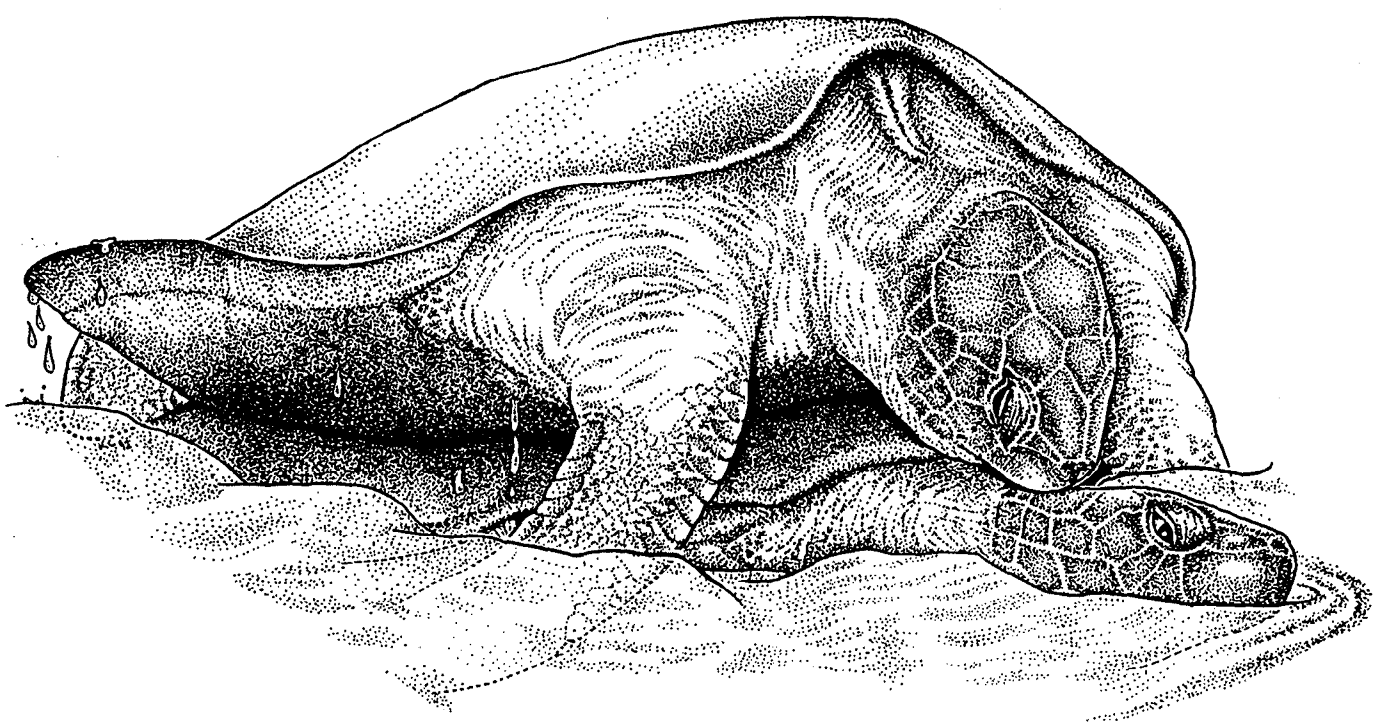
NOAA Technical Memorandum NMFS-SEFSC-341

PROCEEDINGS OF THE THIRTEENTH ANNUAL SYMPOSIUM ON SEA TURTLE BIOLOGY AND CONSERVATION

23-27 February 1993
Jekyll Island, Georgia

Compilers:
Barbara A. Schroeder
Blair E. Witherington

January 1994



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

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U.S. DEPARTMENT OF COMMERCE
Ronald H. Brown, Secretary

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
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NATIONAL MARINE FISHERIES SERVICE
Rolland A. Schmitten, Assistant Administrator for Fisheries

NOTICE

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PREFACE

The Thirteenth Annual Symposium on Sea Turtle Biology and Conservation was hosted by the Nongame and Heritage Trust Section of the South Carolina Wildlife and Marine Resources Department and the Nongame and Endangered Species Section of the Georgia Department of Natural Resources from 23 - 27 February, 1993. The Symposium brought together 565 participants representing 29 countries. Eighty-six technical papers and 50 posters were presented on topics which covered all aspects of sea turtle biology and conservation efforts. There were several meetings held in conjunction with the Symposium. These included: Wider Caribbean Sea Turtle Conservation Network (WIDECAST), U.S. Army Corps of Engineers dredging research, NMFS non-trawl incidental catch mortality, the Sea Turtle Stranding and Salvage Network (STSSN) and the IUCN/SSC Marine Turtle Specialist Group.

Many individuals worked very hard for many months to make the Thirteenth Annual Symposium a great success. Among these are the Symposium Planning Committee: John Coker, Ed Drane, Mike Harris, Charlotte Hope, Sally Krebs, Joan Logothetis, Charles Maley, Tom Murphy, and Jim and Thelma Richardson. Many people served as chairpersons for committees and were, in turn, assisted by others on their committees. These committee leaders include: Mailings, Joan Logothetis; Program, Dave Owens; International Travel, Jim Richardson; Printing, Thelma Richardson and Saundra Green; Logo Design, Colin Limpus and Kate Couper; T-shirts, Charles Maley; Mementos, Ed Drane; Co-host and Local Arrangements, Mike Harris; Registration, Thelma Richardson; Transportation and Housing, Jim Richardson; Student Award, Ken Dodd; Auction, Sally Krebs and Road Mast; Audio and Visual Aids, Charlotte Hope; Logistics, John Coker; Evening Refreshments, Charles Maley; Posters and Vendors, Rod Jackson; Trivia Quiz, Blair Witherington; Jack Woody Tribute, Richard Byles; Symposium Proceeding, Barbara Schroeder and Blair Witherington. Coffee breaks were graciously sponsored by Georgia Southern University, Marinelife Center of Juno Beach, Center for Marine Conservation, Gyotaku Designs, and Geomar Environmental Consultants. Thanks also to the U.S. Fish and Wildlife Service for providing mailing services. The Institute of Ecology, (University of Georgia), the Georgia DNR Coastal Resources Division, and the National Marine Fisheries Service provided logistical assistance. The Center for Marine Conservation provided prizes for the trivia quiz winners and the Rent-All Party Center donated much of their equipment at below retail prices. Ed Drane did a superb job of handling all of the finances involved with meeting. To keep the continuity of the meeting for next year, Chuck Oravetz and Barbara Schroeder are thanked for chairing the Nomination and Time and Place Committees, respectively. Finally, I would like to thank everyone for the jobs they undertook. It made this Symposium enjoyable for me as well as everyone else, I hope.

Sally Murphy
1993 Symposium Coordinator and President

Seventy-four papers and 30 posters have been compiled in these Proceedings. The extended abstract format allows the dissemination of more complete information than simple abstracts. While some authors have provided extended abstracts, others have chosen to provide traditional abstracts. In either case, the format involves limited editorial control. The content of these Proceedings does not necessarily reflect the views of the compilers, the Florida Marine Research Institute of the Florida Department of Environmental Protection, the South Carolina Department of Natural Resources, or the National Marine Fisheries Service. We thank Dave Crewz, Allen Foley, and Brad Weigle for their assistance with scanning of abstracts and translation of incompatible disk formats. The publication of the Symposium Proceedings was made possible through the efforts of Nancy Thompson and Wayne Witzell of the National Marine Fisheries Service, Southeast Fisheries Science Center, Miami Laboratory. William Richards serves as editor of the Technical Memoranda series.

Barbara Schroeder and Blair Witherington
1993 Symposium Proceedings Compilers

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PART I: PAPER PRESENTATIONS

FIBROPAPILLOMAS IN THE HAWAIIAN GREEN TURTLE: SEARCHING FOR AN ETIOLOGIC AGENT

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Thirty two juvenile green sea turtles (*Chelonia mydas*) were trapped in Kaneohe Bay, Oahu Island, Hawaii, during September 1991. Thirty one percent of the turtles sampled presented green turtle fibropapillomas (GTFP) with different degrees of severity. Virus isolation attempts were negative in all individuals. Nasopharyngeal and cloacal swabs taken yielded 28 Gram negative bacteria, 5 Gram positive cocci, *Bacillus* spp., and diphtheroids. The most common isolates included *Pseudomonas fluorescens* (68%), *P. putrefaciens* (66%), *Vibrio alginolyticus* (50%), non-hemolytic *Streptococcus* (50%), *V. damsela* (47%), and *V. fluvialis* (47%). Chlamydial antigen was detected in 12.5% of the turtles sampled. No hemoparasites were observed in thin blood smears analyzed. Light and electron microscopy were performed in tumor biopsies providing histopathologic characterization of GTFP. The primary lesions in these animals were characterized by a hyperplasia of squamous epithelial cells and mesodermal proliferation with a marked degree of orthokeratotic hyperkeratosis. Mites, leeches, and other organisms were associated with the surface of papilloma lesions. Although the etiologic agent of GTFP was not isolated or characterized this pilot study provided new information and possible insights in identifying the etiology of GTFP. Further parasitologic, pathologic, toxicologic, and epidemiologic studies are recommended.

MARINE TURTLES ON PLAYA LARGA (Chocó, COLOMBIA) : A CONSERVATION MODEL

Diego Amorocho

Fundacion Natura

I am very pleased to participate in this symposium for the third consecutive year, sharing the results of work undertaken three years ago on Playa Larga (Chocó), located on the buffer zone of Utria National Park, one of the most important conservation Units in the Colombian Pacific. This effort represents only the partial result of an initiative that was thought of five years ago, when I decided to start working on the conservation of marine turtles. From that moment on I think the fate of the turtles, subject to an enormous predatory pressure, started to change.

Playa Larga is a beach that links the North boundary of Utria National park with the small town of El Valle, a small community in the Chocó, forgotten by the central government and excluded from all the benefits of the modern world. In this 8 kilometer sand strip, between the months of August and December, the *Lepidochelys olivacea* turtles come to lay their eggs. However, in spite of the number of turtles that nest on this beach, the chances that these animals fulfill their reproductive cycle are minimal. This being a developing country, many people must face an everyday challenge to keep on living and the eggs that are constantly poached represent a food source.

In view of this, in 1991 we installed a station in order to protect the nesting females and their nests. After several years of rapprochement, we were able to encourage a group of youths from El Valle, to assume the leadership in the protection of important marine resources such as the marine turtles. In this manner, we integrated a team of co-researchers prepared to undertake tasks and projects on the protection, conservation and management of these marine reptiles; hoping to compile a better knowledge of the biology of this species and the circumstances that motivate the local inhabitants to indiscriminately exploit them.

