicated that immediately after leaving the beach all 19 turtles headed North into the Gulf of Papagayo and traveled an average of 20 - 40 km per day. For the first 6 days immediately after nesting the female leatherbacks had average dives of 60 - 160 meters that reflected a pattern of 10 - 16 minute, V shaped dives down to water temperatures that averaged between 14 - 16°C, with little bottom time. During the last 1 - 3 days prior to the subsequent nesting the turtles returned to a location directly off the nesting beach and remained in the top 20 meters with only shallow dives. They remained in water that was above 25°C. During this time there were a number of U shaped dives in which the female appeared to remain on the bottom for 2 - 4 minutes.

USING SATELLITE TELEMETRY TO DETERMINE POST-NESTING MIGRATORY CORRIDORS AND FORAGING GROUNDS OF GREEN TURTLES NESTING AT POILAO, GUINEA BISSAU

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Recent surveys have shown that the small island of Poilão, located amongst the islands of the Bijagós archipelago, Guinea Bissau, hosts the largest green turtle (*Chelonia mydas*) rookery on the west coast of Africa, and one of the largest in the Atlantic Ocean. Traditionally, Poilão has been regarded as a sacred site by the Bijagós people, and this has contributed to turtle conservation. However, an emerging threat is the rapid development of fisheries in this region. In order to support efforts towards the recently established MoU Concerning Conservation Measures for Marine Turtles of the Atlantic Coast of Africa under the CMS we set out to identify important foraging areas for green turtles from this rookery. We attached 10 satellite transmitters to nesting turtles in November 2001 and were then able to follow these individuals via satellite giving insights into interesting and migratory behaviour.

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FLATBACK SEA TURTLE INTER-NESTING HABITAT IN FOG BAY NORTHERN TERRITORY, AUSTRALIA *

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Satellite transmitters were attached to four nesting Flatback Turtles (*Natator depressus*) in August 2001 on Bare Sand Island. These were tracked successfully for approximately 15 days when they returned to Bare Sand Island to nest. The satellite tracking results indicated that each of the turtles moved quickly away from the island after nesting. One individual travelled approximately 22 km in one day and remained at that location Southwest of the island until the day before she returned to the island and nested. Another two went approximately 15 km to the Northeast of the island and remained in the area before returning to nest 14 days later. The remaining turtle travelled 30 km to the Northwest of the island and remained in at that location until returning to the island to nest. Time depth recorders attached to these tracked turtles indicated that they spent a good deal of their time resting on the bottom. They went to the surface to breathe and then returned to approximately the same depth. Each turtle spent the inter-nesting period in waters up to 40 metres in depth. They spent very little time in the water column as most of their time depth profiles showed a strong tidal cycle that indicated the turtles were stationary at rest on the bottom. It appears that the Flatback Sea Turtles at Bare Sand Island occupy an inter-nesting habitat that is between 30 to 40 metres in depth.

**INTERNATIONAL MOVEMENTS OF ADULT FEMALE AND JUVENILE HAWKSBILL TURTLES,
ERETMOCHELYS IMBRICATA, FROM BARBADOS, WEST INDIES**

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Flipper tagging and satellite telemetry are two methods that can be used to assess international movements of sea turtles. Barbados has tagged 637 adult females since 1987 and has deployed five satellite transmitters on nesting females since 1998. A total of 391 juvenile turtles from foraging aggregations on the west coast of Barbados have been tagged since 1998. Of those individuals tagged, tags from seven adult females and two juveniles have been returned from other countries. All animals fitted with satellite transmitters were found to leave Barbados' waters. The migratory patterns of juvenile and adult hawksbills are discussed.

SATELLITE TRACKING MARINE TURTLES: AN ASSESSMENT OF DATA ANALYSIS OPTIONS *

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Satellite tracking is widely used in marine turtle studies as the most cost-effective way to investigate at-sea movements. However, there are a number of limitations in interpreting position data derived from Doppler-shift calculations through the ARGOS system, and these are rarely dealt with adequately or efficiently in marine turtle work. This paper explores some of the limitations and options for data analysis, to furnish repeatable, objective methods that provide the most effective utilization of location data. Three species of turtles in three different localities were involved in this study: *Caretta caretta* in Brazil, *Lepidochelys olivacea* in India, and *Chelonia mydas* in Philippines; data were collected from a total of 18 individuals between 1998 and 2001. One option is to use only 'standard locations' (LC 3, LC 2, and/or LC 1), that ARGOS provides together with error estimates, but with marine turtle work this often means using 20% or less of the position data available. Alternatively, ARGOS position data can be 'filtered' based on preset distance, angle and rate criteria (see also Lemke et al., this volume). Comparisons of six sets of data were made (all data; highest quality [LC3]; two highest ARGOS categories of data [LC3 and LC2]; all data assigned an error by Argos [LC3, LC2 and LC1]; data filtered based on distance, angle and rate; and only the best position per day, selected through a distance-angle-rate filter). The results indicate that using the 'best' position per day provides the most useful data for analyzing patterns and rates of movement as well as 'home ranges'.

SATELLITE TELEMETRY OF LOGGERHEADS IN BRAZIL

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Introduction

The second largest nesting population of loggerheads in Brazil is concentrated on Comboios and Povoação beaches, Espírito Santo, where project TAMAR has operated for more than 20 years. In the 2001/2002 season there were more than 1,000 nests. Little is known about feeding areas and post-nesting movements of these animals. Offshore areas along the Brazilian coast are

subject to intense development pressures, particularly fishing and coastal construction, so information to support conservation actions for turtles after they leave the protected beaches is needed.

Methods

From 14 to 25 January 2001 eight nesting female loggerheads from Comboios and Povoação beaches were tagged with KiwiSat 101 satellite transmitters, manufactured by Sirtrack, New Zealand (transmitter specifications: housing approximately 57 x 28 x 12mm, tear-drop shaped, keeled, hydrodynamic, pressure-proof housing; two C-cell batteries, 1 Watt output; repetition rate 20 sec; three duty cycles: (1) first 60 days on continuously, (2) days 61-90 12 hours on / 30 hours off, (3) remainder of transmitter life 12 hours on / 78 hours off; saltwater switch (SWS); two 8-bit surface time counters (transmits the amount of time the SWS has not had a connection between contacts over the past 24 hour period, starting from when transmitter was activated, with a resolution of 2 seconds); 8 bit temperature sensor [accuracy of +/- 1C; estimated to have a latency of about 20 minutes]; 8 bit sensor for battery current). By design, this was the end of the 2000/2001 nesting season, and it was expected that the turtles would not remain in the nesting areas for extended periods of time. Carapaces were cleaned of all epibionts, wiped clean with rubbing alcohol, and transmitters were attached using two-part Power-Fast epoxy. Generally it took about an hour for the process, and the turtles were released immediately. Individual transmitters/turtles were referred to as B 74 through B 81.

Position estimates and sensor data were received from Service ARGOS on a daily basis. Positions are categorized by ARGOS into location classes (LC), depending on the quality of the data. In the simplest of terms, the error estimates for these different LC can be thought of as circles around the estimated point. The radius of the "error circle", representing one standard deviation, for the respective location classes is: LC3 = 150 m; LC2 = 350 m; LC1 = 1000 m. No error estimate is provided for LC0, LCA, LCB, or LCZ; the worst data have no location at all.

Less than 20% of the position estimates received from Argos were of high enough quality to include error estimates (LC3, LC2, and LC1). Most of the Argos data were "low quality" positions, and in the cases of some transmitters/turtles as much as 20% of the data had no estimated position at all (Table 1). Hence, it is important to have objective, defensible methods for selecting position data to be used for analysis.

Table 1. Number of data points for each ARGOS location class, for each of eight PPTs attached to loggerhead turtles in Brazil.

PTT	LOCATION CLASS								TOTAL
	LC3	LC2	LC1	LC0	LCA	LCB	LCZ	No loc.	
B74	9	46	111	260	116	162	60	182	765
B75	8	25	55	184	36	60	47	70	416
B76	7	9	58	172	69	123	62	142	501
B77	1	5	70	154	15	24	31	42	301
B78	2	23	130	447	110	211	132	228	1056
B79	0	5	36	221	12	40	79	46	394
B80	0	5	74	280	45	81	61	97	547
B81	2	5	27	169	30	38	72	71	344
TOTAL	29	123	561	1887	433	739	544	878	4324

Position data were "filtered" using different strategies that included: all data; only LC3; only LC3 + LC2; only LC3 + LC2 + LC1; and only those values selected by a systematic algorithm written by David C. Douglas. The Distance-Angle-Rate (DAR) algorithm (PC-SAS code) evaluated plausibility of each location by assessing its proximity to the previous and subsequent locations, the acuteness of the angle formed by the preceding and subsequent movement vectors, and the derivative rates-of-movement for each vector. In general, locations were considered plausible and were retained for further analyses if: 1) the LC index was 3, 2 or 1; or 2) the distance to the previous or subsequent location was <10 km; or 3) the rate of movement between consecutive locations did not exceed 7 km/hr and the angle formed by the previous and subsequent locations did not indicate extreme return-movements, which we considered to be a signature of Argos location errors. The final filtering strategy extracted one location per day from the subsample of locations that passed the DAR algorithm, as determined by picking the best ranking Argos location class every 24 hours ("best/day"), or best per duty cycle when there were transmissions less than every 24 hours. Although the "best/day" subset greatly reduced the amount of location data (Table 2), it retained the highest quality positions over a more evenly dispersed temporal distribution.

To determine if current output was related to the quality of the position estimates, the data for all 8 transmitters for the first 300

days were grouped by location class. There was no clear relationship between location class and battery current readings. With the exception of LC3, which has a rather small sample size ($n = 29$), all location classes had mean battery current values around 580 mA and relatively small standard errors. When each of the 8 transmitters was analysed separately, only in the case of B 77 was there a significant difference in battery current value between location classes (Tukey's multiple comparisons).

Table 2. Number of data points for each PTT/turtle under six different filtering techniques, loggerhead turtles in Brazil.

PTT	FILTERING TECHNIQUE					
	All	LC3	LC2 & LC3	LC1, LC2 & LC3	DAR	Best/duty cycle
B74	765	9	55	166	453	64
B75	416	8	33	88	286	67
B76	501	7	16	74	284	46
B77	301	1	6	76	204	66
B78	1056	2	25	155	477	77
B79	394	0	5	41	175	47
B80	547	0	5	79	329	58
B81	344	2	7	34	140	48

Tracks were plotted based on the “best/day (or best/duty cycle). The routes taken showed no generalized pattern, other than the fact that most of tracks stayed over the continental shelf. Two tracks went south and southwest; one went east; and the remaining five went north, but with very different distances and trajectories, one of which included a large loop off the continental shelf.

Results

B 74 headed south and southwest almost immediately after release on 14 January, and after traveling more than 1,600 km in 87 days, then turned back northeast before settling into a “home range” area that was more than 2000 km² (20% kernel ellipse size). The track stayed within 100 km of the coast, and never went off the continental shelf. The rate of movement was fastest during the first 13 days, averaging 62 km/day from point to point.

B 75 went north steadily after release on 15 January, traveling more than 1,400 km in 95 days. The track was between 5 and 150 km offshore, but did go off the continental shelf on two occasions, notably where it is relatively narrow. The rate of movement during the first 42 days was fastest, averaging 37 km/ day from point to point.

B 76 headed south along the coast for 13 days after release on 16 January, then returned north and entered into a large clockwise loop, spending over a week in deep ocean as it covered more than 750 km. It finally headed northeast from the release site, settling onto the Abroleos Bank. During the 68 days for which transmissions were received, the track went more than 1,200 km.

B 77 immediately on release the 16 of January, this track went east, out to sea, leaving the continental shelf. After a week it stopped, apparently settling on a sea mount about 200 km offshore, and after 91 days the track had covered less than 1000 km.

B 78 followed a route similar to that of B 75, traveling southwest from the release site. It stayed closer to the coast than B 75, and may have even gone to the shore about a week after leaving the release site: a LC 3 position from on land was received on 27 January, possibly indicating a nesting emergence. Although leaving the release site later, B 78 passed B 75, and continued southwest until 5 April, having moved 1250 km from the point of release. It never left the continental shelf. During the first 21 days, the average point-to-point rate of movement was 46 km/day, while the average value for the remaining period was 6 km/day. The period of transmissions from B 78 were the longest, lasting 301 days.

B 79 showed an interrupted series of movements, first staying just a few km north of the nesting beach, and then moving about 100 km north to finally settle in a home range of about 570 km² (20% kernel ellipse size). While it did not leave the continental shelf, the home range was situated right on the edge.

B 80 stayed around the nesting beach from the date of release, 24 January, until 19 February, then moved about 450 km north to a home range right on the edge of the continental shelf. It took nearly two months from the date of release until the animal finally seemed to settle into a home range; transmissions lasted for more than nine months. Before it settled, the average point-to-point movement per day was 28 km, and after settling, the rate of movement was only 2 km/day.