Today, the number of youths involved in this task has considerably increased. Their active participation is reflected in the decision making and in the significant contribution in the elaboration of new proposals that arise entirely from their own initiative. This has been my greatest incentive in continuing a task in which the disappointments and interference in some cases seem enough to deter the most committed and convinced. However, the results are no more than an encouragement, when one looks back the achievements are nothing more than the permanent eagerness to construct a path that will lead to a brighter future.

I have not come here today, to talk exclusively of my personal experiences. I would like to talk to you about the research process that has been developing in Playa Larga. After evaluating the best site to gather information on the *Lepidochelys olivacea*, in 1991 we decided to situate the marine turtle station in the 4 kilometers, out the total 8 km of this beach, furthest away from the town. In this zone, defined as the study area, we performed nocturnal patrols during three months in order to mark, measure and transfer the nests of all the females that would arrive. The 4 km were divided in sectors 200 m long. We compiled information regarding the time of arrival, site of oviposition and location of the nest, be it in an open zone, border or vegetation, we also counted the "false arrivals". All of the females intercepted were marked and measured.

The data gathered during this past two years displayed the following information:

1. In the 4 km segmented every 200 m we observed that for the year 1991 the greatest number of arrivals was in the sector 0/200; while for the year 1992 it was in the sector 0. This is probably related to the fact

that this is the part of the beach with the least human activity. It can also be related to the proximity of the Caveatee creek, which would support the fact that *Lepidochelys olivacea* prefers to nest near fresh water course.

2. We can see here how the tendency to nest increase towards the sector 0, whose limit is the Caveatee creek's mouth.

3. Regarding the time of arrivals, we can see that in 1991 most arrived between 10 p.m. and 12 a.m. In 1992 we had to stay awake a little longer since the majority of turtles arrived between 2 and 4 a.m.

4. In 1991 the greatest number of arrivals occurred during October, while in 1992 it was in September. This is probably due to the climate variation registered between these two years in the Colombian Pacific. It is worth noting that none of the females marked in 1991 was intercepted in 1992 (we also marked turtles in 1992). This would seem to suggest that the nesting process observed in Playa Larga is not an annual phenomenon but rather an biannual phenomenon. This year we will be able to confirm this.

5. In this graph we can see how we were able in 1992 to intercept more turtles than in the previous year. We probably owe this to our improving efficiency in capturing the turtles during our night patrols.

6. With respect to the location of the nest on the beach itself, we see that in 1991, 56 nests were placed on the border zone; while in 1992 most, 74, were placed in the open zone. This makes it necessary to estimate the thermal gradients in the study area, both transversely and longitudinally, in order to establish the natural sex ratio for this beach.

7. Hoping to reduce the poaching of nests by the local inhabitants and increase the rate of emergence, the nests were transferred to our nursing beach. However, even in our nursery we were unable to completely stop the poaching.

8. Taking the measures of the female's shell length and the nest's size, we were able to confirm that there is a correlation between these variables.

To finish, I would like to add that while we were realizing the work corresponding to the period 1992, two of the most experienced researchers visited 13 communities neighboring El Valle, in order to share the successful results obtained during our first year in Playa Larga. They organized meetings with the residents, using a slide show showing the work undertaken, and they spoke with the people about the actual problems of the marine turtles and the need to contribute from different positions in the conservation of this important marine resource as a compromise with the future generations.

SEA TURTLE CONSERVATION AND SUSTAINABLE TOURISM FOR THE PROPOSED MARINE PARK ON ZAKYNTHOS ISLAND, GREECE

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INTRODUCTION

Conservationists are often faced with the task to communicate with planners and decision makers in order to ensure appropriate site management. This task may be a tedious exercise because it requires the application of qualitative and quantitative criteria in order to reconcile existing land uses with conservation.

The island of Zakynthos, W. Greece, hosts the largest nesting population of *Caretta caretta* in the Mediterranean, with a number of nests ranging from about 1,000 to 2,000 each summer (Table 1), on six distinct beaches of Laganas Bay, southern Zakynthos (Figure 1), totalling 3.6 km in length (Margaritoulis, 1985). During the last 15 years, Zakynthos became a major destination for summer tourists. This fact poses an enormous threat to the turtles and their nesting beaches and undermines the future of tourism on the island. The long-standing proposal of conservationists for the establishment of a Marine Park in Zakynthos has recently been accepted by the Greek State. This paper presents an approach to evaluate the potential for conservation and sustainable tourism in the six nesting beaches of Laganas Bay, which can be used as the basis for the planning of the Park.

METHODS

The management potential of nesting sites was assessed by the application of: (a) the ecological and pragmatic criteria for the establishment of marine protected areas as they are proposed by UNEP and IUCN (UNEP/IUCN, 1980), and (b) a set of criteria for mass tourism development which was elaborated for this purpose.

Nesting sites are considered the sandy beaches and their surrounding areas in the coastal zone. Sites are listed on a scale of relative value from 1 to 6 for each criterion. Since sea turtles are the most outstanding feature of the area, the estimation of their dependency on each nesting beach was of great importance. The parameters used to estimate dependency were: (a) percentage of total nests, (b) nesting success, (c) nesting density and (d) hatching success. Comparative data of sea turtle nesting activity over the past 8 years (obtained by the Sea Turtle Protection Society of Greece) were used for these estimations.

Rating of sites according to the remaining criteria was based on significant biological, ecological and geomorphological features. Special attention was paid to the existence of other protected and/or endangered species (*Monachus monachus, Falco eleonorae, Pancratium maritimum*, etc.) as well as important terrestrial and marine habitats (sand dunes, small wetlands, clusters of healthy Mediterranean-type vegetation, underwater meadows of *Posidonia oceanica*, etc.). Elaboration of criteria for tourism value was based on: (a) size of sandy beaches, (b) accessibility, (c) absence of nearby sandy beaches, (d) existing public facilities and (e) potential for establishing of facilities.

RESULTS AND DISCUSSION

Table 2 presents the relative rating of the degree of sea turtle nesting dependency on each of the nesting beaches. Table 3 presents the relative rating of sites according to their ecological importance and their potential for conservation. The beach of Sekania is placed first on the scale, followed by the beaches of Marathonissi, Daphni, Gerakas, East Laganas and Kalamaki.

Table 4 presents the relative rating of the same sites on the basis of their potential for tourism development. A reversal of the previous rating is noted here, with the beaches of East Laganas and Kalamaki having the highest scores, followed by the beaches of Gerakas, Daphni, Sekania and Marathonissi.

This inverse relationship between the potential for conservation and that for tourism development of the nesting beaches of Laganas Bay was expected since : (a) there is significantly lower nesting density in the already developed long beaches of Laganas and Kalamaki due to heavy disturbance, and (b) tourism has already been developed at the most suitable areas for it.

It is suggested that the design of the core areas of the Marine Park should follow the site-rating according to the ecological and pragmatic criteria, in order to effectively safeguard the nesting habitats. As a consequence of this, the beach of Sekania with its surrounding area and the whole of Marathonissi islet should serve as "sanctuaries" or "strict natural areas" requiring a very low level of human interference (just for monitoring or other essential research or conservation purposes) and the prohibition of any kind of development (buildings, roads, etc.). Intensive management is required for the beaches of East Laganas and Kalamaki in order to minimize impacts of tourism development and reverse the continuing loss of beach space. As for the remaining two "middle-rating" beaches of Daphni and Gerakas, the suggested management regime requires a very soft human interference (low numbers of visitors and non-disturbing, carefully designed activities).

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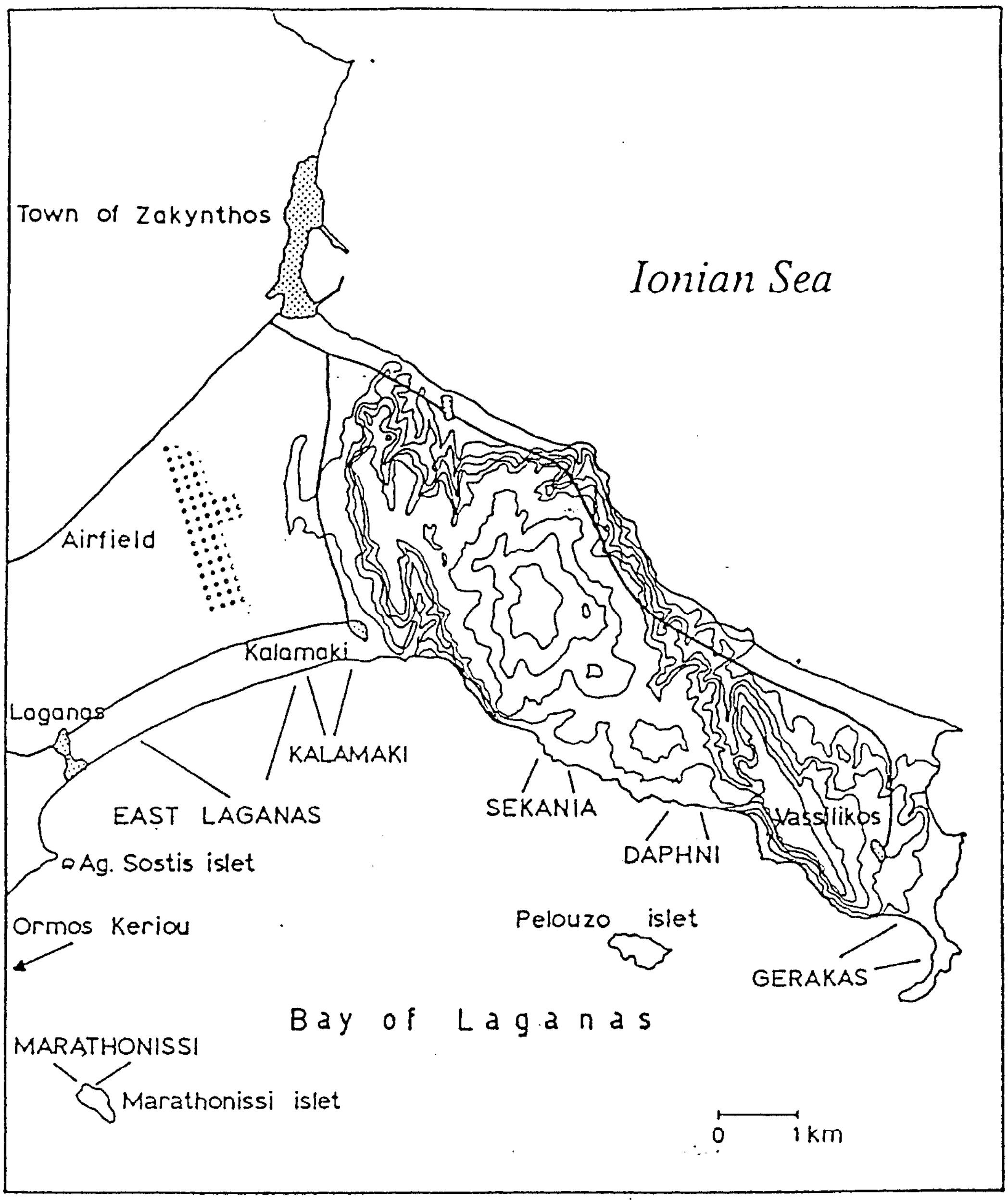

MAP 1. SKETCH MAP OF LAGANAS BAY IN ZAKYNTHOS, SHOWING (IN CAPITAL LETTERS) THE NESTING BEACHES OF *CARETTA CARETTA*.

TABLE 1. COMPARATIVE NESTING DATA ON ZAKYNTHOS OVER EIGHT NESTING SEASONS (MARGARITOULIS, 1991)

Nesting season	Number of emergencies (incl. nests)	Number of nests	Nesting success (%)	Nesting density (nests/km)
1984	3,674	1,061	28.9	298.9
1985	3,212	857	26.7	241.4
1986	5,908	1,822	30.8	513.2
1987	5,776	1,110	19.2	312.7
1988	5,682	1,408	24.8	396.6
1989	5,543	1,699	30.7	478.6
1990	3,370	926	27.5	260.8
1991	3,738	1,029	27.5	289.9

TABLE 2. ESTIMATION OF THE RELATIVE DEPENDENCY OF SEA TURTLES ON THE SIX NESTING BEACHES, LAGANAS BAY, ZAKYNTHOS, GREECE

	M	L	K	S	D	G
Percentage of total nests	2	4	3	6	5	1
Nesting success	3	4	2	6	1	5
Nesting density	5	1	3	6	4	2
Hatching success	1	5	4	6	3	2
Total	11	14	12	24	13	10

M:Marathonissi, L:East Laganas, K:Kalamaki, S:Sekania, D:Daphni, G:Gerakas

TABLE 3. RATING OF NESTING BEACHES ACCORDING TO ECOLOGICAL AND PRAGMATIC CRITERIA (UNEP/IUCN)

Ecological criteria	M	L	K	S	D	G
Dependency (see table 2)	11	14	12	24	13	10
Naturalness	5	2	1	6	4	3
Representativeness	5	6	1	4	2	3
Uniqueness	5	2	1	6	3	4
Diversity	6	2	1	5	4	3
Integrity	6	2	1	5	4	3
Sub-total (1)	38	28	17	50	30	26
Pragmatic criteria						
Urgency	5	2	1	4	6	3
Opportunism	5	2	1	6	4	3
Defensibility	5	1	2	6	4	3
Availability	6	3	1	5	2	4
Accessibility	6	1	2	5	4	3
Restorability	5	1	2	6	4	3
Sub-total (2)	32	10	9	32	24	19
Total {(1)+(2)}	70	38	26	82	54	45

TABLE 4. RATING OF NESTING BEACHES ACCORDING TO CRITERIA FOR TOURISM DEVELOPMENT

Tourism criteria	M	L	K	S	D	G
Size	1	6	2	4	3	5
Accessibility (*)	1	6	5	2	3	4
Absence of nearby beaches	1	6	5	2	3	4
Existing public facilities	2	6	5	1	3	4
Potential for establishing of facilities	1	5	6	2	3	4
Total	6	29	23	11	15	21

M:Marathonissi, L:East Laganas, K:Kalamaki, S:Sekania, D:Daphni, G:Gerakas

(*) The application of this criterion in Table 4 is done in an inverse way than in Table 3 (under the pragmatic criteria). This is because "easy" accessibility is an asset for tourism development, but at the same time a burden to conservation.

HATCHING SUCCESS OF LEATHERBACK TURTLES (*Dermochelys coriacea*) IN THE LEATHERBACKS OF GUANACASTE MARINE NATIONAL PARK, COSTA RICA

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INTRODUCTION

In Costa Rica, important leatherback beaches have been documented on the North Pacific coast, such as Langosta, Grande, and Naranjo (Chaves et al., 1990). In spite of the fact that the colony that nests at Langosta and Grande is considered one of the most important of the world (Pritchard and Koberg, 1992), only recently have any protection measures or research efforts been directed toward the conservation of this nesting habitat.

This document presents the results of a hatching success study carried out from January to April, 1991, at The Leatherbacks of Guanacaste Marine National Park, Playa Grande, Santa Cruz, Guanacaste, in an effort to determine some of the basic parameters of this important population, such as hatching success, fate of eggs, and survival of nests.

MATERIALS AND METHODS

A total 72 nests were marked from January 8-31, 1992. The exact location of each nest was marked *in situ* with a 1.75 m stake which was driven into the sand at least 1.50 m and placed exactly 1.75 m due north.

For the following two months the destiny of the tagged nests was followed, recording nests lost to erosion, predation, and human factors. After 70 days the nests were dug up to study the fate of the eggs.

RESULTS AND DISCUSSION

Of the 72 nests marked, only the destinies of 39 are known. Table 1 presents the fate of the known destiny nests, of which 4 (10%) were poached, 2 (5%) were destroyed by turtles, 1 (2%) was lost to erosion, and 32 (82%) survived to the estimated hatching date.

Figure 1 presents the total amount of eggs analyzed (n= 1912) in the surviving 32 nests. The average hatching success was 31.4%. 15.4% of the eggs showed no embryonic development (fertility rate = 84.6%). In 6.4% of the eggs, embryonic development was obvious yet impossible to determine due to advanced decomposition. In 0.5% of the cases very small embryos were detected (< 3 cm). Advanced embryos accounted for the highest numbers (46.6%).

As observed in Figure 2, infection by fly larvae is low in eggs with no apparent development (1.1%), as well as in the unknown development category (0.1%). Nonetheless, 29.8% of the eggs corresponded to advanced embryos with larvae infections, against 16.6% advanced embryos with no larvae infections.

As may be observed in Figure 3, 91% of the hatchlings were able to emerge from the nest, while 9% were found dead or as stragglers, with very scarce chances of emergence.

Table 2 compares our results with other studies. Our 31.4% hatching success is low if compared with Hirth and Ogren, 1987 (70.2%), Guadamuz, 1990 (60.8%), and Basford et. al, 1990 (70.5%). Nonetheless, the fertility rate is high (84.6%), comparable with Hirth and Ogren, 1987 (80.3%). Embryonic mortality is high (53.5%), when compared with Guadamuz (1990) and Hirth and Ogren (1987) with 4% and 10.1% respectively. Our percentage of dead and straggled turtles (9%) compares with Hirth and Ogren's (8.6%), contrasting with Guadamuz's (43%).

In summary, we conclude that even though the fertility rate is normal in Playa Grande, high embryonic death occurs, specially during the most developed stages. Although infection of eggs by fly larvae is high, the exact cause of embryonic death is unknown. For a future study we recommend that other parameters be studied, such as nest temperature, oxygen consumption, and soil humidity.

ACKNOWLEDGEMENTS

We would like to thank Mrs. Maria Teresa Koberg, Director of the Ministry of Natural Resources' National Sea Turtle Program, and Lic. Anny Chaves, Director of the University of Costa Rica's Sea Turtle Program, whose joint effort made this study possible. A very special thanks to Felipe Obando, for his great help with the field work.

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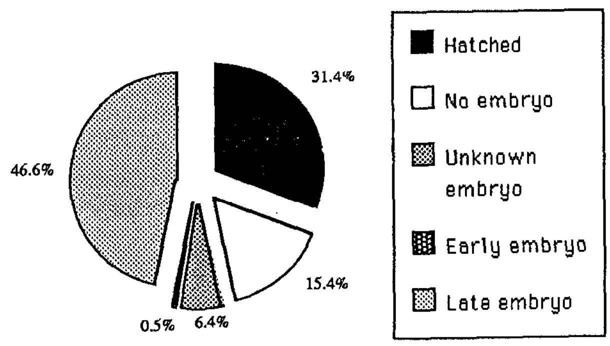

FIG. 1 Desting of analysed eggs (n=1912) in 32 leatherback nests (Dermochelys coriacea). Playa Grande, Santa Cruz, Guanacaste 1992

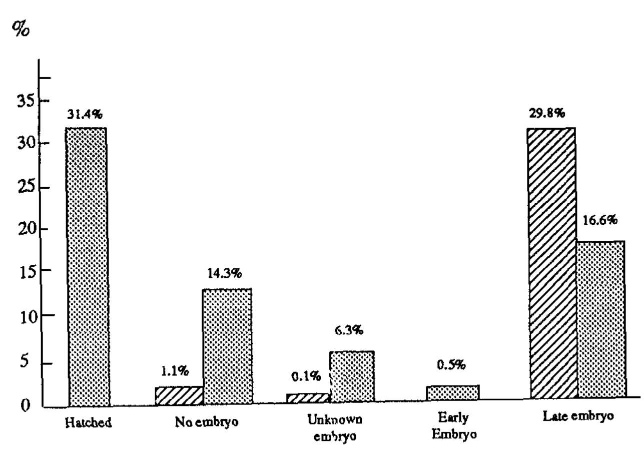

Fig. 2 Percentage of eggs infected by fly larvae by class. Playa Grande, Santa Cruz, Guanacaste

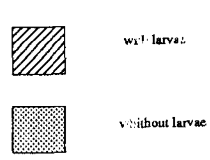

Table 1
Destiny of tagged leatherback nests (Dermochelys coriacea)
Playa Grande, Santa Cruz, Guanacaste 1992

Total tagged nests	Known Destiny	Poached	Destroyed by turtles	Eroded	Hatched
72	39	4 (10%)	2 (5%)	1 (2%)	32 (82%)

Table 2
Related Studies

Locality	# neds	Hatching success %	Fertility %	Embrionic mortality %	Dead and stragg led hatchlings %	% poached	% eroded
Playa Grande, C.R. (Guadamuz, 1990)	10	60.8	-	4	43	4.2	-
Playa Grande, C.R. (Arauz y Naranjo, 1992)	32	31.4	84.6	53.5	9	10	2.6
Jalova, C.R. (Hirth & Ogre, 1987)	24	70.2	80.3	10.1	8.6	-	-
St. Croix, Islas Virgenes (Basford et al, 1990)	75	70.5	-	-	-	0	-

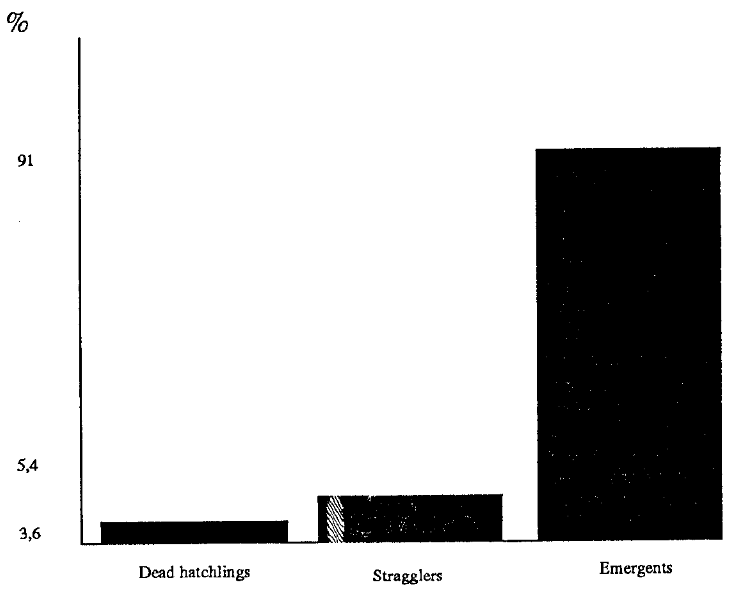

Fig. 3 Destiny of hatchlings to emergence.
Playa Grande, Santa Cruz, Guanacaste 1992