B 81 showed a track similar to that of B 80, spending time in two distinct areas, first for a month in a fairly defined territory 100 km northeast of the nesting beach, then migrating about 400 km north and settling into a home range of more than 2,700 km² (20% kernel ellipse size). Once it had settled into this second home range the average daily point-to-point movement was only 1 km, whereas when it was moving between areas the rate was 25 km/day.

Conclusions

Maximum straight-line distances from the tagging site were 1300 km southward, 200 km eastward, and 1000 km northward; total estimated distance traveled by an individual during 10 months was as much as 2600 km. With the exception of B 77, that went east and apparently settled on a seamount, all of the post-nesting routes were over the continental platform, although three of them made short excursions off the shelf. Most turtles had relatively high rates of movement as they left the tagging site, before settling into an area over the continental shelf with much smaller rates of movement, or a home range. It is clear from the high degree of variability that we observed among the movements of these eight turtles that it is impossible to conclude a general pattern of post-nesting migration for loggerhead turtles from Brazil.

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DISTRIBUTION AND MOVEMENT OF JUVENILE / SUBADULT HAWKSBILL TURTLES (*ERETMOCHELYS IMBRICATA*) IN DOCE LEGUAS KEYS, JARDINES DE LA REINA ARCHIPELAGO, CUBA

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Introduction

The hawksbill *Eretmochelys imbricata* is a circumtropically distributed marine turtle that inhabits and forages on coral reefs (Marquez, 1990). Juveniles are thought to take up residence in benthic habitats after the pelagic post-hatchling life phase (Carr et al, 1966). The habitats of Doce Leguas Keys, Jardines de la Reina archipelago is an important foraging sites for the hawksbill turtle in the Cuban archipelago. A intensive tagging program of juveniles/subadults hawksbill turtles in this area has been conducted since 1989 (but mainly from 1998). The objective of the study was to investigate aspects of biology and population ecology (eg distribution, seasonality, density, grow rates etc) of juveniles/subadults hawksbill turtles in a foraging area.

Study-site

Doce Leguas keys is located between 21°12' to 20°30'S and 78°17' to 79°28'W about 60 km south of Camaguey, and is composed of more than 20 keys. It contains an extense habitat of shallower waters and coral reefs available for turtle foraging. These warm inner waters appear to be optimal for growth, and there is an abundance of the sponge *Chondrilla nucula*, the main food item for hawksbill turtles in Cuban waters (Anderes and Uchida, 1994).

Materials and Methods

From 1989 to 2002 a total of 336 juveniles/subadults hawksbill turtles have been tagged in Doce Leguas. The individuals were caught by hand, snorkeling and nets (86.6 %). Turtles were tagged on one or both front flippers. Tags were made of titanium and applied in the second or third scute of the flipper. The animals were also measured for straight and curved carapace length (nuchal notch to posteriormost marginals) and weighed before release, at the capture location.

Results

Distribution: Juveniles/subadult hawksbill turtles were found in various important sites for turtles: Cayo Cinco Balas, Cayo Caballones Oeste, (mainly Boca de Guano and Las Auras); Cayo Caballones Este (specifically in Anclitas) by hand capture while snorkeling and with nets). Tagging was mainly done during the nesting period (October- March).

Size Composition: Hawksbill turtles ranged between 17.5 to 60 cm. (n = 231; mean SCL = 31.8 cm; s = 9.044). Most individuals (85.3 %) were between 17.5 and 35 cm SCL. Given the high densities of juveniles recoded in the area (< 280 / km²), Doce Leguas keys was considered an important developmental habitat for juvenile and subadult hawksbill turtles. These were generally encountered on coral reefs and individuals were frequently seen feeding on sponges.

Recaptures: Forty-four recaptures involving 32 individuals were recorded. Tags applied to the front flippers at the time capture were in good conditions at the time of recapture. Time between capture and recapture for the 32 individuals ranged between 15 to 1460 days (mean = 293 days). Turtles were recaptured between one and four times, with 22 (65.6%) being recaptured once, nine (28.1%) twice, and one (3.1%) four times.

Distance Between Captures and Recaptures: Some information on movement and distribution within the study area was obtained through the recapture of the 31 individuals. Most recaptured turtles showed limited displacement from the first capture site. Twenty-three individuals (71.8%) stayed in the same place (range = 0 km), four individuals travelled up to 3 km from their capture sites, and three individuals went 3 to 6 km away, all within Doce Leguas keys. One hawksbill moved outside Doce Leguas keys, but within the Jardines de la Reina archipiélago. Another individual is known to have moved out of the Cuban shelf, having been the first Cuban turtle caught in Colombian waters, four years after it was initially tagged. These preliminary results suggest that juvenile and subadult hawksbill turtles appear to be resident in Doce Leguas keys for long periods of time.

Growth: The mean growth rate of juvenile/subadult hawksbill turtles in Doce Leguas Keys was 8.9 cm SCL/year.

Conclusions

The preliminary results of this long-term study are providing important insights into site fidelity and residency for juvenile and subadults turtles. Satellite telemetry has already shown that most nesting females remain in the Doce Leguas area after nesting. The shallow warm waters of the area provide optimum food and temperature conditions for both large and small turtles. High growth rates recorded for juveniles turtles likely allow maturity to be attained in shorter time. Mitochondrial data support the contention that most foraging hawksbill turtles in Doce Leguas are of Cuban origin.

Acknowledgements

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THE ARGOS GLOBAL SATELLITE TRACKING AND DATA COLLECTION SYSTEM FOR SEA TURTLES *

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The Argos Global Satellite tracking and data collection system has been used extensively since the mid-eighties by the scientific community to study animal behaviour and migration patterns, protecting endangered species and for the reintroduction of species. Argos has been used for the following species globally - penguins, cormorants, albatrosses, swans, flying foxes, dingoes, elephants, ibexes, reindeers, dugongs, seals, whale sharks and of course sea turtles.

This presentation will outline the Argos system in terms of the current and future status and the expected results that can be obtained from the system by biologists. Different models and functions of satellite transmitters (platform transmitter terminals) will be addressed for wildlife application with a focus on specialised transmitters for sea turtles. Several case studies of Argos satellite tracking of sea turtles (location and data collection) will be presented.

Additional information such as Argos mapping functions - tracks of locations plotted on vector maps and altimetry maps (sea surface height anomalies) will also be presented both orally and during the Tagging Workshop (see Workshop Report this volume).

TELEMETRY OF LOGGERHEAD TURTLES (*CARETTA CARETTA*) IN AMVRAKIKOS BAY, GREECE

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Introduction

After identifying and protecting the major nesting beaches in Greece, ARCHELON has begun focusing its work on protecting turtles at sea, in accordance with the priorities set-out in the Action Plan for the Conservation of Mediterranean Marine Turtles, within the framework of the Barcelona Convention.

Amvrakikos Bay, a closed bay in western Greece, is characterised by shallow waters, lagoons, and wetlands hosting many threatened species of wildlife, among them marine turtles. The bay is a Ramsar site, and a proposed NATURA 2000 site in the context of the European Union's Habitats Directive (Fig. 1). In conjunction with a regional management agency (ETANAM) and in the context of a co-funded, EU LIFE-Nature project, ARCHELON initiated a telemetry study to provide insight in the habits of marine turtles in the bay. The study involves deploying both satellite and radio and acoustic transmitters. The satellite transmitters were deployed during June 2002 and the radio and acoustic transmitters in September of the same year.

Methods

All sea turtles used in the study to date were deliberately captured for this purpose, using a large mesh net and 'rodeo' technique. Forays into a specific shallow (<1.5 m deep) area of the Arachthos-Vovos Estuary System (A-VES) (Fig. 1) were undertaken using a small boat. The time between turtle-capture and subsequent release was generally under 4 hours.

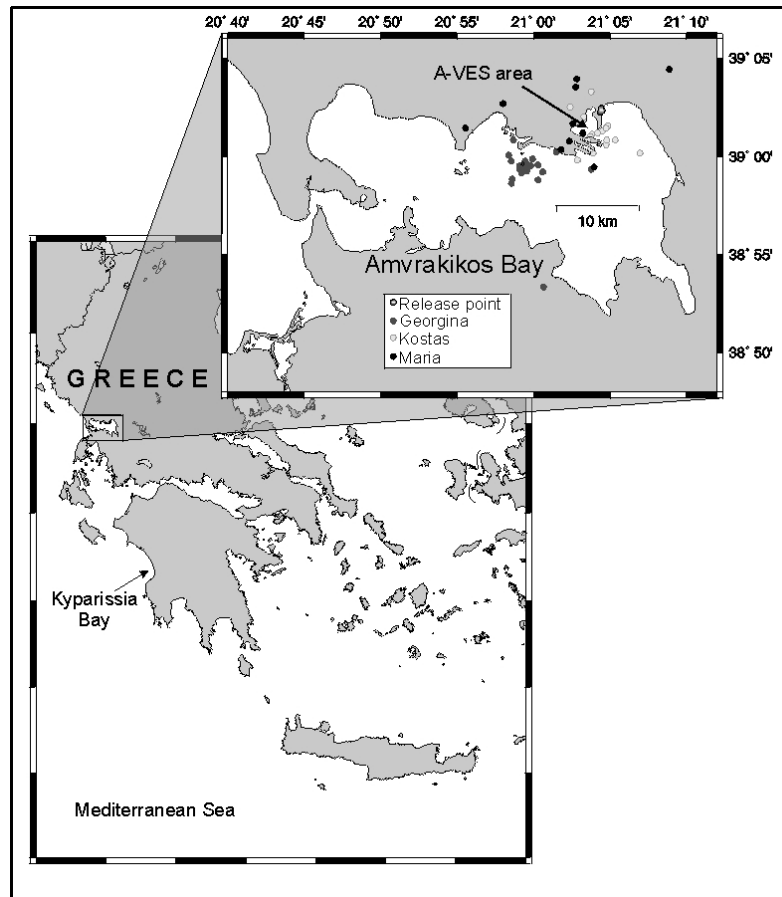


Figure 1. Locations of Amvrakikos and Kyparissia Bays within Greece and turtle locations obtained from Argos tracked turtles. See text for details of locations included and omitted.

Once the turtles were ashore, they were enclosed in a specifically built wooden box and their heads were covered with damp cloths to block their vision. Satellite transmitters were KiwiSat 101 PTTs (Sirtrack Ltd.), using the Argos data collection system. Argos provide quality indexed locations (LC), three have assigned accuracy (LC 3, 2 & 1 <1 km) and three without assigned accuracy (LC 0, A & B). Radio and acoustic transmitters (RAT) were RMMT_3 and CAFT11_4 (Lotek Wireless Inc.). Location information obtained from these transmitters involved on-site investigation; the bay was patrolled in a small boat to observe the telemetered turtles and then locations made using a hand-held GPS unit. A total of eight field visits were made for the RAT system from 6/9/02 until 31/10/02 at which time weather and other factors made it impractical to undertake further investigation. Attachment of the three types of transmitter was achieved employing the same process, after Balazs *et al.* (1996). Satellite and radio transmitters were attached to the second central scute of the carapace and acoustic transmitters was attached to the fifth central or lateral scute.

Results

By March 2003 six turtles (all loggerheads) had been equipped with transmitters, three received satellite transmitters (Georgina, Kostas & Maria) and three radio and acoustic transmitters (Iouli, Grigoris & Zoë). Sex was determined by presence or absence of a long tail. Iouli (the smallest turtle) was assumed female as she was larger than the minimum size nesting turtles in Greece (69 cm in Margaritoulis, 1988) and displayed no evidence of male-specific tail development. Interestingly, one turtle (Zoë) equipped with transmitters on 7/9/02 had been observed nesting in southern Kyparissia Bay on 30/6/02.

Data acquired from the Argos system are shown in Table I and Figure 1. All LC A fixes have been included in Figure 1, as they have been shown similar in accuracy to LC 1 (Hays *et al.*, 2001; Vincent *et al.*, 2002). LC B fixes have been plotted when they lie within 7 km of water, as they have been demonstrated to have 7 km accuracy (but with significant variability) (Hays *et al.*, 2001). After promising initial results indicating the turtles were at least temporarily resident within the bay, even possibly, with distinct "home ranges" (see data for Georgina, Fig. 1), the location data has ceased, with only on-board sensor data being received. Table I shows the differing amounts and quality of data that have been received to date from the three transmitters. It can be seen that the proportion of quality-assured locations varied between individuals from 0 to 35% and that all locations were acquired during the first two months of transmission (Table I). The abrupt cessation of transmissions from Georgina may, sadly, be due to death of the turtle, as during one field visit, rumour amongst the friendlier fishermen was that another had deliberately killed a turtle that bore a transmitter on its carapace. This story has however not been confirmed.