ASPECTS OF GREEN TURTLES IN THEIR FEEDING, RESTING, AND CLEANING AREAS OFF WAIKIKI BEACH

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BACKGROUND

Long-term tagging studies of green turtles (*Chelonia mydas*) in near shore waters of the Hawaiian Islands have been underway to gather comprehensive data on growth rates, movements, food sources, health status, and habitat requirements (Balazs 1980, 1982, 1991; Balazs et al. 1987). The isolated Hawaiian archipelago extends for 2400 km across the North Pacific. However, the large and inhabited volcanic islands of Kauai, Niihau, Oahu, Molokai, Lanai, Kahoolawe, Maui, and Hawaii, located at the southeastern end of the chain account for 96% or 1165 km of the existing coastline. The majority of post-pelagic Hawaiian green turtles, ranging from 35 cm juveniles to adults >82 cm, reside in the shallow benthic habitats bordering these eight islands.

Green turtles in the Hawaiian Islands have been listed and protected since 1978 under the U.S. Endangered Species Act. The population presently contains an estimated 1400 adult females. Reproductive migrations take place over considerable distances to French Frigate Shoals, located at the mid-point of the archipelago (Balazs 1976). A gradual increase in the number of nesting turtles at this site has been recorded since systematic monitoring started in 1973.

Discrete foraging and resting areas being intensively studied have been selected on the basis of 1) sufficient numbers of turtles residing in an area, and 2) the accessibility of the area to safely and successfully capture the turtles for tagging. The increased sightings of turtles during recent years in waters along world-famous Waikiki Beach have resulted in the inclusion of this site for investigation.

Located on the south shore of Oahu a short distance from downtown Honolulu, Waikiki extends for 3 km from Diamond Head to the Ala Wai Yacht Harbor. Turtles foraging along the shallow Waikiki reef, particularly in front of the Sheraton Waikiki Hotel, can regularly be seen by beachgoers and occupants of oceanfront hotel rooms. It is not unusual for turtles to briefly surface right next to tourists swimming, wading, or floating on air mattresses. In addition, scuba divers just 500 m from shore commonly encounter turtles resting on the bottom at depths of 5-15 m. Greater numbers of turtles along Waikiki offer special opportunities for research. The potential also exists to expand the role of sea turtles in ecotourism and conservation education programs. Both avenues are presently being pursued. Results of a preliminary study of the turtles along Waikiki have recently been presented in Miya and Balazs (1993).

METHODS

All capture efforts were conducted during daylight hours. Turtles resting on the bottom were caught by hand during the course of skin and scuba diving. Numerous underwater observations of the behavior of turtles were also made during these activities.
Large-mesh nets were rapidly deployed from the beach to capture turtles foraging close to shore. Netting was facilitated by stationing an observer on an upper floor of the Waikiki Sheraton Hotel. The location and

movements of turtles underwater could be readily seen from this vantage point. Information was relayed by hand-held radio to the capture team waiting on the beach. Extended observations on the diving behavior of turtles were also possible from the hotel.

Turtles were measured, weighed, identified with Inconel 681 alloy flipper tags, and carefully examined for health problems before being released. An oral inspection using a speculum was also conducted on each turtle. Food sources were determined by harmless esophageal flushing, following the procedures described by Balazs (in press). Fibropapillomas present on turtles were counted and ranked on the basis of tumor size and location (severity scores ranging from 1-4, with 4 being the most severe).

During the 30-month study period reported upon in this paper (Oct. 90 - Apr. 93), four turtles, two of which were tagged, were found dead or dying along Waikiki Beach. Necropsies conducted on these animals also contributed useful information.

RESULTS AND DISCUSSION

Forty-six turtles were captured and tagged ranging from 37.6 to 80.8 cm in straight carapace length and weights of 7.7 to 81.8 kg. An 80.7 cm turtle showed evidence of being an adolescent male, based on tail length. The sex of all other turtles captured could not be discerned due to their immature size. Nine (20%) of the 46 turtles were recaptured one or more times, all within the Waikiki study area. No turtles tagged at other study sites in Hawaii were among those captured off Waikiki. Thus far, none of the turtles tagged at Waikiki have been captured elsewhere.

Although only green turtles were captured, an adult female loggerhead (*Caretta caretta*) was regularly seen and videotaped by scuba divers off Waikiki starting in October 1991. This is an exceedingly rare species in the Hawaiian Islands. Attempts to capture and tag the turtle, which probably originated from Japan, have not yet been successful.

<u>Cleaning symbiosis</u>- Many of the turtles captured were in the vicinity of a site called "Canyons" where cleaning by several species of fish commonly occurs. Turtles were seen here posing in unusual positions while fish grazed on algae and small barnacles growing on their skin and carapace. The presence of cleaning stations like this in the Hawaiian Islands has been reported by scuba divers with increasing frequency during recent years. A specialized cleaning behavior between a wrasse (*Thalassoma duperry*) and the green turtle in Hawaiian waters has recently been demonstrated by Losey et al. (in review).

<u>Growth rates</u>- Recapture intervals greater than a year existed for only 3 of the 9 turtles recaptured. The growth rates of these three turtles were: 3.7 cm/yr for a 57.6 cm turtle; 3.0 cm/yr for a 69.3 cm turtle; and 0.3 cm/yr for the largest (80.8 cm) turtle captured. Growth exhibited by two of these turtles was higher than the overall average of 2.5 cm/yr computed for green turtles residing at the various other Hawaiian coastal areas under investigation.

As research off Waikiki progresses, growth rates of turtles in this area will have to be carefully interpreted. The practice by some divers of attracting and "taming" fish, eels, and turtles by hand feeding them squid and other proteinaceous food could alter natural growth. Two turtles that fall into this category have thus far been tagged for comparative purposes. It should be noted, however, that not all of the turtles that show little or no fear of humans diving off Waikiki are the result of hand feeding. During recent years turtles at several sites throughout the Hawaiian Islands have demonstrated a surprising tameness to swimmers, divers, and people walking along the shoreline. The reason for this phenomenon is unknown, but could be due to protective regulations and their generally effective enforcement.

<u>Food sources</u>- The food sources of turtles residing along Waikiki were found to consist of benthic algae, including *Ulva fasciata*, *U. reticulata*, *Spyridia filamentosa*, *Pterocladia capillacea*, *Gelidium pusillum*, and *Hypnea musciformis*. The latter red alga is now widespread along the coastline of Oahu, as well as Maui,

following its introduction from Florida into Kaneohe Bay on Oahu in 1974. Green turtles have been found to forage heavily on *H. musciformis* at a number of these locations (Russell and Balazs in review).

Tumors and ectoparasites- Four (9%) of the 46 turtles captured were found to have fibropapillomas. The carapace lengths of these turtles ranged from 52.6 to 70.3 cm. Two of the cases were serious (score= 3), and two were considered moderate (score= 2). The largest turtle, which was also the most severely tumored in addition to being emaciated, was found dead on Waikiki Beach five months after being tagged. The cause of fibropapillomas is unknown, but investigations both in Hawaii and Florida are in progress (see Balazs and Pooley 1991). It should be noted that the 9% affliction rate off Waikiki is relatively mild when compared to other coastal areas studied on Oahu, Molokai and Maui. For example, the prevalence of tumors on turtles at Palaau, Molokai, is estimated to now be 50%. Virtually no tumors were present on turtles sampled at this location up until 1985.

The presence of small numbers of leeches, *Ozobranchus branchiatus*, and/or their eggs was found on 5 (11%) of the turtles captured. In three of these cases, leeches were present in the mouth. Only one turtle with leeches had fibropapillomas.

Mortality and injury- Two of the four turtles found dead or dying along Waikiki Beach had severe propeller wounds to their carapace. Another turtle was found swimming in a weakened condition with the same kind of injury. The wound was treated and sealed with dental adhesive by a consulting veterinarian. Since its release the turtle has been seen on several occasions in good condition.

Two turtles were documented as having been entangled in gill nets. One was found dead washed ashore, and the other was rescued alive from a net. It is not uncommon for gill nets to be set in the near shore waters of Waikiki.

Other significant findings included two turtles with small fishhooks, one in the mouth and one in a front flipper; two turtles with healed puncture wounds resulting from a three-prong spear; one turtle with partly missing but healed hind flippers likely resulting from shark attack; and two turtles entangled in monofilament fishing line. One of the entanglements had resulted in the amputation of a front flipper that had completely healed. Monofilament line protruding from the esophagus was wrapped tightly around the base of the other front flipper. The line was cut as close as possible in the mouth. It was expelled in a fecal pellet 34 days later and found to be 2 m long.

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This on-going research program off Waikiki Beach would not be possible without the generous cooperation of Atlantis Reef Divers and the Sheraton Waikiki Hotel. We appreciate the continuing assistance and advice of John Wilson, who dives daily with turtles and videotapes their behavior. We also express our gratitude to Dr. Robert Morris for his special efforts in the veterinary care of turtles in trouble. Many other people, too numerous to name here, have contributed their time and talent to this work. We sincerely thank them all and look forward to their future involvement.

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NOTES ON THE CARDIOVASCULAR ANATOMY OF A JUVENILE BLACK TURTLE (*Chelonia mydas agassizi*)

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INTRODUCTION

Studies on the heart anatomy of sea turtles are very rarely found, since the majority of the studies of this kind are made on freshwater turtles or other kind of reptiles (Holmes, 1976; Jackson, 1979; Barragán, 1992). This is mainly due to the difficulty in obtaining the proper biological material. For this reason, all opportunities available for making this kind of research are very important since they constitute the morphological basis for further physiological studies.

On November 15, 1992, a juvenile black turtle (*Ch. mydas agassizi*) was found sick in Playón de Mexiquillo, Michoacán, Mexico. The turtle was captured and treated in "El Farito" turtle camp, where it died 18 days later. Necropsy was immediately practiced, hoping that this chance of observing the anatomy of this species would yield some interesting data.

METHODS

The heart and great vessels were removed and fixed in 10% formaldehyde. Outer and inner anatomy were observed. The pulmonary artery was opened to look for a muscular sphincter. Both atria were opened by means of an incision in their lateral walls, and inner anatomy was analyzed. The ventricle was opened in its right and left sides through paramedial cuts from the atrioventricual grooves to the apex. Atria were removed, as well as the great vessels at the level of their semilunar valves, in order to observe the atrioventricular valves.

RESULTS

External Anatomy - The complete heart measured 6 cm after it was fixed. It had three main chambers: right and left atria and a ventricle, the right atrium (RA) being larger than the left atrium (LA). It had three great vessels emerging from its right side, the pulmonary artery (PA), right aorta (RAo) and left aorta (LAo). The PA presented an evident constriction 3.5 cm above the point of bifurcation of the artery. This constriction was presumed to be the muscular sphincter mentioned by some authors (Dunlap, 1955, Sapsford, 1978). However, when sectioned, this portion didn't show any evident muscular tissue, looking like connective tissue in gross section. Two large coronary arteries emerged from the RAo; the coronary ostia were 3.0 cm above the semilunar valve of the aorta, and such arteries descended and ramified just below the emergence level of the great vessels, covering the whole ventricle.

Internal Anatomy - Both inner atrial walls had thick trabeculations and both atria were separated by an intact interatrial septum (IAS). They were communicated to the ventricle through two atrioventricular (AV) valves, right and left, sustained by a single fibrous AV annulus. Each valve had a single leaflet with three insertion points, one to the IAS and two (anterior and posterior) to the ventricular wall, without chordae tendinae or papillary muscles. Internally, the ventricle is subdivided in two chambers: the main ventricular chamber which receives blood from both atria, and an outlet chamber located in the right side of the heart, from which originates only the PA. No interventricular septum was present. The outlet chamber is communicated to the main ventricular chamber through an interchameral forament (ICF). The main ventricular chamber exhibits a great number of fine trabeculations, while the outlet chamber is smooth-walled. Along with the PA, the other two great vessels emerge from the right anterior portion or the heart, the RAo originating from the main ventricular chamber and the LAO, whose semilunar valves function as roof for the ICF.

An unusual (and unexpected) featured was discovered. A connective tissue band was attached to the anterior and posterior ventricular wall in its right side, just below the emergence point of the RAo, and very close to the AV valvular apparatus. This connective tissue band inside the ventricle has never been described in any vertebrate heart.

DISCUSSION

The anatomy of the heart described show similar features to those described for *Lepidochelys olivacea* and *Dermochelys coriacea* (Barragán, 1992), with slight variations, like the coarse trabeculations of the inner atrial walls, different from the thin trabeculations found in the other species. This variation could be due to changes occurred during growth process, since this is a juvenile turtle, and the ones used in previous studies were hatchlings (Barragán, 1992). It should be interesting to study adult sea turtle hearts to prove if this differences are caused by growth or are proper from the species.

The inner ventricular anatomy also showed interesting results, since the absence of an interventricular septum is not in accordance with some authors' conclusions (Jackson, 1979; Burggren, 1988). It is very likely that these authors are confusing some structures in the ventricle, as stated by Holmes (1976),as there are not two ventricles in the turtle heart, and the different chambers are not separated by a muscular wall as such.

The connective tissue band inside the ventricle was such an unexpected characteristic since it was never described before, and being it in a place where there should be nothing (just below the AV right valve), it makes us think of an abnormality which may contributed to the sickness of the turtle when it was found. Nevertheless, the possibility of it being an alteration caused during the fixation process is not discarded. Further studies of the heart anatomy in this species become necessary, since a single specimen can't yield any definitive conclusions.

Anatomy studies of this kind provide an important morphological basis in which further physiological studies should be sustained, as physiology processes are often a direct cause of certain anatomical features, being this the case of the circulatory physiology which depends directly on the characteristics of the circulatory system. Understanding cardiovascular morphology, can help us reveal the way circulatory physiology happens, specially in sea turtles, whose physiological features are just beginning to be studied.

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THE 1992 ST. CATHERINES SEA TURTLE PROGRAM: NEST VALIDATION BY BEACH STRATIGRAPHY

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The St. Catherines Sea Turtle Program was strengthened and enhanced in 1992, by integrating instruction, service, and research functions utilizing the mechanism of two-week internships. Routine daily monitoring activities were combined with student and faculty research projects from May 15 until Sept. 22, 1992. One hundred forty eight Loggerhead nests, producing 7,212 hatchlings, were deposited, validated by excavation, and monitored daily. The nesting season was terminated by erosion of all unhatched nests on September 23, 1992, due to the combined effects of unusually high spring tides, Hurricane Danielle, and a cold front which combined to produce an intense Nor' easter. During the nesting season two Georgia Southern faculty members and two interns lived on St. Catherines Island placing them in proximity to St. Catherines 22 km of sandy beach habitat. Fourteen internships were filled by 9 Georgia school teachers and 5 other Georgia Southern University students for two-week intervals. The internships provided the students with a hands-on, real-life research experience which school teachers carried back to their classrooms. Results of the integrated program included daily monitoring of St. Catherines beaches, production of the first draft of a Handbook for Sea Turtle Interns, the development of the use of horizontal stratigraphic discontinuity in validating egg chambers through shallow excavation, observation and documentation of multiple emergences, and the first phase of documentation of the effects of beach stratigraphy on nest success. Experience gained during 1992 will be applied to further enhancing and strengthening the 1993 St. Catherines Sea Turtle Program.

BEACH STRATIGRAPHY AS A VALIDATION TOOL FOR EGG CHAMBERS

Sandy beaches fronting Georgia Barrier Islands are formed on a mesotidal coast with an average tidal range of approximately 2 m and with low wave energy (wave heights average 0.25 m) except during periodic storms (Howard, Frey, and Reineck, 1972; Howard and Scott, 1983). Beaches, comprised of fine-grained quartz sand with admixed heavy mineral suites and shells derived from local invertebrates, are wide (150-200 m), very compact and hard, and dip gently seaward at 1 to 2 degrees. The beach can be subdivided into several zones with a typical transect crossing backshore dune ridges and dunes, a backbeach scarp delineating the position of highest spring tides and/or storm waves, the backshore (area between high tide and back beach scarp which varies in width from 0 m at spring tide to approximately 30 m at neap tide), the foreshore which is 120 to 150 m wide (the area between high tide line and low tide line) having a characteristic slope of 1 degree in the upper foreshore and a steeper slope of 2 degrees in the lower foreshore which is also characterized by ripple-marked sands, runnels, and an abundance of openings of ghost shrimp burrows (Bishop and Bishop, 1992).

Beach processes, including wave swash and tidal sorting, sort beach sediment by size, shape, and density resulting in seaward-dipping layers of beach sediments. The sedimentary layering of the upper and lower foreshore tends to consist of laterally continuous quartz layers with minor interlaminations of heavy minerals, all with a diffuse appearance due to bioturbation of burrowing organisms. The sedimentary layering of the backshore consists of laterally continuous layers of quartz sand interbedded with thick, laterally continuous layers of heavy minerals which are often 1 cm thick and reach thicknesses of upwards of 20 cm. The interlaminated sands of the backshore terminate abruptly against the erosional surface of the backbeach scarp and an erosional surface beneath the beach separating the active beach layers (commonly 20-100 cm thick) from older, underlying sediments. These stratigraphic features can be investigated by excavating trenches with flat surfaces planed by a trowel or machete to make the laminations visible (Fig. 1). Because of the near horizontal attitude of the laminations underlying the backshore, the laminations form contour-like features when cut by horizontal surfaces in excavated trenches.

On the Atlantic barrier islands, typified by St. Catherines Island, most nesting Loggerhead sea turtles exit from the ocean, crawl across the foreshore onto the backshore until they encounter either the backbeach scarp or the backshore dunes where they then turn and dig a shallow body pit and a near vertical, urn-shaped egg chamber (Hailman and Elowson, 1992). Because the inherent backshore laminations of alternating quartz and heavy mineral sands are disrupted by this digging, the nesting behavior results in a body pit discontinuity and an egg chamber discontinuity which disrupt the continuous patterns of the well-laminated backshore sands (Brannen, et al., 1992). These features can be easily seen (Fig. 2) by trenching and scraping techniques usually employed by geologists to study sedimentary structures.

Because of heavy predation pressure, it is often necessary to locate and protect each nest' s egg chamber by screening. The process of locating the egg chamber is made easier if the conservationist reads the nest sign (entrance and exit crawls, flipper scarping, and rear flipper mound), then scrapes away the sand filling of the body pit until the laminated sands of the undisturbed laminated sands of the backshore below the body pit are encountered. Scraping horizontally across the nest area with a small trowel will then expose the circular to elliptical cross section of the neck of the egg chamber which will usually stand in stark contrast to the contour-like patterning of the surrounding undisturbed backshore sands (Fig. 3). This contrast is particularly evident with horizontal excavation within a heavy mineral layer cut by an egg chamber neck back-filled with white quartz sand (Fig. 4). This technique normally allows one to validate or locate the egg chamber precisely with relatively little expense in labor and little chance of damage to the uppermost eggs in the nest.

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NESTING BIOLOGY OF A LEATHERBACK TURTLE (*Dermochelys coriacea*) ON SANDY POINT, ST. CROIX, U.S.V.I.: 1979 TO 1992

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The largest nesting population of leatherback turtles under U.S. jurisdiction occurs at Sandy Point, St. Croix, U.S. Virgin Islands. Opportunistic tagging of this population was first performed in 1979. Since 1981 this population has been intensively studied during each annual nesting season (Boulon, 1992), and approximately 270 individuals have been tagged. Annual remigration rates have averaged 28.6 percent with 56 percent of the remigrations occurring on a two year interval, 28 percent on a three year interval and the remaining on one or four year intervals (Dutton, et al., 1992). One turtle (original tag number G603), was first tagged in 1979 on Sandy Point and has returned to nest on the same beach in 1981, 1983, 1985, 1987, 1990 and 1992. This has enabled us to obtain both growth data and reproductive output of an adult individual leatherback over a long period of time.

METHODS

The study area is a 2.6 km long portion of the Sandy Pt. National Wildlife Refuge. To ensure encountering every turtle that nests on this beach, hourly patrols are performed from 2000 to 0500 hours nightly from late March until 10 days after the last nest of the season. All turtles that nest on Sandy Pt. are measured and many have been weighed. All turtles are tagged on their front and rear flippers with either Monel or inconel tags. Starting in 1992, all turtles have been tagged with a PIT tag in the shoulder region.

Most turtles are encountered when laying and egg counts are made at that time. Relocated nests are enumerated when they are being reburied. All nests are located by a series of numbered stakes placed every 20 m around the inside perimeter of the beach. Triangulation from the nearest two stakes provides precision location to within 10 cm. Erosion is the most serious natural threat to nests on this beach. To obviate this threat, all nests laid in historically erosion prone areas on the beach are relocated at the time of laying to stable parts of the beach. Nest dimensions are duplicated and relocated sites are physically similar to that of the original nest site. Relocation generally is accomplished within one hour with a minimum of handling. After hatching, nests are excavated and nest contents are examined to determine hatching success and stages of development of unhatched eggs.