Table 1. Data obtained from Argos for satellite tracked turtles.

	Iouli	Grigoris	Zoë
Observations in A-VES	3	4	5
Observations out of A-VES	1	1	0
Total number of observations	4	5	5

Initial results from the RAT system were also encouraging. Upon first return to the A-VES area, where the turtles were captured, all three individuals were identified by radio signal and at least two turtles were noted in close proximity, confirmed by overlapping acoustic signals. After this first investigation no further signals were obtained from the acoustic transmitters, despite strong signals being received from the radio transmitters. It is not known why. From the fourteen recorded re-encounters, twelve were from within or at the mouth of A-VES and the remaining two were obtained west of this area (Table 2). No signals were ever recorded to the east of A-VES, although other turtles were regularly observed along the shore in the area. The recording of Grigoris outside of the A-VES was near to a mussel farm, but it is not known if the turtle was foraging on the farmed molluscs. There were no physical landmarks noted and no GPS location taken for the observation of Iouli out side of A-VES, therefore this record is of incidental importance.

Discussion

We can group the telemetry data gained thus far from the Satellite and RAT systems together with other on-site observations to make some inferences on the behaviour of sea turtles that inhabit Amvrakikos Bay. From direct, but not-quantified, observations of turtles in the bay, it is clear that the north and north-east area of the bay (characterised by warm shallow waters) hosts numerous loggerhead turtles at considerable density during the summer months (at least June through to September). All locations obtained from the Satellite and RAT systems showed the turtles remaining in the same northerly area of the bay, for periods of up to two months. These are some of the longest foraging site fidelities published for Mediterranean loggerheads (compare; Houghton *et al.*, 2000; Bentivegna, 2002; Godley *et al.*, 2003). The demonstrated specificity of habitat utilisation is an important finding as it allows conservation activities to be directed in specific area and target group i.e. the fishermen who live and work around the A-VES area.

Local fishermen have the belief that turtles remain in the bay year-round and that they move to deeper waters from the shallows during the winter. This observation is partially supported by the RAT results that showed the turtles to be generally located

within the A-VES area at times of fine weather and less likely to be observed there during periods of rough or cold weather. It was obvious, though not properly quantified that fewer and fewer turtles were spotted in the A-VES area during the field activity season of September and October. Early maximum observations were upwards of ten turtles observed from the boat at one location and dropped to spotting only one turtle within the whole A-VES area during the last patrol.

None of the satellite transmitter equipped turtles were confirmed as leaving the bay although this may be the case for Kostas and Maria as they were both still intermittently transmitting sensor data but no location information has been received since July and August respectively. It is hoped that further locations will be provided during the expected spring migrations to reproduction areas, as Plotkin (1998) has demonstrated that satellite transmitter performance can be dependent on turtle behaviour. Use of the bay by migrating mature female turtles has already been proven by tag return information gathered by ARCHELON (unpublished data and this study) and also has been reported for a male turtle captured, fitted with a PTT and released in the Gulf of Naples (Bentivegna, 2002). Thus it may be that turtles specifically choose Amvrakikos Bay as a foraging habitat, due to its favourable conditions, and may travel many kilometres to the bay from the north Ionian and bordering seas.

As conventional flipper tagging was also undertaken for the turtles used in this study these individuals will be identifiable when observed away from the bay even if the transmitters have become dislodged and lost. Thus despite the apparent lack of interesting and novel findings within from this first stage of the telemetry project (i.e. no migrations out of the bay or significant shifts proven within the bay), the repercussions of these first actions are wide ranging and long lasting, with potential to gain data on important aspects of Mediterranean loggerhead biology.

Table 2. Locations of turtles with RAT. Observations are from a total of eight field visits.

Location Class	Georgina	Kostas	Maria
3	1	2	0
2	1	1	0
1	1	3	0
0	0	0	0
A	5	0	2
B	17	11	11
Total Locations	25	17	13
Locations, Class 3-1	12%	35%	0%
Transmissions with no location calculated	124	88	136
Deployment date	6/16/2002	6/18/2002	6/19/2002
First Location	6/22/2002	6/18/2002	6/27/2002
Last Location	8/8/2002	7/2/2002	8/24/2002
Duration (days)	47	14	58
First Transmission	6/16/2002	6/18/2002	6/19/2002
Last Transmission	8/12/2002	2/24/2003	3/5/2003
Duration of Transmissions (days)	57	251	259

Acknowledgements

Fieldwork was carried out mainly with the assistance of Yannis Roussopoulos, Andreas Koutsodendris, Kostas Pasas and Kostas Dimos. Attendance to the symposium was made possible (for AFR) thanks to the Symposium Overseas Travel Committee and funding assistance from the Sea Turtle Symposium, Fisheries Canada, WWF (UK) and also through the Amvrakikos Bay LIFE-Nature project. The map for the figure was created using "Maptool" provided without charge by seaturtle.org.

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TAGGING OF SEA TURTLES IN BANGLADESH

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Introduction

Along the coast of Bangladesh, from Sundarbans to St. Martin Island, 14 areas have so far been identified for sea turtle nesting. Research on sea turtle inter-nesting periods and movements have not been done due to lack of tags until recent years, although conservation work was initiated in 1996 at St. Martin island (Islam, 1998). In 1997-1998, 16 nesting olive ridley were marked with waterproof white paint (Plate 1) but on return none of them were recognized. A few of the individuals might not have been re-nested, but it is presumed the majority of the painted females emerged subsequently and were not recognized, presumably washed off in the seawater (Islam, 1998, Islam et al 1999, 1999a).

Marine turtles are highly migratory and each turtle typically lives for several years at feeding grounds and return to its natal nesting area to reproduce. Most of the knowledge of migration of marine turtles has been revealed from the capture of female turtles that were originally tagged while laying eggs on nesting beaches. This research has now been more reliably confirmed by the use of satellite tracking. Simple flipper tags can help determine foraging habitat in offshore areas and also post nesting feeding grounds with tag recoveries, though the turtles are not easy to capture. Data on nesting turtle health can be an indicator of the overall environmental situation in the nesting areas offshore and the interesting habitat. While not all tagged turtles are recaptured, tagging can provide some answers related to movements and habitat distribution. The Marinelife Alliance at St. Martin island started tagging for the first time in Bangladesh to determine interesting periods, migration, foraging habitats and threats in offshore areas.

Tag Information

Tagging activity started in 2000 following methods in Balazs(1999). Tags were donated by Dr. George Hughes of Kawa Zulu Natal (Natal Parks Board) of South Africa, and were of Monel metal (No. 49) with numbers ranging from N401 to N500 and H300 to H400. The return address on the tags read O. RESEARCH BOX 736, DURBAN, SOUTH AFRICA. Tags were applied on the hind margin of the front flipper (left/right)s and some were also attached on rear flipper.

Results and Discussion

Tagging activity revealed some of the unknown parameters of the sea turtles' life cycle in Bangladesh, and of threat levels inshore and offshore that have high significance in terms of conservation measures. The major achievements of the tagging objective were the determination of interesting period (nesting interval); movements to and from the nesting beach; recognition of beach disturbance and threats in offshore areas. So far 65 individuals have been tagged from both species. The following summarises data from tagging and tag recovery during the period 2000-2003:

- Olive ridley turtles come to nest every year, but green turtles spend at least one year out of the nesting area;
- Olive ridley emerge to nest on the same beach with varying distance from the previous nest or original site that can be as close as 8 m;
- Simple light disturbance from a beach side resort can take displace nesting females to other sites adjacent to original site;

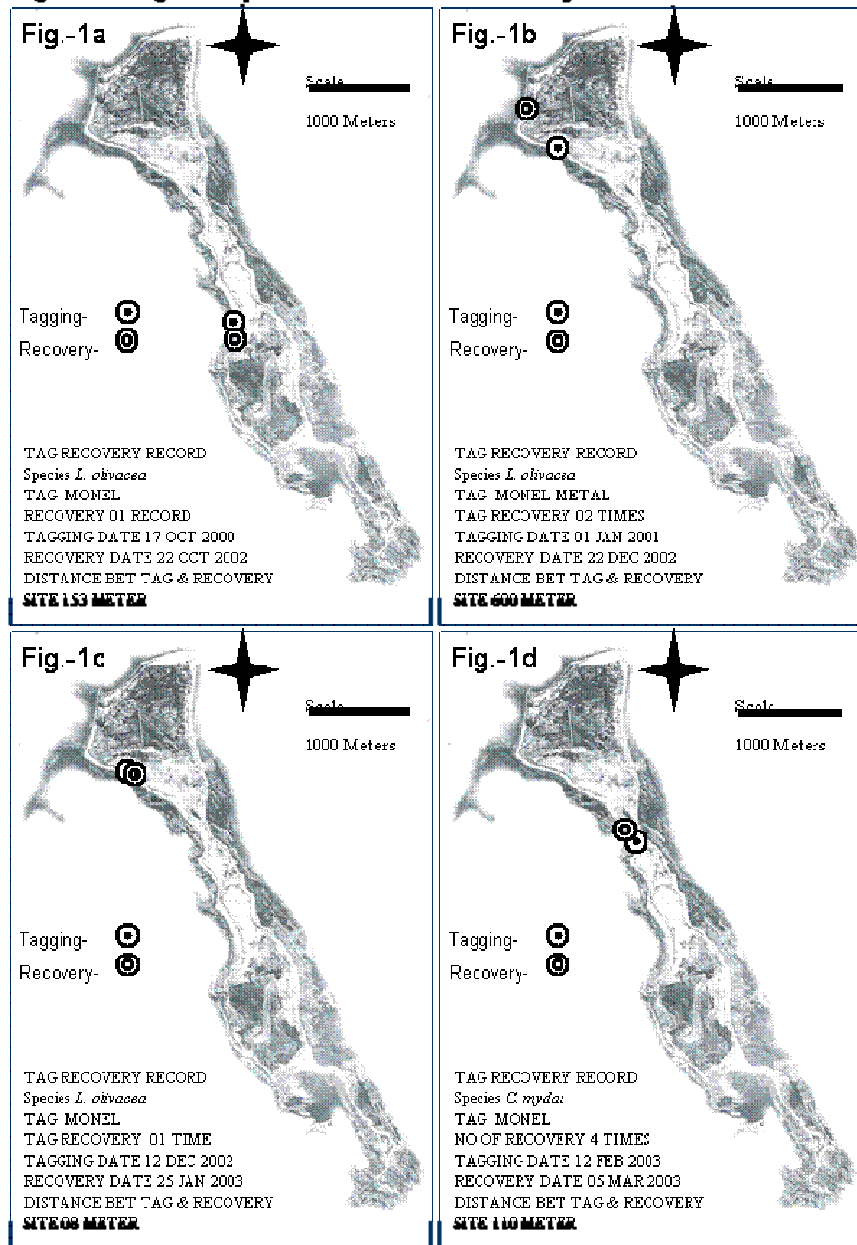
Telemetry and Migration

- Nesting intervals ranged from 14 to 16 days ($x = 14.8$ days; $n = 18$) in *Lepidochelys olivacea* and was 14 to 21 days ($X = 19.33$ days; $n = 5$) in *Chelonia mydas*; and
- Although one particular nesting site was hazardous due to rocks, an individual female repeatedly emerged at that site and tried to dig several times.

Internesting Period or Nesting Interval: Turtles spend up to two weeks between consecutive nests. Records for green turtle record were too few for detailed analysis, (only five records), but one turtle nested after 14 days interval, and the longest interval was 21 days (recorded in 2003). A record of 31 days was excluded as the turtle may have nested in this period and not been recorded. Tagging records helped us to identify a green turtle emerged several nights nesting successfully, and we also recorded one female on two consecutive nights.

Nest Site Fidelity: Sea turtles have excellent navigational capabilities as we recorded one olive ridley emerging 8 meters apart from a previous nesting site. Other distances were 153 m, 600 (the highest recorded distance); and a green turtle was recorded within 110 m from the tagging site (Fig. 1a,b,c,d).

Fig-1. Some tag recovery record at St. Martin Island during 2000-2003



Beach Disturbance: Beach disturbances such as lighting, noise and other hazards from tourism can affect emergence location for nesting turtles. We recorded one female nesting in December at Konapara and tagged it on a windy and dark night (while a tourist resort started its business few days before no lighting problem existed at the time). Later, in January 2003, we recorded the same turtle again 600 meters northward from the tagging site while the original site in front of resort was under bright lighting.

Threats in Offshore Areas: Seven females have been found with serious injuries on the carapace, two individuals with one hind flipper cut and one with tumor formation. The injuries indicates the severity of threats in the foraging and interesting habitats.

Acknowledgements

I would like to express my heartfelt thanks to Dr. George Hughes; Chief Executive of Kawa Zulu Natal (Natal Parks Board) for donating the TAGs. Without such cordial support this program could not be initiated.