RESULTS AND DISCUSSION

Although no size or nest data were obtained for G603 in 1979, and no hatching data was obtained in 1981, the intensive nature of the project has enabled nearly complete data sets to be collected for all of her nesting events in subsequent years. This turtle has nested on a consistent two year internesting interval with the exception of a three year period from 1987 to 1990. This change in periodicity may have been related to a period of lower nutrition affecting reproductive development between those seasons.

Since 1981 G603 has exhibited an over the curve growth from 155 to 159.4 cm or approximately 0.4 cm per year (Figure 1). As G603 is one of the largest turtles nesting at Sandy Point, this low growth rate is consistent with that which would be expected at the upper end of a typical growth curve. In 1987 this turtle was weighed once at 402 kg.

G603 demonstrated a similar distribution of landings on Sandy Point as did the population from 1982 to 1985 (Eckert, 1987). G603 laid 72.9% of her nests (N=37) on the Sandy Side (stakes -3 to 50) as did the entire population from 1982 to 1985 (71.1%, N=582). This demonstrates a landing preference for the Sandy Side which is a much wider, easily seen beach from the ocean than is the Grassy Side(stakes 51 to 116). When we further break the Sandy Side into a Safe Zone (stakes -3 to 20, 19% of nesting habitat) and an Erosion Zone (stakes 20 to 50, 25% of nesting habitat) we find that G603 laid 17 nests in the Safe Zone and 10 in the Erosion Zone. By contrast, she laid 10 nests on the Grassy Side (56% of nesting habitat). This might indicate a preference for the historically Safe Zone on this beach. Thus, G603 may not fall within the majority of turtles which display no landing preference among zones of the beach (Eckert, 1987).

G603 has consistently laid a higher quantity of yolked eggs (103.1, N=33) than a ten year average for the entire population (80.1, N=918)(Boulon, 1992). Her lowest years of egg production were on either side of her one three year internesting interval (Figure 2). This may support the theory that a nutritional deficiency required her to add one year to her internesting interval in order to regain reproductive health. Annual hatch success for G603 has varied from 46.6 to 65.8 percent with the highest hatch success in 1990 and the lowest in 1992 (Figure 3). It is interesting to note that the highest hatch success followed the three year internesting interval from 1987 to 1990. With the exception of 1983, the success of G603' s nests have been below the mean success for the season and have shown a gradual decline with the exception of 1990. Were it not for the dramatic increase in that year the trend might be considered indicative of a decline due to an age related decrease in viability of her eggs.

There are no obvious annual trends in any of the components of the unhatched nest contents for G603 (Figure 4). With the exception of 1983, undeveloped eggs are the greatest annual contributor to the unhatched portion of G603' s nests. In 1990 she produced the lowest numbers of midterm, fullterm pipped, fullterm unpipped and dead hatchlings. This resulted in the peak in hatch success for that year. Likewise, the increase in these components in 1992 apparently produced a low hatch success for that year. There were no obvious climactic or other external causes for this low success. When the composition of term nests are compared between G603 and all nests with known fates from 1982 to 1985 (Eckert and Eckert, 1990), there are some obvious differences (Figure 5). Over the years, G603 has produced a much greater number of eggs per nest that did not develop than the average for Sandy Point. Also G603 has produced more midterm embryos and fullterm unpipped per nest than the average. She has produced slightly less fullterm pipped per nest than the average. Data were not analyzed for average dead hatchlings per nest so it is not known how G603 differs for this component. As little is known about changes in reproductive output for sea turtles as they age, it is only speculation to say that G603 is producing greater numbers of eggs than the average that do not develop due to her age. Although G603 has had a lower annual hatch success (53.48%) than the population average from 1981 to 1990 (62.75%), her higher number of yolked eggs per nest (103.06 vs. 80.1) has resulted in a greater number of emergent hatchlings per nest (52.42, N=33) than the population average from 1981 to 1990 (50.26, N=918).

No data are available on longevity of leatherback turtles, their age to maturity nor on the duration of their reproductive life. As G603 has now nested at least seven seasons on Sandy Point, she may be providing information which can begin to answer some of these questions. However, G603 is an anomaly since as many as 76% of all turtles nesting on Sandy Point may only nest in one season (Boulon, 1992). This factor, coupled with her high level of hatchlings produced per nest, makes her an extremely valuable member of this population. The continuation of this project may provide us with information on other turtles that are similarly important. This turtle may be the longest studied individual leatherback turtle on a nesting beach.

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Figure 1. G603 growth: 1981 to 1992. Measurements are over the curve, notch to tip.

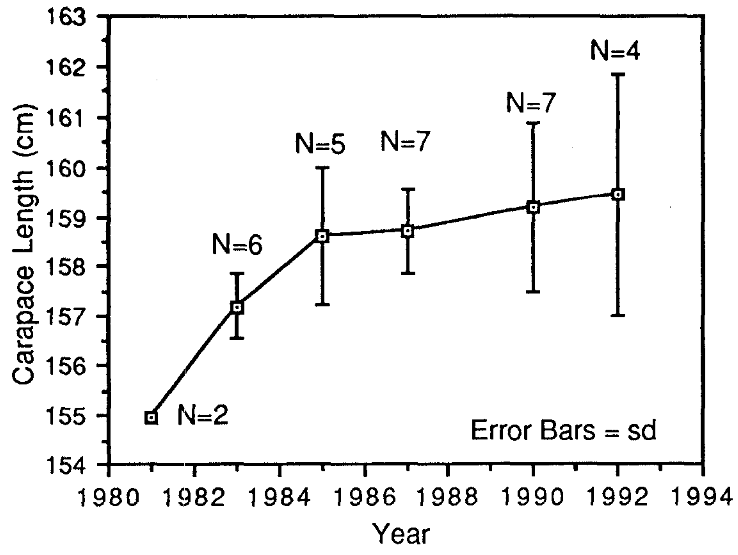


Figure 2. Mean no. eggs laid per nest (G603): 1981 to 1992. N = no. nests with egg counts.

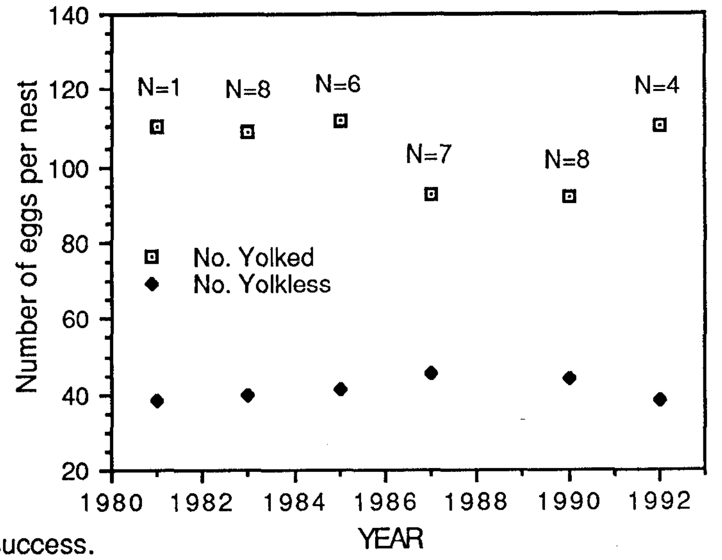


Figure 3. Annual hatch success vs G603 hatch success. N = Number of nests with known nest fates.

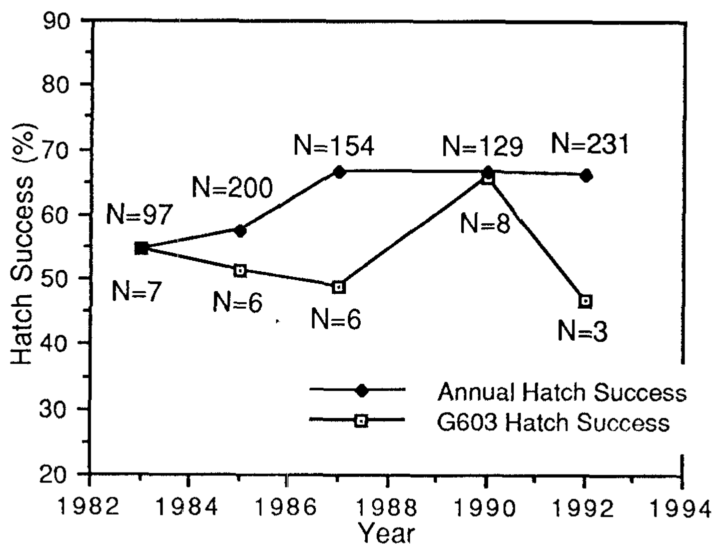


Figure 4. G603 nest fates: 1983 to 1992

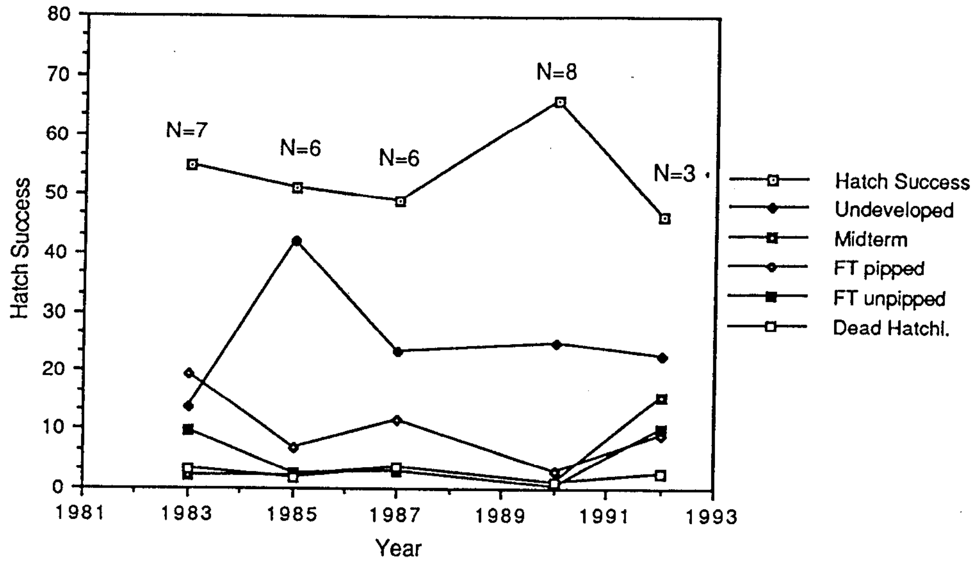
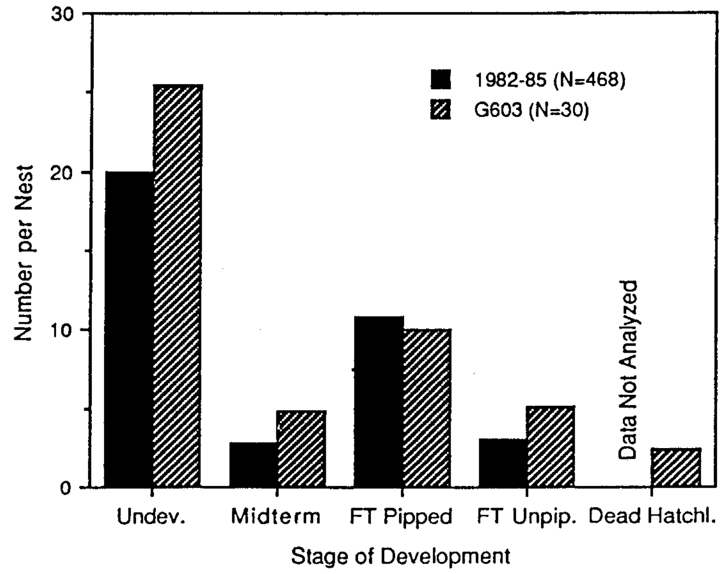


Figure 5. Composition of term nests: G603 vs 1982-85 (Eckert & Eckert, 1990), Sandy Pt., St. Croix.