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VETERINARY MEDICINE, HEALTH AND DISEASE

MARINE TURTLES AS SENTINELS OF ECOSYSTEM HEALTH: IS FIBROPAPILLOMATOSIS AN INDICATOR?

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Marine turtle fibropapillomatosis (FP) is a disease characterized by multiple cutaneous masses that has primarily affected green turtles (*Chelonia mydas*). In addition, the condition has been confirmed in other species of sea turtles. The disease has a worldwide, circumtropical distribution and has been observed in all major oceans. Although reported since the late 1930s in Florida, it was not until the late 1980s that it reached epizootic proportions in several sea turtle populations. Longterm studies have shown that pelagic turtles recruiting to near shore environments are free of the disease. After exposure to these benthic ecosystems, FP manifests itself with primary growths in the corner of the eyes spreading to other epithelial tissue. One or more herpesviruses, a papillomavirus, and a retrovirus have been found associated with tumors using electron microscopy and molecular techniques; however, the primary etiological agent remains to be isolated and characterized. Field observations support that prevalence of the disease is associated to heavily polluted coastal areas, areas of high human density, agricultural runoff, and/or biotoxin-producing algae. Marine turtles can serve as excellent sentinels of ecosystem health in these benthic environments. FP can possibly be used as an indicator but correlations with physical and chemical characteristics of water and other factors need to be made. Further research in identifying the etiologic agent and its association to other environmental variables can provide sufficient parameters to measure the health of coastal marine ecosystems, which serve not only as ecotourism spots but also as primary feeding areas for sea turtles.

THE MICROBIOTA OF NESTING SITES AND EGGS OF *CHELONIA MYDAS* IN OMAN

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Introduction

To date, not enough information is available regarding the microbiota of the sea turtles' eggs and their nesting sites. Some investigations have shown that the presence of different microbial populations causes egg spoilage (Acuna et al., 1999; and Swamy et al., 1996). A survey conducted on the sea turtle *Chelonia mydas* suggested that turtles harbor microbial pathogens (Glazebrook & Campbell, 1990). Studies of Salmonella suggested that bacterial population differ from eggshell (Berrange et al., 1999), albumin (Wong et al., 1996) and yolk (Gast et al., 1997). Others have isolated *Vibrio mimicus* from turtle eggs (Acuna et al., 1999).

Little is known about fungi that infect turtles eggs. *Aphamomyces* spp was found to cause integumental necrosis and ulceration in soft-shelled turtle (*Pelodiscus sinensis*) (Sinmuk et al., 1996). *Paecilomyces lilacinus* was reported to cause a systemic mycotic infection causing granuloma formation on hawksbill turtle (Posthaus et al. 1999), and *Fusarium solani* and *Pseudallescheria boydii* were isolated from green loggerhead turtles (Phillott and Parmenter 2001).

Some fungi were also found associated with sea turtle eggs and nests (Acuna, 1995; Phillott and Parmenter, 2001). It has been suggested that fungal presence on sea turtles egg may impede respiratory gas exchange that may result in high embryo mortality (Phillott and Parmenter, 2001). The purpose of this study was to conduct a survey of microbiota population in turtle eggs and their nesting sites.

Methods

Collection of Samples: Fifty-four intact fresh *Chelonia mydas* eggs collected during oviposition and forty already-hatched eggshells collected from nest chambers at the Ras Al Jinz Reserve, Oman, were immediately transferred to sterile plastic bags. Soil samples taken aseptically from 22 nests chambers were placed in sterile plastic bags. Ten oviductal fluid samples were

collected directly from the cloacal chamber while the turtles were in the process of secreting fluid on the eggs during oviposition. All samples were stored in a cool box and transported to the laboratory for immediate analysis.

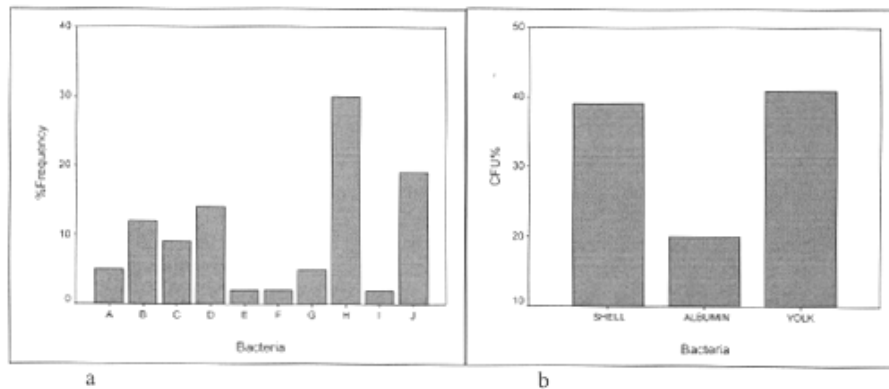
Sample Processing, Isolation and Identification of Bacteria and Mycobiota: Turtle eggs were washed with sterile water, disinfected with 70% ethanol, air dried and the contents (shell, albumin, and yolk) aseptically separated using sterilize scissors and forceps. Serial dilution standard method was followed for egg contents and oviductal fluid samples and heterotrophic bacteria cfu/ml was determined. Eggshell, albumin and yolk from each sample were used to isolate bacteria. The isolates were then identified. Serial dilution standard method was followed for isolation of fungi from soil samples and eggshells. The eggshells were disinfected with 1% sodium hypochlorite for 5 min and were cultured on potato dextrose agar containing seawater, and the fungal isolates were identified.

Results

The percentages of bacterial contamination ranged between 82% for shell, 20% for albumen and 41% for yolk and 30% of oviductal fluid. Many of the isolates were reported to be pathogens to animals and may cause severe diseases. In our study, only 18% of 54 eggs from 22 nests showed negative results whereas the rest exhibited different bacterial populations (Fig 1a) from ten different genera. *Pseudomonas* spp was the most frequent isolate (30%), followed by *Salmonella* (19%) and *Enterobacter* (14%). Other bacterial isolates *Flavobacterium*, *Pasteurella*, *Rhennella*, *Aeromonas* spp, were not common. Yolk was the most infected portion of the egg (41%) while albumin had the least number of bacteria, 20% (Fig 1b). The oviductal fluid samples were contaminated with *Enterobacter* spp and *Pseudomonas* spp. The average cfu/ml of the plate count was 5.4×10 cells/ml.

Pasteurella and *Rhennella* were isolated infrequently. No fungi were isolated from albumen and yolk. The average total count of aerobic bacteria in soil was 2×10^2 , mainly spore forming Gram positive bacteria (*Bacillus* spp.).

Fungi found were *Aspergillus flavus* 1×10^4 cfu/ml, *A. niger* 2×10^3 cfu/ml, *A. terreus* 1×10^4 cfu/ml, *A. nidulans* 3×10^2 cfu/ml, *A. fumigatus* 2×10^2 cfu/ml, *Rhizopus stolonifer* 2×10^2 cfu/ml, *Fusarium* spp. 2×10^2 cfu/ml and *Penicillium* spp. 3×10^4 cfu/ml., *A. ochraceus* 0.5×10 , *Emirecellula nidulans* 1×10 , *Cladosporium cladosporoides* 1×10 *Eurotium amystelodami*, *E. rubrum*, and *Trichoderma viridis*.



A=*Aeromonas*, B=*Citrobacter*, C=*E. coli*, D=*Enterobacter*, E=*Flavobacterium* F=*Pasteurella*, G=*Providencia*, H=*Pseudomonas*, I=*Rhennella*, J=*Salmonella*.

Fig. 1. Bacterial isolates from egg samples; a=frequency of isolation of bacteria genera; b= bacteria isolated from shell, albumin, and yolk in relation to egg components.

Table I. Sand mycobiota taken from nest chambers and eggshells.

Fungi	Soil from nest chamber cfu/g	Eggshells cfu/g
<i>Asperigillus flavus</i>	1x10 ³	1x10 ²
<i>A. niger</i>	2x10 ³	1x10 ²
<i>A. terreus</i>	1x10 ⁴	0.5x10
<i>A. nidulans</i>	3x10 ²	1x10
<i>A. fumigatus</i>	2x10 ²	0.5x10
<i>A. ochraceus</i>	ND	0.5x10
<i>Rhizopus stolonifer</i>	2x10 ²	1x10
<i>Fusarium</i> spp	2x10 ²	1x10 ³
<i>Penecillium</i> spp	2x10 ⁴	1x10 ³
<i>Emericelula nidulans</i>	ND	1x10
<i>Cladosporium cladsporoides</i>	1x10	1x10 ³
<i>Eurotium amystelodami</i>	ND	1x10 ²
<i>E. ruburn</i>	ND	1x10
<i>Trichoderma viridis</i>	ND	1x10

ND = Not detected

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HEAVY METAL MONITORING OF GREEN SEA TURTLES USING EGGS

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Introduction

Turtles can be effective biological monitors and environmental indicators with wide-ranging applications by facilitating biodetection of contaminants occurring at low levels. Preliminary data suggest that turtles amplify environmental signals through biomagnification, thus making them extremely sensitive biomonitors. Turtles are effective, long-term bioaccumulators that can function as sentinels of the chemical makeup of a region.

Heavy metals can be responsible for a variety of acute and chronic toxic effects in vertebrates (Parmegianni, 1983), but The monitoring of such substances in the ocean environment is time consuming and expensive. Sea turtles are known to cover large stretches of ocean between nesting seasons during which time they may accumulate and concentrate heavy metals in their tissues. While tagged sea turtles may serve as sensitive indicators of the level of environmental contamination (Overmann and Krajicek, 1995) it would be irresponsible to kill adult turtles for this purpose. The use of eggs from nests in the tidal zone or disturbed by other nesting turtles represent ideal subjects for routine sampling, as they are otherwise lost to predators or environmental effects. Formation of eggs is one possible route for the female to rid itself of environmental toxins. Correlation of the accumulation of these toxins with levels measured in the blood of nesting turtles may prove a noninvasive tool in assessing the overall well-being of the sea turtle population. There are no reference concentrations for metals in the eggs and eggshells of the green turtle and it is also not known how these concentrations relate to concentrations in the blood and tissues of the adult. The aim of this experiment was to quantify concentrations of toxic metals (Pb and Cd) in eggs of the Green turtle *Chelonia mydas* at Ras Al-Hadd, Oman, as correlation with levels in blood collected from the nesting turtle. This information may be used as a noninvasive indicator of the metal body burden to the turtle. The present work is also directed at inter- and intra-clutch samples to assess the relative homogeneity of heavy metal transfer from females to eggs.

Materials and Methods

Eggs collected from randomly selected turtle nests were used to measure heavy metal transfer from the female. Shell, albumin and yolk components were separately digested and representative metals determined. Calcium and sodium were determined using flame atomic spectroscopy while cadmium, copper and lead levels were determined using a graphite furnace. Standard addition of the metals to representative samples was used for validation.

All eggs were thawed at room temperature, albumin and yolk were separated, and metal concentrations were determined. All glassware was washed with three acid treatments (10% HNO₃, followed by 10% HCl and 3% HNO₃ of high purity grade) and rinsed with distilled water. Accurately weighed samples of approximately 2 g dry weight eggshell were digested by boiling in 10 mL concentrated nitric acid (ultrapure grade, Merck Co., Darmstad, Germany) in 0.5 L glass digestion tubes covered with funnels overnight. The solutions were then quantitatively rinsed with water into 25 mL volumetric flasks and diluted to the mark. A Varian Flame Atomic Absorption Spectrophotometer was used for analysis of sodium and calcium and a Graphite Furnace Atomic Absorption platform was used for lead and cadmium analysis. Lead and cadmium concentrations were determined by GF-AAS employing pyrolytic platform graphite tubes, ammonium dihydrogen phosphate (10 g/L for lead and 20 g/L for cadmium) for matrix modification and the method of additions used for quantification. Untreated eggshell samples were analyzed for elemental composition and image mapping with an Oxford energy dispersive x-ray spectrometer (EDS) at 20kV and a working distance (WD) of 20mm. The Mann Whitney nonparametric method was used test significance at $p = 0.05$.

Results and Discussion

The ultrastructure of Green turtle eggshell consisted of 2 layers including calcareous and fibrous layers duplicating previous studies on other reptilian eggshells (Packard & Hirsh 1986). The calcareous layer of the eggshell shares common characteristics, consisting of calcium carbonate crystals in aragonite form attach to a fibrous layer (Solomon & Baird 1976, Baird & Solomon 1979). Scanning electron microscopy (SEM) coupled with energy dispersive x-ray (EDX) microanalysis was used to study the ultrastructure of the calcified layer of green sea turtle eggshell. The results showed a two-layer organization with major changes in calcium carbonate crystallite density and minor variations in elemental composition. Variations between clutches examined were not significantly correlated ($p=0.05$). A third insoluble organic substrate layer, which can provide a template for controlled nucleation of specific crystallographic phase or orientation, acts as a boundary surface for controlling crystal size and shape. The EDX values (Table 3) for trace metal content were correlated with graphite furnace atomic absorption results (Table 1) of lead deposition in the eggshell matrix, providing a noninvasive means of measuring the levels present during shell formation. GFAA of all egg components showed lead and cadmium levels were significantly higher ($p=0.05$), dry wt. basis) in the yolk and albumin of the eggs (Table 2).