A MOLECULAR PHYLOGENY FOR MARINE TURTLES: TRAIT MAPPING, MOLECULAR CLOCKS, AND CONSERVATION

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Nucleotide sequences from mitochondrial (mt) DNA cytochrome b were employed to resolve phylogenetic controversies and to assess molecular evolutionary rates in marine turtles. Several widely accepted elements of marine turtle systematics were supported by this molecular data, including (1) a distant position of *Dermochelys* relative to the Cheloniid turtles; (2) within Cheloniidae, a deep evolutionary separation of the tribe Chelonini and the tribe Carettini; (3) the systematic affiliation of Lepidochelys with *Caretta*; and (4) the grouping of two *Lepidochelys* species as sister taxa. Findings of special relevance to conservation biology include the affirmation of a distant relationship between *Natator* and other cheloniid species, the paraphyly of *Chelonia mydas* with respect to *C. agassizi*, and the genetic distinctiveness of *Lepidochelys kempi* from *L. olivacea*. Phylogenetic mapping of dietary habits demonstrates that the spongivore *Eretmochelys imbricata* is affiliated with the carnivorous Carettini rather than the herbivorous Chelonini, indicating that the unusual dietary habit of *E. imbricata* evolved from a carnivorous rather than a herbivorous ancestor. Phylogenetic analyses based on parsimony and genetic distance methods tentatively support a monophyletic grouping for marine turtles relative to an outgroup, *Chelydra serpentina*. However, this conclusion is not strongly supported by bootstrapping criteria, such that several additional outgroups may be necessary to determine whether extant marine turtles arose from a single ancestral lineage. Sequence divergences at intergeneric and interfamilial levels, when assessed against fossil-based separation times, support previous suggestions that mtDNA in marine turtles evolves much more slowly than under the "conventional" vertebrate molecular clock. This slow pace of nucleotide replacement is consistent with recent hypotheses linking nucleotide substitution rate to generation length and metabolic pace. For a more detailed discussion of these results consult: Bowen, B.W., W.S. Nelson, and J.C. Avise. 1993. Proc. Natl. Acad. Sci. USA 90:5574-5577.

SEA TURTLE DISTRIBUTIONS AND DOCUMENTED FISHERY THREATS OFF THE NORTHEASTERN UNITED STATES COAST

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The purpose of this study is to correlate the existing data bases regarding sea turtle distribution and the incidental take of sea turtles in the Northeast. The National Marine Fisheries Service defines the northeastern United States as the region from Cape Hatteras, North Carolina to Maine and the surrounding offshore waters.

According to Bleakney and Carr (1965,1952), the four species of sea turtles that most commonly occur in the Northeast are leatherbacks (*Dermochelys coriacea*), loggerheads (*Caretta caretta*), Kemp's Ridleys (*Lepidochelys kempi*), and greens (*Chelonia mydas*). Lazell (1980) suggested that this region is a critical feeding area for Kemp's Ridleys, loggerheads, and leatherbacks. Work conducted in embayments in the Northeast since that time, such as the work by Morreale and Standora (1989), and Burke (1990), support this suggestion; however, no feeding studies have been conducted in offshore waters.

The objectives of our study are as follows:

1. Compile the various data sets that include sea turtle sightings, strandings, and incidental take in fisheries in the northeastern United States. The compilation includes the location and accessibility of the data;
2. Evaluate the data to determine which data sets provide reliable information;
3. Choose the most reliable and complete data sets and develop distributional plots by turtle species, fishery, and season using a Geographic Information System for the northeastern United States;
4. Identify potentially important habitat and probable fishery interactions; and
5. Recommend, to the National Marine Fisheries Service Northeast Regional Office, improvements in the quality of data collection for each data set and institute appropriate management measures concerning these species.

Aerial surveys conducted over 10 years ago by Shoop (1981) provide the only comprehensive observations of the pelagic distribution of these turtles north of Cape Hatteras. Opportunistic sighting data and data on incidental captures in commercial fisheries are currently located in 12 databases collected under varying programs managed by the National Marine Fisheries Service, as well as museums and aquariums.

METHODS

Sighting, stranding, and fishery data collected both systematically and opportunistically were provided by the NMFS, as well as museums and aquariums, for compilation and analysis. A total of 12 data sets within NMFS contain information on sea turtles in the Northeast. The data sets were divided into two categories: fishery-dependent and fishery-independent.

Fishery-dependent data sets are:

1. Foreign fishery catch (1977 - 1990)
2. Foreign observer sighting records (1977 - 1990)
3. Sea Sampling Program (1989 - 1992)

4. Marine Mammal Exemption Program (1989 - 1992)
5. Southeast logbook data for longline and gillnet (1986 - 1992)

Fishery-independent data sets are:
1. Bottom Trawl Survey (1963 - 1992)
2. Manomet Observer Program (1980 - 1986)
3. Cetacean and Turtle Assessment Program (CeTAP) (1979 - 1981)
4. Marine Mammal shipboard surveys
5. Marine Mammal Stranding Network
6. Marine Mammal aerial surveys
7. Sea Turtle Stranding and Salvage Network (STSSN) (1980 - 1991)

The relative quality of the accessed data sets was evaluated by placing value judgments on the parameters measured. The quality of each parameter was judged to be either poor or good in terms of its usefulness and reliability.

To date, all of the data have been reviewed and based on the evaluations, six of the 12 data sets have been chosen and distributional plots have been made of five. Aerial and ship-board surveys, records of incidental takes from fishing vessels, and beach surveys were methods used to collect information contained in the selected data sets.

RESULTS AND DISCUSSION

A preliminary look at the 1992 Southeast logbook data for the longline fishery demonstrates that 50 leatherbacks were recorded as taken (Figure 1). Taken is defined as any turtle that was caught on a longline hook. The longliners record the turtles as either being hooked in the mouth or on the flipper. Some preliminary analysis suggests that all of the leatherbacks were taken when the longliners were targeting swordfish, which occurred at night, and with the use of dead bait. These data suggest that leatherbacks are feeding in the water column.

Estimates of the number of turtles as taken incidentally in the longline fishery are conservative because the data are recorded on a volunteer basis by the fisherman. The fishermen have the opportunity to record sea turtles in the logbooks as of 1992, because a key to turtle species identification was provided for them but it is not required by NMFS. Also, the number of sea turtle sightings or incidental take in the fishery is probably lower that what is realistically occurring because information on sea turtles is not a priority research goal of the various programs, except the for STSSN and CeTAP. Research efforts should be modified to fulfill the requirements of complete and usable data sets to help these endangered species.

Individual records in the data bases vary in quality because of differences in time and effort allocated to the surveys from which they were obtained. As such, value judgments are essential in interpreting the data. For example, some sets were collected voluntarily by fisherman rather than trained observers. This was considered in the assessment of the data's reliability.

The study will result in a synthesis and analysis of the various data bases contained by the NMFS, and will demonstrate what is lacking or non-representative, and what is appropriate in the available information and in the methodology used to obtain the data. Then, recommendations will be made to make the data bases more complete and statistically robust, which will help in developing guidelines for effective management of these endangered species.

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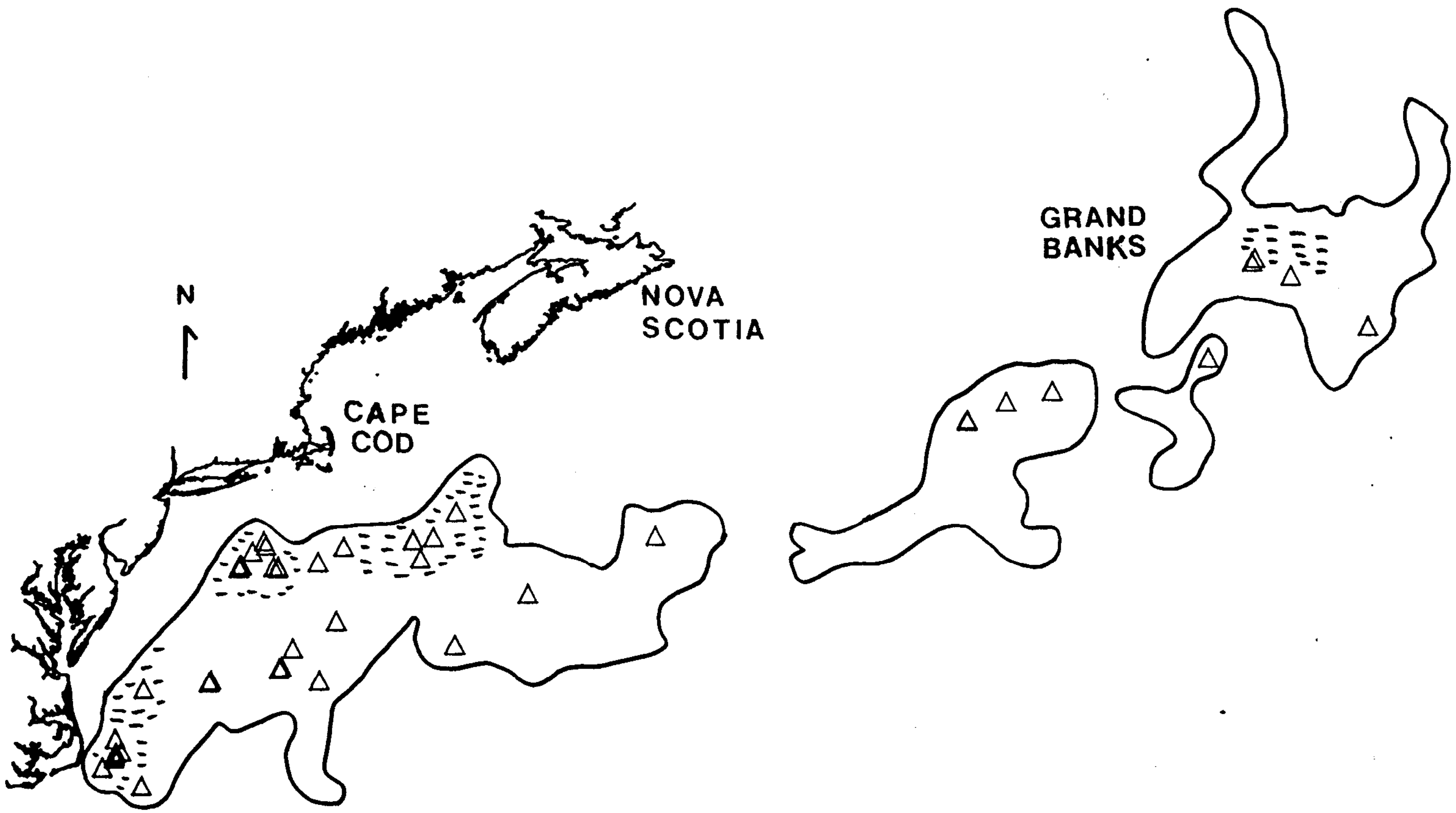

Figure 1. Preliminary records of leatherback sea turtles taken in the 1992 longline fishery off the northeast US coast. Lines indicate area fished, dashed lines indicate high concentration of fishing, and triangles indicate individual takes of leatherback turtles.