Table 1. Mean values for selected metals in Green sea turtle eggshell digests. Na and Ca using flame, Pb and Cd using graphite furnace. N = 16 ND = not detected

Parameters	Value	Range	Std. Dev.
Mean Shell wt. (g)	1.851	2.816-1.181	0.469
Mean wt. % Ca	11.8	16.16-7.651	2.295
Mean wt. % Na	0.212	0.348-0.140	0.062
Mean Pb (ppm)	1.669	3.180-ND	0.092
Mean Cd (ppb)	33.59	143.4-ND	5.2

Table 2. Concentrations of heavy metals in egg components produced by green sea turtles (Ras Al- Hadd, Oman). NS=not significant

VARIABLES			
	µg/g dry wt.	Clutch A Mean	Clutch B Mean
Pb in Yolk		0.29	0.24
Cd in Yolk		0.74	0.83
Pb in Albumin		0.054	0.051
Cd in Albumin		0.559	0.578
			SEM
			0.02
			0.035
			0.01
			0.02

The complex morphology of biogenic minerals is controlled by two important aspects of their environment during mineralization: the soluble chemical species present, which affect the rate of crystal nucleation and growth, and can also stabilize different crystal faces; and an organic insoluble substrate, which can provide a template for controlled nucleation of specific crystallographic phase or orientation, and acts as a boundary surface for controlling crystal size and shape. The mineralization process can be influenced by natural and manmade pollutants incorporated by the female turtle during migration. The use of eggshell matrix as a bioaccumulation indicator of pollutants in the sea turtle may be coupled with blood plasma measurements to offer complimentary means of assessing the status of the marine environment. Further work is needed to extend the use of EDX and GFAA to morphological and ultrastructural features in Green sea turtle eggshell.

Additional studies are directed at correlation of atomic absorption results with scanning electron microscopy, X-Ray fluorescence metal level analysis of sea turtle egg shells and morphological examinations.

Table 3. Percentage weight of elements (±SE) in the XRF spectrum N=8.

ELEMENT	Percent wt ± SE
C	22.73 ± 0.23
O	10.90 ± 0.24
Ca	10.41 ± 0.05
S	0.60 ± 0.02
Cu	0.32 ± 0.05
Pb	0.0016 ± 0.0003
Zn	0.24 ± 0.06
Na	0.18 ± 0.03
Al	0.06 ± 0.01

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DISEASES OF WILD-CAUGHT MARINE TURTLES IN INDONESIA AND THEIR POSSIBLE IMPLICATIONS ON TURTLE CONSERVATION MANAGEMENT

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During January 1994 to June 1995, a study on the commercial harvest of turtles in Indonesia in relation to their capture areas, mortality, and debilitation during capture-slaughter was carried out in several turtle slaughterhouse in Bali. Slaughter of a large number of turtles provided a unique opportunity to examine the presence and prevalence of several diseases, some of which have not ever been reported. Green turtle fibropapillomatosis (GTFP), cardiovascular and gastrointestinal trematodiasis, bacterial and fungal pneumonia, probable coccidiosis, and birna- or adeno-like virus were infectious diseases that we encountered during the study, either with or without overt clinical or pathological changes. Other conditions such as renal oxalosis and probable dysplasia of intestinal mucus-secreting cells were also observed in green sea turtles and hawksbill turtles. Impacts associated with the husbandry aspects were also prominent, including bruising, deep-rounded ulcers, and prolapsed cloaca. Findings suggested that diseases might play significant roles in the declining trends of the turtle population in Indonesia, and should be taken into account in conservation and management efforts for turtle populations. The potential impacts associated with the release of confiscated turtles to mix with their free-ranging counterparts after law enforcement in the country is also discussed in considerable detail.

THE TOXIC CYANOBACTERIA *LYNGBYA MAJUSCULA* IN THE DIET OF GREEN TURTLES (*CHELONIA MYDAS*)

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Introduction

Lyngbya majuscula occurs in tropical and subtropical inshore habitats throughout the world (Osborne et al. 2000). Extensive blooms, lasting up to four months, have recently been observed in Moreton Bay, Australia (Dennisson et al. 1999). The cyanobacteria contains a suite of biologically active compounds including Lyngbyatoxin A (LA) and Debromoaplysiatoxin (DAT) (Mynderse et al. 1977, Carellina et al. 1979), toxins which were determined to be the cause of outbreaks of contact dermatitis in Hawaii during 1950's (Grauer 1961) and in Japan during 1970's (Hashimoto et al. 1976) and have since been shown to be potent tumour promoters (Fujiki et al. 1983, 1984). Tumour promoting toxins from marine organisms have been implicated in the debilitating marine turtle disease fibropapillomatosis (FP) (Landsberg et al. 1999), a disease that has been observed in turtles in areas where *L. majuscula* is in bloom.

Methods

Intensive sampling was undertaken at three major green turtle feeding areas, Moreton Bay, Shoalwater Bay and the Hawaiian Islands to estimate the availability of *L. majuscula* and to quantify the amount of the blue-green algae that green turtles ingest. At each site an estimate of *L. majuscula* coverage was made by assessing the percent cover of the cyanobacteria. Green turtles were captured either by hand on snorkel (Work et al. 2001) or using the turtle rodeo technique (Limpus & Reed 1985), brought to shore and stomach flushed (Forbes & Limpus 1993, Balazs 1980) to obtain food from the most recent feeding event that was located in the anterior of the crop and oesophagus. Diet samples were analysed using the principles of microstereology (Gander 1970; Schaefer 1970) and the relative volume of each dietary component was determined using the modified methods of Channells and Morrissey (1981). The amount of LA and DAT was determined using High Performance Liquid Chromatography (HPLC) after overnight extraction with acetone (nagai et al. 1996).

Results and Discussion

Although extensive blooms of *L. majuscula* have been present in Moreton Bay during the past four years (Dennison et al. 1999), none was observed during the sampling period of this study. However, an extensive bloom was observed in Shoalwater Bay (Table 1) and a small amount > 1% of *L. majuscula* was observed during sampling in the Hawaiian Islands.

Table 1: Estimated coverage of *Lyngbya majuscula* present at each site during sampling period

Site	Estimated <i>L. majuscula</i> coverage	Sampling period
Moreton Bay (Australia)	None observed at time of sampling	3rd-7th June 2002
Shoalwater Bay (Australia)	Approx. 75% coverage	23rd June-6th July 2002
Hawaiian Islands (USA)	Scarce <1% coverage	19th-31st January 2003

The presence of LA and DAT varied greatly both within and between sites (both spatially and temporally) (Table 2). High variability has been found not only on a temporal scale, but also on a spatial scale (1m to global) (Cardellina et al. 1979, Nagle & Paul 1999).

Table 2: The content of Lyngbyatoxin A and Debromoaplysiatoxin in *Lyngbya majuscula* from Shoalwater Bay and the Hawaiian Islands

Site	n	Lyngbyatoxin A (ug/kg)			Debromoaplysiatoxin (ug/kg)		
		Mean	SD	Range	Mean	SD	Range
Shoalwater Bay	9	45.8	82.5	DL-260.3	DL		
Hawaiian Islands	18	21561	211.87.3	DL-168000.0	63156.4	160413.8	DL-540000.0

DL=detection limit

Where *L. majuscula* was present at the site during sampling, it was observed in approximately half the crop samples examined (Fig 1). However, *L. majuscula* contributes only a small proportion of green turtle diet even when in great abundance in a foraging area, suggesting that turtles try to avoid consuming the cyanobacteria.

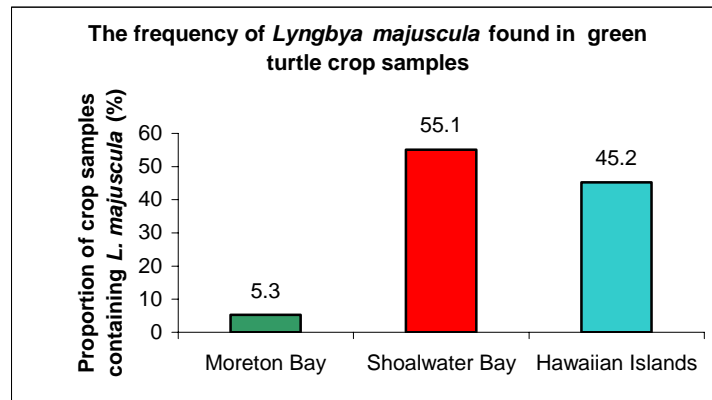


Figure 1: Frequency of *Lyngbya majuscula* observed in turtle diet samples

Based on these results, the hypothetical toxin intake for green turtles was found to be greatest in the Hawaiian Islands where it could be as high as 266ig/day LA and 735ig/day DAT. Although the effects of consuming LA and DAT have not been studied in reptiles, the lethal dose of LA for immature mice is 250ig. Effects of prolonged oral administration at sub-lethal doses included erosion of stomach and small intestine and ulceration of the caecum and large intestine (Ito et al. 2002). These symptoms have not been observed in marine turtles and it is not known whether these toxins bioaccumulate in turtles. However, LA has been associated with a fatal turtle poisoning in Madagascar (Yasumoto 1998), suggesting that these toxins may build up in turtle tissue.

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ORGANOCHLORINE CONTAMINANTS ON SEA TURTLES FROM BAJA CALIFORNIA, A PRELIMINARY ANALYSIS

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Introduction

Despite more than 20 years of protection on nesting beaches, sea turtles continue decreasing. Why? By the end of the last century, sea turtle population levels began to decline, and since then they have been declared as endangered and have been protected by several national and international laws. Commercial and subsistence takes of adults, accidental fisheries mortality, commercial and subsistence egg harvests, and habitat degradation have been considered the main causes for this decrease. Many non-governmental and governmental organizations in Mexico have instituted conservation efforts, mainly focusing on nesting beaches. On some of the main nesting beaches, the aforementioned threats have been reduced by some 80% in the last 20 years. However, with the exception of one species, turtles either do not appear to be recuperating or continue to dramatically decline. These results could be due to the late maturation periods in sea turtles, the need to increase enforcement in migratory and foraging areas, or additional factors, such as like pollutants.

Other studies have reported different PCB congeners (although the majority report only the sum of PCB's), DDT and other organochloride concentrations in sea turtles, and although no cases of mortality have been reported due to these concentrations, these same pollutants are known to promote reproductive disturbances in tortoises. Most of toxicology research on sea turtles has been developed in Atlantic and Mediterranean basins and almost no data is available for the Pacific.

The goal of this study was to create a baseline of organochlorides and toxicological information for sea turtles, to evaluate if these pollutants are a problem. We monitored sea turtles of Baja California to evaluate possible changes associated with tourism and industrial development which has been proposed for the peninsula.

Methods

Sampling: We collected approximately 20 grams of kidney, fat, liver and muscle tissues from incidentally-captured sea turtles in several Baja California localities. Samples were wrapped in aluminum foil, transported in a plastic bag on ice and stored in an freezer at -80°C.

Laboratory: 36 tissue samples from nine sea turtles were analyzed at the Environmental Protection Agency (EPA), Cincinnati, USA. Each sample was homogenized and approximately 1.0g of homogenate was extracted with 30mL of a 50:50 methylene chloride:hexane solution using an Accelerated Solvent Extraction System (Dionex ASE 200). The extract was evaporated and taken up in hexane (5 mL). The hexane was then passed through a sodium sulfate column, rinsed with hexane (10 mL) and concentrated to 6 mL. Two mL was used for lipid content; two mL passed through an Alumina-N column and concentrated to 1 mL for the GC; and 2 mL were kept for a reserve.

A two μ L injection was used on a Hewlett Packard HP 5890 gas chromatograph equipped with a micro electron capture detector. Two instruments were used to resolve coelution problems. These treatments follow EPA method 508. The analyte of interest was verified qualitatively by retention times on both columns. Quantification required agreement on both columns. If agreement was not met, the lowest concentration was reported.

Lipid Content was determined by gravimetric process. Drying temperature was 50°C. Moisture was determined by Karl Fischer titration (Mettler DL 18) using procedures outlined in the manufacturer's manual. Each batch of analyses contained a blank, a matrix spike and a duplicate of a real sample. Blanks had to produce peaks of less than 3 times the MDL to be considered acceptable.

Results

Seventeen of the 21 examined organochloride pesticides were detected, with heptachlor epoxide and γ -hexachlorocyclohexane being the most prevalent [14 (40%) and 11 (31%) of the 35 tissue samples, respectively]. Twelve of the 20 PCB's congeners were detected and at least one congener was present in all but one of the nine turtles studied, with congener 18 the most commonly detected [8 (23%) of the samples] (Table 1). The dioxin-like congeners 118 and 180 were detected in 4 (11%) and 3 (9%) of the samples, respectively. Σ OC's among tissue types were not significantly different (ANOVA, $n = 27$, $df = 3$, $p = 0.74$), however mean lipid-corrected Σ PCB's among tissue types were significantly different (ANOVA, $p = 0.001$, $n = 18$, $df = 3$) and were lowest in adipose (0.24 ng.g⁻¹ lipid) and greatest in muscle (14 ng.g⁻¹ lipid) (Fig. 1).

Discussion

Despite the fact that these are preliminary data, our results highlight interesting information previously unreported. Data for hexachlorobenzene has not been reported in sea turtles despite its status as the most toxic and persistent of the chlorobenzene compounds. With the exception of a single value published by McKenzie et al., lindane (the *gamma* isomer hexachlorocyclohexane, a known neurotoxin) has never been detected in either tissues or eggs of sea turtles. We found very low levels of organochloride contaminants compared to concentrations reported in sea turtles collected in other locations around the world, maybe due to the fact that this is a relatively unindustrialized region.

PCB concentrations were present below those reported in reproductively stressed freshwater turtles; however congeners 180 and 118 with dioxin-like toxicity were present in our samples, (detected in 11% and 9% of the samples, respectively). Because dioxin-like compounds at any concentration are considered to have the potential for endocrine disruption, no safe level has been established for these contaminants. Therefore, their presence, even in at low concentrations as observed here (0.0017-50 ng.g⁻¹ lipid) should be carefully monitored. The present study represents the first data for any post-yearling sea turtle species from the Eastern Pacific.

Table 1. Organochlorine residues detected in tissue samples from three sea turtle species collected along the Baja California peninsula, Mexico. Data are expressed as ranges on a wet weight basis (ng.g⁻¹). Detection limits were 3.0 ng.g⁻¹ww; ND signifies not detected and sample sizes are given in parentheses.

Species	Tissue	Contaminant Class							
		ΣPCB ^a	Σ DDT ^b	ΣChlor ^c	HCB	Aldrin/Dieldrin	Endosulfan I &	Endrin	Lindane
<i>C. mydas agassizii</i>	Muscle	ND -	ND-14.0	ND-13.5	ND	ND-4.8	ND-7.6	ND-4.0	ND-9.7
	Liver (7)	ND-	ND -	ND-10.4	ND-18.6	ND	ND	ND	ND-11.5
	Adipose	ND-	ND-	ND-65.1	ND	ND	ND-7.8	ND-3.5	ND-11.9
	Kidney	ND-15.9	ND-10.2	ND-	ND	ND-4.8	ND-7.7	ND-3.9	ND-9.7
<i>L.</i>	Muscle	16.9	8.6	9	4.5	ND	14.3	ND	14.3
	Liver (1)	58.1	10.4	45.3	3.5	7.3	32	ND	22.4
	Adipose	18.4	5.1	8.1	ND	ND	ND	ND	9.7
	Kidney	63.4	18.3	17.2	ND	7.3	ND	ND	17.4
<i>C. caretta</i>	Muscle	49.2	ND	ND	ND	ND	ND	ND	ND
	Liver (1)	41	ND	ND	ND	ND	3.9	ND	ND
	Adipose	ND	ND	ND	ND	ND	ND	ND	ND

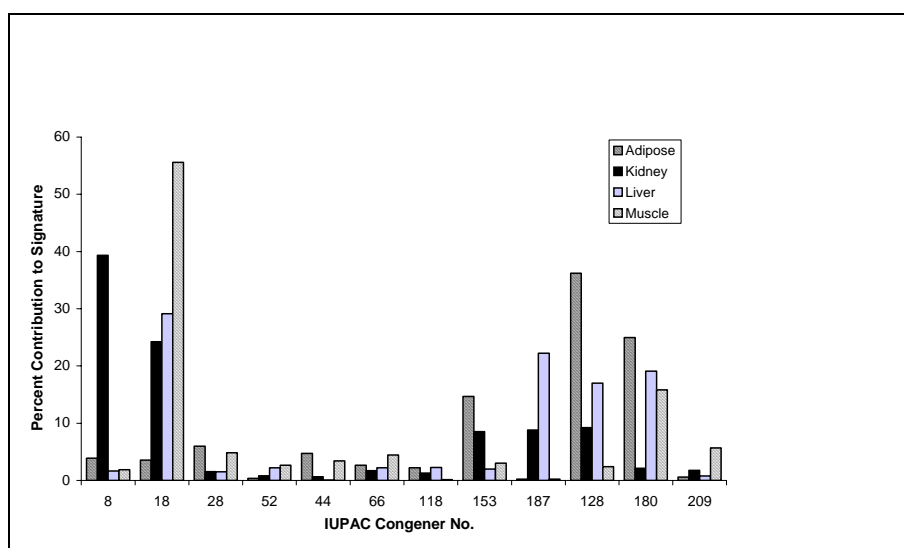


Figure 1. PCB congener compositions (percent contribution to totals) of representative sea turtle adipose, liver, kidney and muscle samples.

Notes:

^aΣPCB = Sum of congeners 8, 18, 28, 44, 52, 66, 77, 101, 105, 118, 126, 128, 138, 153, 170, 180, 187, 195, 206, 209

^bΣDDT = 2,4'-DDD, 4,4'-DDD, 2,4'-DDE, 4,4'-DDE, 2,4'-DDT, 4,4'-DDT

^cΣChlor = *cis*-chlordan, *trans*-chlordan, *cis*-nonachlor, *trans*-nonachlor, oxychlordan, heptachlor, heptachlor epoxide.

^dValues represent aldrin concentrations only since all dieldrin values were below detection limits.

^eValues represent endosulfan II concentrations only since all endosulfan I values were below detection limits.

HCB = Hexachlorobenzene; Mirex was below detection limits in all tissues analyzed.

SEROLOGICAL RESULTS FROM THE BLACK TURTLE (*CHELONIA MYDAS AGASSIZII*) FROM THREE DIFFERENT LOCATIONS AT BAJA CALIFORNIA, MEXICO FOR HERPESVIRUS, RABDOVIRUS AND ORTHOMYXOVIRUS

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Serum samples from live sea turtles captured at Punta Abreojos, Bahia de los Angeles (Baja California Norte, México) and Bahia Magdalena (Baja California Sur, Mexico) were evaluated by reduction methods for fluorescent foci, cytopagonecity and hemagglutination. Positive results were obtained for the viral genera: *Herpesvirus*, *Rabdovirus* and *Orthomyxovirus*. These tests were developed from infectious and transmittable agents in humans.

This work highlights the presence of the above viral genera for the Baja California Peninsula, and we are waiting for confirmation that these could be potential pathological agents or associated to the pathologies reported in sea turtles, as the individuals tested did not manifest any symptoms associated with viral infections or any other kind of infection.

INFECTION OF THE BLACK TURTLE (*CHELONIAS MYDAS AGASSIZII*) BY *LEAREDIUS LEAREDI*. AN HISTOLOGICAL AND PARASITOLOGICAL EVALUATION

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Marine turtles are frequently infected by espirochide trematodes. The adult parasite affects mainly the cardiovascular system, while the eggs invades different organs and tissues, producing an intensive inflammatory response. Our study included the histological and parasitological evaluation of 42 dead black turtles collected as incidental catch from fishing fleets in Magdalena Bay, Baja California Sur. México. In contrast to that reported in the literature, inflammatory responses against the parasite do not show an intensive inflammatory infiltrate. The analysis of the samples indicated abundant eggs migrating through parenchyma outside of the blood vessels, in an apparent spiral movement, emerging from the epithelium to the intestinal lumen. This observation may elucidate the natural life cycle of the parasite. Additionally, in the wake of the parasitoscopical evaluation of four hearts we obtained 180 parasite adult of a single genera, classified by their morphological characteristics as *Learedius learedi*. Our results represent the first report of the *Learedius learedi* occurrence in the black turtle, and the first report of the migration of their egg forms outside of sanguine vesicles from the infected organs to the intestinal light. This mechanism could be a potential predisposing and/or increasing factor for infections in the migration sites of *Chelonia mydas agassizii*.

MERCURY IN LOGGERHEAD SEA TURTLES, *CARETTA CARETTA*, IN THE SOUTHEAST US: ASSESSING HEALTH IMPACTS AND DEVELOPING MONITORING STRATEGIES *

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For six stranded loggerheads the Hg content in each potential monitoring tissue (blood, keratin, and skin) was regressed against Hg content in each internal tissue (liver, kidney, muscle, and spinal cord). Blood was the most accurate overall predictor of internal Hg burden (mean $R^2 = 0.9430$), followed by keratin (mean $R^2 = 0.8726$). Mercury content in blood and keratin from 34

live captures was 0.0051-0.1883 µg/g and 0.061-2.8373 µg/g respectively, were highly correlated (linear regression $R^2 = 0.9257$, $P = 0.0001$), and increased significantly with body weight ($R^2 = 0.1725$, $P = 0.0162$, $R^2 = 0.1874$, $P = 0.0119$). The residuals from this regression (representing recent Hg intake in blood compared to the average past deposition measured in keratin) were modeled in a multiple regression with 12 parameters. Only the proximity of capture site to industrial river mouth was significant ($P = 0.0102$). In light of the recent evidence for foraging site fidelity, these areas of elevated anthropogenic Hg may explain the variability in contamination and the occasional 'hot turtles' seen in this study with potentially toxic Hg burdens. Mean blood and keratin Hg concentrations in dead turtles were significantly higher than live turtles ($P = 0.0023$ and $P = 0.0499$). This trend could reflect a higher rate of Hg accumulation in chronically ill loggerheads or an immunotoxic effect by Hg that increases mortality. Hematology and immune function assay of selected individuals revealed a negative relationship between blood Hg concentration and total white blood cell count ($P = 0.0198$) and b-cell proliferation ($P = 0.0112$) suggesting these concentrations of Hg may be capable of immunosuppression that could increase the susceptibility of loggerheads to pathogens such as Fibropapilloma.

RESULTS OF RECOVERY AND REHABILITATION EFFORTS FOR INJURED LOGGERHEAD SEA TURTLES PROVIDED BY FISHERMEN

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We analyse the results of three years of efforts with damaged turtles recovered by fishermen. We also compare results of awareness-raising and collaboration with fisheries, and the evaluation of different veterinary interventions on sea turtles. Finally, we compare interventions, anesthetic proceedings, time of recovery, survival rates, and recapturing data.

PLASMA LEVELS OF TWO VITAMINS, (RETINOL AND TOCOPHEROL), ESSENTIAL FOR IMMUNE SYSTEM FUNCTION IN JUVENILE MARINE TURTLES FROM FLORIDA *

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Vitamins A (retinol) and E (tocopherols) are fat-soluble organic compounds required for the survival of many higher animals by having integral functions in growth, reproduction and immune function along with many other physiological processes. These nutrients are obtained by turtles either directly from the diet or through conversion of dietary carotenoids (vitamin A only). Growth, differentiation and integrity of epithelial tissue, bone remodeling, reproduction and vision are all reliant on a supply of vitamin A. Vitamin E is an integral constituent of cell membranes where it acts as an antioxidant and free radical scavenger. Both vitamins are necessary for proper immune system function, and therefore are of interest in attempting to understand the health status of populations afflicted with fibropapilloma disease. This study establishes baseline plasma levels for vitamins A and E in juvenile marine turtles (*Caretta caretta* and *Chelonia mydas*) and compares vitamin levels to turtle fibropapilloma status. Populations studied include: *Chelonia* and *Caretta* from the Indian River Lagoon (IRL) in Indian River County, *Chelonia* from the near-shore reef off Indian River County and *Chelonia* from the Trident Submarine Basin in Brevard County. Trident Basin turtles have had no incidence of fibropapillomatosis whereas some *Chelonia* from the near-shore reef and both species from the IRL have expressed the disease. Comparisons also will be made between vitamin levels in turtles from these three different developmental habitats.

ABNORMAL VITELLOGENIN PRODUCTION IN VIVO AND ALTERATIONS OF AROMATASE ACTIVITY IN VITRO DUE TO ORGANOCHLORINE CONTAMINANTS IN SEA TURTLES

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Low concentrations of organochlorine (OC) contaminants have been detected in tissues of endangered and threatened sea turtles (Keller 2003). OCs are known to disrupt the endocrine system and cause feminization of reptiles (Guillette et al. 1996; de Solla et al. 1998; Willingham and Crews 2000), but the effects of OCs on sea turtles have not yet been thoroughly investigated. Juvenile sea turtles have very low levels of circulating estradiol and may be highly sensitive to estrogen and estrogenic contaminants. Estradiol injections have been shown to produce a female-specific protein, vitellogenin (VTG) in both juvenile and male turtles (Heck et al. 1997). The goals of this study were to 1) determine if environmental exposure to OC contaminants can cause abnormal production of VTG in loggerhead sea turtles, and 2) develop an in vitro model system for assessing the effects of contaminants on aromatase activity using a green sea turtle testes cell line (GST-TS).

VTG is an egg yolk protein precursor expressed normally in adult breeding females of egg-laying species. Estrogenic contaminant exposure causes males and juveniles of many oviparous species to abnormally produce this protein. We screened 405 plasma samples from loggerhead turtles captured along the southeast coast of the U.S. for the presence of VTG using a polyclonal antibody raised against VTG from the red-eared slider turtle (Selcer and Palmer 1995). VTG was expressed by 100% of the nesting female loggerheads (n = 5), 90% of the females greater than 87 cm straight carapace length (SCL) (n = 10), 71% of the females that ranged in size from 77 cm to 87 cm SCL (n = 14), and 2% of the females below 77 cm SCL (n = 195). This finding suggests that loggerheads from this geographical area begin vitellogenesis around 77 cm SCL. One male, whose sex was determined by laparoscopy, was expressing VTG (n = 92). Four females smaller than 77 cm SCL (n = 195) and five turtles of unknown sex that were smaller than 77 cm SCL (n = 85) were expressing VTG. These turtles and the male may be considered precocious or abnormal.

OC contaminant concentrations were measured in whole blood and fat biopsies of many of the turtles using gas chromatography with electron capture detection and mass spectrometry. Polychlorinated biphenyl (PCB) concentrations in the blood of two of the precocious females (mean of 4270 ng/g lipid) were double the concentrations observed in blood of 36 size-matched normal females that were not expressing VTG (mean of 2360 ng/g lipid). The smallest precocious female had the second highest adipose concentrations of OPCBs (1080 ng/g wet mass) and 4,4'-DDE (221 ng/g wet mass) compared to 43 juveniles that were smaller than 77 cm SCL and were not expressing VTG (means of 237 ng/g wet mass OPCBs and 60.8 ng/g wet mass 4,4'-DDE). These findings suggest that OC contaminants may induce abnormal VTG production in juvenile loggerheads, but a larger sample size is needed.

Aromatase is an enzyme that converts testosterone to estradiol and is very important in temperature-dependent sex determination of sea turtles. Environmental contaminants are known to alter the activity of this enzyme in reptiles (Willingham and Crews 2000). Low aromatase activity was detected in the GST-TS cell line using the ³H-water release assay. This activity followed Michaelis-Menton kinetics ($V_{\text{max}} = 15 \text{ fmol/mg/h}$; $K_m = 201 \text{ nM } ^3\text{H-androstenedione}$). Three known aromatase inducers (dexamethasone, 8Br-cAMP, and human chorionic gonadotropin) failed to increase the activity of this enzyme at all concentrations except 1000 nM dexamethasone at a 21 hr exposure. An inhibitor (4-hydroxyandrostenedione) inhibited aromatase activity as expected. Atrazine, a heavily-used herbicide known to induce aromatase, increased aromatase activity slightly in the GST-TS cells at 0.1, 1.0, and 10 μM during a 24 hr exposure. 4,4'-DDE, a metabolite of the pesticide DDT, inhibited aromatase activity, but only at cytotoxic concentrations (100 μM). These preliminary findings suggest that this cell line may be used as an in vitro model to test endocrine disrupting compounds. Future studies are needed to clarify the genetic mechanisms of how environmental contaminants influence the activity of this important enzyme by examining aromatase expression.

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A SURVEY OF THE DISEASES FOUND IN MARINE TURTLES AT THE CENTRE FOR STUDY AND DISCOVERY OF MARINE TURTLES IN REUNION ISLAND FROM 2000-2002

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The Center for Study and Discovery of Marine Turtles on Reunion Island rehabilitates stranded wild marine turtles and also rears more than hundred marine turtles in captivity. In 2000-2001-2002, I conducted clinical examinations and necropsy exams of sea turtles at the center, and twelve necropsies were also done. Significant clinical findings in live turtles included:

- Bacterial skin infections due to *Vibrio alginoliticus*,
- Buoyancy problems,
- Hook ingestion in a young green turtle, and
- Arthritis.

LIPIDS REQUIREMENTS OF HAWKSBILL TURTLE HATCHLINGS (*ERETMOCHELYS IMBRICATA*)

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Introduction

Artificial breeding plays an essential role in the protection and conservation of marine turtle populations. In the Isle of Youth, Cuba, there is a turtle hatchery which has, among its main objectives, the protection of hawksbill turtles (*Eretmochelys imbricata*) in their first months of life.

Internationally, reports on feeding and nutrition of this species are scarce (Acevedo, et al., 1984 and Anderes et al., 1994). These authors indicate that the hawksbill turtle in its juvenile and mature stages possess a wide feeding spectrum, with sponges being the most frequent in the stomach content (fundamentally *Chondrilla nucula*), and that it is considered an opportunistic animal. It is inferred that hatchlings, when living among the Sargasso convergences where there is a great variety of organisms of animal origin, have a tendency to be more carnivorous.

In captivity, with limitations in the provision of fresh foods, it becomes necessary to use artificial diets that need to be adapted to the physiological requirements of the species, be nutritionally complete, available during the whole breeding cycle and within reasonable cost (Pelegrín et al., 1994; Pelegrín et al., Pelegrín and Fraga, 2000 y De Arazoza et al., 2002).

This study had as its key objective to determine the growth of hatchling hawksbill turtles, given different levels of lipid in their diet.

Materials and Methods

A randomized experiment, under controlled laboratory conditions, was performed over 63 days. Hawksbill turtle hatchlings from Cayerias de las Doce Leguas, in the southeastern region of Cuba, were moved to the experimental installation following procedures in Nodarse et al. (1998). Once in the laboratory, they were acclimatized for 2 weeks and fed on an artificial diet.

Rectangular plastic receptacles of 0.28 m² surface and 40 l capacity were used with filtered and UV-treated sea water. Two receptacles were used for each treatment. Five animals were placed in each one corresponding to a density of 18 animals/m², with average initial weight of 21.61 ± 0.21 g and 5.04 ± 0.15 cm of initial average straight carapace length. The animals were marked in the lateral right or left marginal scutes, always beginning with those at the posterior end of the animal.

Six semi-purified diets were tested in two classes: isocaloric (362 kcal /100 g) and isoproteic (51%) which contained 0, 1, 3, 5, 7 and 9% of lipids. Feeding dosage was 5% of the animals' biomass distributed twice a day (08:00 and 17:00 hours). For the development of the diets we used meager bonito flour (*Katsuwonus pelamis*), with gelatin as protein source (1:1). As lipid source, a mixture of shark liver oil and sunflower oil (1:1) was used. The chemical analysis of the raw materials and the diets were carried out following AOAC (1990). For the calculation of the energy values of the diets, Castell (1986) was followed.

The receptacles were cleaned daily, eliminating food remains and excreta by siphoning, and replacing 30% of water. The health condition of the animals was monitored and biweekly samplings were carried out to adjust the feeding dosage. Temperature and dissolved oxygen of the water were recorded twice a day; and salinity was determined once the exchange of water was complete. The photoperiod was 12:12 (L/D) and the pH was measured once per week.

When conducting the bioassays, samples of liver from two animals per treatment were taken for histological analysis. The samples were fixed in 10% neutral formalin for 72 hours and were processed by the inclusion in paraffin method. A dyeing routine of hematoxylin-eosin was used, following Coolidge and Howard (1979). At the conclusion of the experiment each of the animals was weighed and measured to determine gain in weight (GW), gain in length of the carapace (GL), proteic efficiency (PE), food conversion rate (FCR), instantaneous rate of growth (IGR) and overall survival was noted. The normality of the final gains in weight and length per treatment was verified by Kolmogorov-Smirnov tests and the variance homogeneity by means of the Bartlett tests. An Analysis of Variance of Simple Classification and Duncan's test of multiple ranges was then performed. Calculations were carried out using Statistica version 5.0 for Windows (Stat Soft Inc.).

Results and Discussion

During the experimental period the average temperature was 28.70°C, the salinity was of 40-41 ‰, the dissolved oxygen remained around 6 mg/L and the pH varied between 7.6 - 8.3. The smallest gain in weight was found with a diet of 0% of lipids, which was significantly smaller ($p > 0.05$) than those obtained with 3%, 5%, 7% and 9% lipid content. The relative growth oscillated between 276.9% and 419.1%, with the best values attributed to treatments from the II to the VI. The average final length of the carapace was higher from treatment II onward, and the results for diets of 3%, 7% and 9% lipids were significantly greater ($p < 0.05$) than diets which did not contain lipids. A 3% lipid content produced the highest values in relative growth (419.1%), index of daily growth in weight (1.4 g/day), index of growth in length (0.71 mm/day), as well as the best food conversion factor (1.59) and the biggest index of proteic efficiency (1.23). Survival varied between 90 and 100% (Table 1).

Daily growths in weight found in this investigation are within the reported values and those of daily growth in length are above those reported. Survival varied from 90% to 100%, similar to the ranges (80-100%) found in previous studies in hatchlings of marine turtles fed with artificial diets (Harfush, 1998; Pelegrín et al., 1994; Pelegrín et al., 1999 and De Arazoza 2002). While actual lipid requirements are not known, artificial diets have been used for other purposes with values between 3 - 12% (Harfush, 1998; Pelegrín et al., 2000 y De Arazoza et al., 2002).

Table I: Experimental Results

	TREATMENTS (% LIPIDS)					
	I (0)	II (1)	III (3)	IV (5)	V(7)	VI (9)
Gain in weight (g)	60.07 ^b	72.65 ^{ab}	89.31 ^a	79.76 ^a	83.49 ^a	78.98 ^a
Weight gain range	± 15.42	± 22.12	± 17.01	± 11.76	± 20.16	± 20.30
Final average length (cm)	8.54 ^b	9.09 ^{ab}	9.54 ^a	9.12 ^{ab}	9.40 ^a	9.43 ^a
Gain in length (cm)	3.53	4.05	4.50	4.11	4.34	4.31
FCR	2.07	1.83	1.59	1.74	1.74	1.64
Proteic efficiency	0.95	1.07	1.23	1.12	1.13	1.19
Daily growth in weight (g/day)	0.95	1.15	1.43	1.27	1.33	1.26
Daily growth in length (mm/day)	0.56	0.64	0.71	0.65	0.69	0.68
Survival (%)	90	100	90	100	90	90
Same treatments did not differ significantly at p> 0.05						

Conclusions and Recommendations

- It is necessary to include lipids in for hawksbill turtle hatchlings.
- The most appropriate level of lipid inclusion in the diet for the hawksbill turtle *E. imbricata* hatchlings is 3%.
- Further investigations are needed to determine the quality and proportion of lipids to include in artificial diets.

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NASAL AND CLOACAL BACTERIAL NORMAL FLORA IN OLIVE RIDLEY TURTLES (*LEPIDOCHELYS OLIVACEA*) IN THE PACIFIC NORTH FROM COSTA RICA

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Introduction

Little is known of the impact of bacterial agents on populations of sea turtles in the wild and the role that various microorganisms can have as pathogenic agents (Glazebrook and Campbell, 1990b). Many bacteria have been identified as the cause of diseases in sea turtles captivity (Glazebrook et al., 1981; Lauckner, 1985; Glazebrook and Campbell, 1990a; Glazebrook et al., 1993) however it is known that a greater number of bacterial agents can cause high mortalities in other marine species in the wild (Medway, 1980; Ghittino et al., 1984; Gulland, 1999). Base line data on the microbial flora of sea turtles in the wild are important to understand the role of infectious diseases in the survival of these species.

Materials and Methods

During July and August 2002, at Nancite Beach (10°48'N, 85°41'W), Parque Nacional Santa Rosa, Guanacaste, Costa Rica, samples were collected from 45 olive ridley turtles (Average CCL = 68.2), at night during nesting, with sterile swabs of the cloaca and the nasal passages. The samples were stored in Stuart's transport media (Difco) and transported for 24 h in an insulated container with ice to the bacteriology laboratory at the Veterinary Medicine School, National University, Heredia, Costa Rica. Material obtained from the nasal swabs was cultured on Blood agar (Oxoid), MacConkey agar (Difco) and Manitol Salt agar (BBL). The cloaca swabs were cultured on Blood agar (Oxoid), MacConkey agar (Difco), XLD agar (Oxoid) and enrichment media Rappaport-Vassiliadis-Soya peptone (RVS) Broth (Oxoid). The plates were incubated to 27°C aerobically and examined after 24 h. Gram-negative bacteria were identified by API System biochemical techniques (bio-Merieux). Gram-positive organisms were identified using conventional techniques (Bisping and Amsberg, 1988).

Results

From the cloaca and nasal samples, 15 species of bacteria were isolated: 11 Gram-negative species and four Gram-positive species; nine in the cloaca and 11 in the nasal cavity, with five species in common (Table 1).

Table 1. Bacterial of nasal cavity and the cloaca found in Olive Ridley turtles *Lepidochelys olivacea* (n=45).

Bacteria	Cloaca		Nasal	
	N	% (n. positive)	N	% (n. positive)
1) <i>Acinetobacter</i> spp.		6.6% (3)		8.8% (4)
2) <i>Aeromonas</i> spp.		28.8% (13)		6.6% (3)
3) <i>Alcaligenes faecalis</i>		2.2% (1)		0
4) <i>Bacillus</i> spp.		0		71.1% (32)
5) <i>Citrobacter freundii</i>		13.3% (6)		0
6) <i>Corynebacterium</i> spp.		0		11.1% (5)
7) <i>Enterobacter agglomerans</i>		0		4.4% (2)
8) <i>Enterococcus faecalis</i>		4.4% (2)		0
9) <i>Escherichia coli</i>		6.6% (3)		2.2% (1)
10) <i>Lactobacillus</i> spp.		0		6.6% (3)
11) <i>Proteus mirabilis</i>		2.2% (1)		6.6% (3)
12) <i>Pseudomonas aeruginosa</i>		6.6% (3)		2.2% (1)
13) <i>Pseudomonas</i> spp.		0		8.8% (4)
14) <i>Salmonella</i> spp.		6.6% (3)		0
15) <i>Staphylococcus aureus</i>		0		13.3% (6)

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TRACE METAL LEVELS IN SEA TURTLES STRANDING ALONG THE TEXAS COAST

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Three threatened and endangered sea turtle species – Kemp's ridley, loggerhead and green - use the Texas coast, home to the largest petrochemical industry in U.S., as prime feeding, developmental, and reproduction grounds. This use may expose them to a variety of pollutants, including heavy metals. Although over 6,000 sea turtles have stranded along Texas shores since 1980, the role of marine pollution in these mortalities is not documented, especially as it relates to heavy metals discharged from the petrochemical industry. This study compares heavy metal (Cu, Cd, Hg and Pb) concentrations in liver, kidney, muscle and carapace tissues of Kemp's ridley, loggerhead and green sea turtles stranding along the Texas coast during 2001-2002.

All three species exhibited higher Hg [(ridleys: mean = 1182.4 ppb, range = 151.4-3726.2 ppb), (loggerheads: mean = 240.3, range = 62.9-758.3), (greens: mean = 529.7, range = 36.0-2957.6)] and Pb [(ridleys: mean = 1376.3 ppb, range = 137.3-9166.3 ppb), (loggerheads: mean = 531.8, range = 297.0-1082.0), (greens: mean = 1619.0, range = 83.9-7272.5)] concentrations in carapace tissue while those for Cu [(ridleys: mean = 4445.6 ppb, range = 733.9-8077.8 ppb), (loggerheads: mean = 5946.5, range = 1582.9-11064.9), (greens: mean = 12216.5, range = 4427.7-19422.1)] and Cd [(ridleys: mean = 644.0 ppb, range = 180.4-1736.2 ppb), (loggerheads: mean = 4048.0, range = 2235.5- 9110.9), (greens: mean = 943.0, range = 1.5-1605.2)] were found in the liver.

Collectively, mean Hg levels were highest in Kemp's ridleys while peak Cd concentrations occurred in loggerheads, regardless of tissue sources. Stranded carcasses of Kemp's ridley and green yielded higher Cd (ridleys:150.9 ppb and greens: 198.7 ppb), Pb (ridleys:1384.4 ppb and greens: 1619.0 ppb), and Hg (greens: 529.7 ppb) concentrations in carapace tissue compared to those found by the author's other studies on live turtles. Positive relationships between Hg level and carapace length were found in ridley (kidney) and green (carapace).

22ND SYMPOSIUM PROCEEDINGS ADDENDUM

JUVENILE GREEN TURTLES OF THE SABELLARIID WORM REEF

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Phragmatapoma lapidosa (Sabellariid worms) build unique reef types called worm reef or worm rock along the East Coast of Florida from Cape Canaveral to Key Biscayne. These reef formations are particularly extensive in high energy surf zones. The greatest expanse of worm reef formation occurs between Brevard and Martin County. In Florida, there have been few studies that characterize the use of nearshore habitat by juvenile green turtles. At the St. Lucie Power Plant green turtles become entrained in the cooling water intake pipe that is located 365 meters offshore, adjacent to extensive worm reef formations. Since 1976, green turtles have been captured, measured, tagged and released from the power plant's intake canal system. The green turtle aggregation over the worm reef in Indian River County has been studied since 1989. Green turtles are net-captured, measured, tagged and released. We compiled information from these two areas that documents the importance of nearshore reef environments as critical developmental habitat.

THE TROPICAL FIRE ANT, *SOLENOPSIS GEMINATA*, ON AN IMPORTANT SEA TURTLE NESTING BEACH IN TORTUGUERO NATIONAL PARK, COSTA RICA

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Introduction

Several species of predatory ants are known to attack the hatchlings of ground-nesting birds & reptiles (e.g., Emlen 1938; Travis 1941; Hughes 1975; Landers et al. 1980; Montgomery 1996; Wetterer 1997; Allen et al. 1994, 1997, 2001; Mueller 1999; Chan & Liew 1999; Reagan et al. 2000). Hatching sea turtles are particularly vulnerable to attack by ants because hatchlings typically take from several hours to several days after pipping before they emerge from their nests. During this time, ants may invade the nests & attack trapped hatchlings (Fowler 1979; Krahe et al., 2003). Ants also sting hatchlings as they exit the nest (Krahe et al., 2003). Hatchlings may die as a direct result of the ant stings, or as an indirect result, due to impairment caused by stings, particularly stings to their eyes (Krahe et al., 2003).

Fire ants (*Solenopsis* spp.), in particular, pose an important threat to sea turtles (Foote et al. 2000; Allen et al. 2001; Wetterer & Wood 2002; Krahe et al., 2003). On Sanibel Island, Florida, LeBuff (1990 in Moulis 1997) concluded that "fire ants were the most dangerous predators upon hatchlings." In Wassaw National Wildlife Refuge, Georgia, Moulis (1997) found a significant decrease in emergence success in loggerhead sea turtle, *Caretta caretta*, nests infested with fire ants compared with uninfested nests (40.6% vs. 54.0%). In Key West Wildlife Refuge, Florida, Wilmers et al. (1996) found that the proportion of sea turtle nests infested with the red imported fire ant, *Solenopsis invicta*, increased greatly between 1990 & 1994. In Palm Beach Co., Florida, Wetterer & Wood (2002) found that 328 of 912 (36.0%) marked sea turtle nests had *S. invicta* present & two nests (<0.1%) had the tropical fire ant, *Solenopsis geminata*, present.

I conducted a preliminary survey of ants on an important sea turtle nesting beach in Tortuguero, Costa Rica. Tortuguero has the largest Atlantic nesting population of green sea turtles, *Chelonia mydas* (Bjorndal et al. 1999). Earlier researchers documented ants preying on sea turtle eggs & hatchlings at Tortuguero, but did not identify the ants (Fowler 1979; Mangel et al. 2001). In my

survey, I wished to determine what species of ants are present on the Tortuguero beach that may attack sea turtle eggs & hatchlings.

Methods

I surveyed ants along an 8.3 km stretch of beach at Tortuguero (10° 33' N; 83° 32' W) at long-term markers set up by Archie Carr in the 1950's (Carr et al. 1978) near the edge of the beach vegetation, & spaced at ~0.2 km (1/8 mile) intervals along the beach. Markers begin at -3/8 at the northernmost end of the beach (mouth of the Rio Tortuguero, 3/8 miles north of the 0 marker). On 9-10 June 2001, with the help of student assistants, I performed a visual survey to examine overall ant diversity on the beach from marker -1/8 to marker 5, collecting ants on the beach & in the vegetation within ~5 m of the marker pole closest to the ocean at each site (n = 42). I also conducted a bait survey to examine dominance (typically only one ant species dominates a bait) from marker 1 3/8 to marker 5. I placed tuna on index cards at each marker (n = 30), collected the cards two hours later, & placed them in separate plastic bags. I later counted the ants at each bait. Stefan Cover, at Harvard University, identified ants to species when possible.

Results

Combining results of the two survey methods, I found a total of 14 ant species on the Tortuguero beach (# of markers where I found each species in parentheses): *Solenopsis geminata* (32), *Pheidole* sp. (26), *Camponotus* sp. (15), *Dorymyrmex* sp. (10), *Brachymyrmex* sp. (10), *Tapinoma melanocephalum* (3), *Cardiocondyla* sp. (2), *Crematogaster* sp. (2), *Ectatomma tuberculatum* (1), *Monomorium ebeninum* (1), *Pachycondyla harpax* (1), *Pheidole laticornis* (1), *Neivamyrmex* sp. (1), and *Tapinoma* sp. (1). Only one of these species is a likely to pose a significant threat to hatching sea turtles: the tropical fire ant, *Solenopsis geminata*.

Solenopsis geminata was more common in visual surveys from marker 2 to marker 5 (at 24 of 25 markers), than along the northernmost part of the beach, from marker -1/8 to marker 1 7/8 (at 7 of 17 markers). *Solenopsis geminata* was the most common ant species in the bait survey; 14 baits had only *S. geminata* present, usually in high numbers (range: 28-764; mean = 359 ±247). Of the remaining baits, nine had other ants present, two had no ants, & five were lost, apparently taken by dogs & crabs. At the one marker between markers 2 & 5 where I did not find *S. geminata* in the visual survey, I did find this species in the bait survey.

Discussion

In 1977, Fowler (1979) studied green turtles nesting at Tortuguero along a 4-km stretch of beach (marker 2 4/8 to 5). She found that ants invaded 35 of 237 (14.8%) nests, where they "fed on the remaining hatchlings. They also were found feeding on undeveloped & unhatched eggs." However, Fowler (1979) "could not tell whether the ants killed developing eggs & hatchlings, or fed only on dead & weak individuals." Fowler (1979) noted that the ants "chew into eggs, particularly those in vegetated areas." In Florida beaches, ants are more common on nests near the vegetation. Wetterer & Wood (2002) found ants present at baits on 93.1% of sea turtle nests within 2 m of the dune vegetation, declining to 50.0% for nests 10-12 m from the vegetation, & 14.8% for nests further than 18 m from the vegetation.

In 2000, Mangel et al. (2001) studied green turtles nesting at Tortuguero along an 8.7-km stretch (marker -3/8 to 5) & noted ants "depredating or killing eggs, pipped hatchlings, hatchlings in the nest & hatchlings in the vicinity of the nest." Mangel et al. (2001), however, recorded infestation by ants at only one of 194 (0.5%) nests. Emergence success for this nest was 60.8 % as compared to 71.0 % hatching success overall for the 194 monitored nests.

From the present study, it seems likely that the tropical fire ant, *Solenopsis geminata*, is the most common ant attacking sea turtles at Tortuguero. *Solenopsis geminata*, though not as virulent as its congener *S. invicta*, is also known to attack the hatchlings of birds & reptiles (e.g., Stoddard 1931; Travis 1938, 1941; Kroll et al. 1973; Mrazek 1974). Because of the very high numbers of *S. geminata* that I observed (and was stung by) on Tortuguero beach, I suspect the impact of these ants on hatchling sea turtles may be more substantial than suggested by Mangel et al. 's (2001) study. The impact on hatchlings stung as they exit their nests may be particularly important.

Solenopsis geminata is native to the Neotropics (including Costa Rica), where in disturbed areas, it can reach very high densities & dominate the invertebrate community (Risch & Carroll 1982). It is also an invasive pest in many other parts of the world (Wetterer 1997), including many tropical & subtropical areas where sea turtles nest, such as Australia, islands of the Pacific & Indian Oceans, the Arabian Peninsula, India, South Africa, Greece, & Cyprus.

Native ants can certainly be important predator of sea turtle hatchlings. Chan & Liew (1999) found that "red ants" infested 53% of hawksbill turtle (*Eretmochelys imbricata*) nests and preyed on both eggs and hatchlings. Chan sent me ant samples and S. Cover identified them as three native Malaysian species: *Dorylus orientalis*, *Lophomyrmex* sp., and *Pheidole* sp.

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