CONSERVATION OF TURTLES: THE CHELONIAN DILEMMA

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It is becoming increasingly evident that the Order Testudines contains an alarming number of species that require conservation efforts. The U. S. Fish and Wildlife Service lists 30 turtle species as either endangered or threatened with extinction. The International Union for the Conservation of Nature and Natural Resources (IUCN) lists 81 turtle species on its Red List of Threatened Animals. We suggest that turtles may be especially vulnerable to population decline because they exhibit reproductive strategies incompatible with exploitation or significant loss of habitat. Our intent is to place the decline of sea turtles into the broader context of the decline of chelonians. Before proceeding, however, a review of the population ecology principles central to this discussion is necessary.

The total number of animals in a population, or species, is determined by the combination of life history traits possessed by that species. In a generalized form, life history traits include; 1) number of offspring per reproductive event, 2) frequency of reproductive events, 3) percent survivorship from one age class to the next, and 4) age at maturity. The specific traits in a turtle species' life history are clutch size, clutch frequency, age-specific survivorship, and age at first reproduction.

The most unusual life history trait exhibited by turtles is age at first reproduction. Although different turtle species mature at different ages, all exhibit delayed reproduction. Among turtles, mud turtles (*Kinosternon subrubrum*) exhibit one of the earliest ages at first reproduction (approximately four years) (Frazer *et al.*, 1991), while Blanding's turtles (*Emydoidea blandingi*) and sea turtles are among the latest maturing (probably greater than 15 years) (Congdon et al., 1983; Frazer, 1986). Relative to other vertebrates, first reproduction at four years or more is clearly delayed reproduction.

In order for a population (or species) with delayed reproduction to be maintained, delayed maturity must be compensated for through one of the other three life history traits. To illustrate the importance of high survivorship to late maturing species, consider the model in Fig. 1. In the model, a modest increase in egg or juvenile mortality considerably impacts mature recruits.

Of course, some species are exploited without a resulting decline in numbers. In such species, mortality due to exploitation is simply compensated for by a reduction in mortality due to some other cause (Table 1). There are no conclusive data, however, to suggest that compensatory mortality applies to turtles. There is some evidence that turtles are subject to additive mortality. Brooks *et al.* (1991) found that increased mortality of adult snapping turtles in Algonquin Park, Ontario, Canada did not result in any compensating effect among juveniles. Congdon *et al.* (in review) suggested that the probability that increased adult turtle mortality due to exploitation might be offset due to juvenile compensation "seems very low."

Because delayed reproduction necessitates unusually high survivorship, we suggest that exploitation of turtles is at odds with prudent wildlife management. Increases in egg, juvenile, or adult mortality have significant effects on population size. Many conservationists are currently incorporating population ecology principles into their arguments. For arguments concerning turtle conservation, such principles seem indispensable. We believe that sea turtles should serve as an example of the consequences of human-induced mortality on late-maturing animals. Research and manuscript preparation were made possible by Contract DE-AC09-76SROO-819 between the Univ. of Georgia and the U.S. Department of Energy.

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TABLE 1. The compensatory vs. additive response to exploitation. In thishypothetical scenario, four causes of mortality result in a 70% mortality ratefor a given unexploited age class. Exploitation can have two consequences. It can result in a similar mortality rate, with exploitation resulting in a decrease in mortality from another cause, such as starvation. This situation usually arises when individuals of a given species compete for a limited resource, such as food (density-dependent mortality). Alternatively, in an additive scenario, exploitation simply results in an overall increase in mortality, and thus increases the probability of population decline.

CAUSE OF MORTALITY	% MORTALITY ATTRIBUTABLE TO EACH CAUSE		
	NON-EXPLOITED	EXPLOITED	
		COMPENSATORY	ADDITIVE
EXPLOITATION	0%	20%	20%
DISEASE	10	5	10
PREDATION	20	20	20
WEATHER	20	20	20
STARVATION	20	5	20
TOTAL	70%	70%	90%

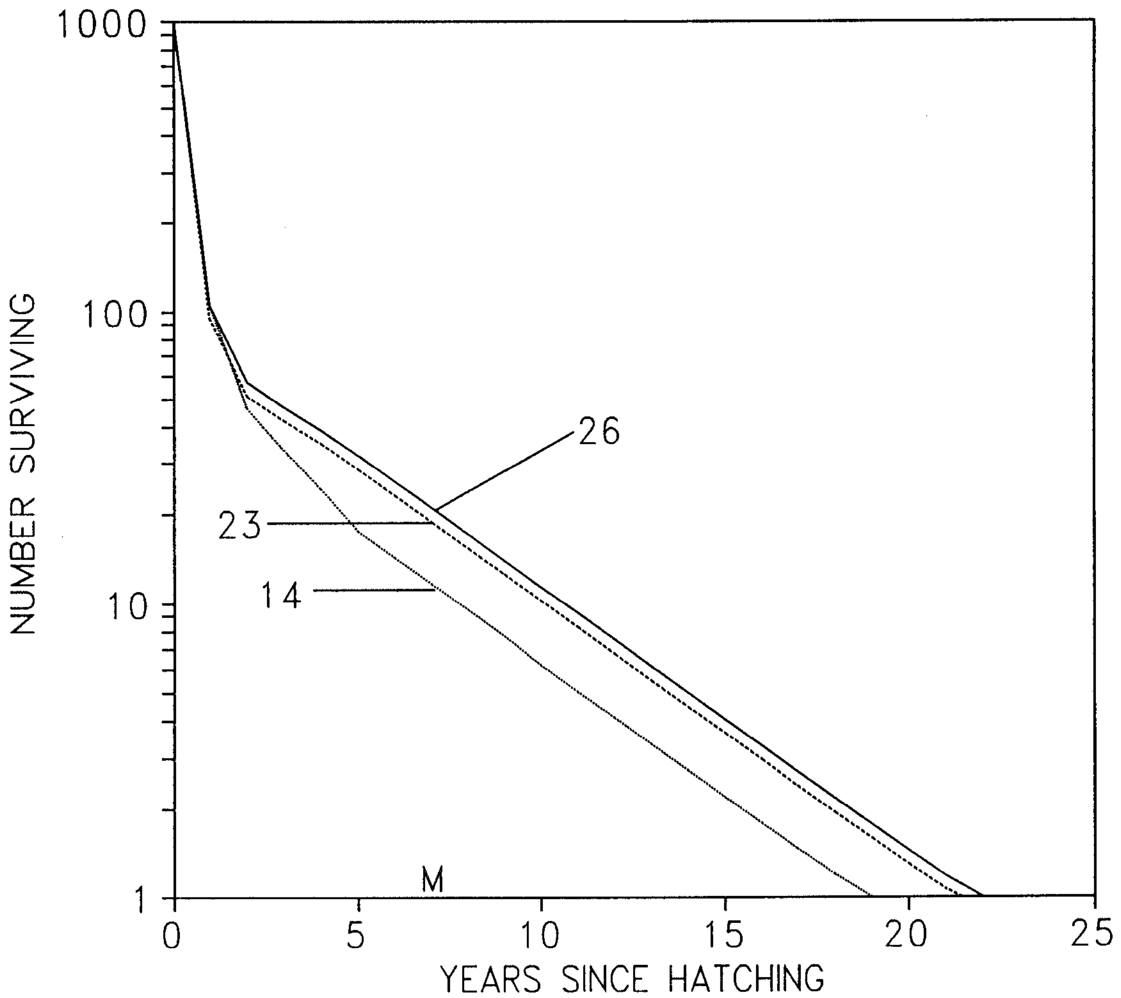

FIGURE 1. A model of the predicted effect of modest increases in mortality on the number of mature animals recruited. The solid line is based on survival data from Frazer et al. (1990) for slider turtles (*Trachemys scripta*). Female maturity in this species is reached at age seven or later. "M" represents age at maturity. Thus 26 of 1000 animals reached maturity under the unexploited assumption. The heavily dotted line considers the consequences of removing 10% of the eggs by exploitation. The result, assuming additive mortality, would be a 10% loss in mature recruits (from 26 to 23). The effect of a 10% increase in juvenile mortality (small dotted line) is a 46% decrease in mature recruits (from 26 to 14).

COMPARISON OF THE MIGRATORY BEHAVIOR OF THE CONGENERIC SEA TURTLES *Lepidochelys olivacea* AND *L. kempii*

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Although the congeneric ridley sea turtles share many behavioral characteristics, including mass, synchronous nesting emergences (*arribadas*), satellite telemetry has revealed differences between the species in their post-nesting migratory behavior. Position and measures of surface activity were obtained from 20 female *L. olivacea* and 18 female *L. kempii* monitored for up to a year with satellite transmitters. *L. kempii* were captured at the species' essentially sole nesting beach, Playa Rancho Nuevo, Tamaulipas, México, and followed throughout their migrations in the Gulf of Mexico. *L. olivacea* were captured at one of the species' three remaining *arribada* beaches in the eastern Pacific, Playa Nancite, Guanacaste, Costa Rica, and were followed on their Pacific migrations. The results were compared for geographic and behavioral differences between the species. *L. olivacea* dispersed widely and were notably oceanic in water of great depths (on the order of kms). A relatively large portion of their time (mean 88.9 min during 12 hr periods, SE=5.1, n=20) was spent on the surface, and they did not establish circumscribed feeding areas. In contrast, *L. kempii* migrated in narrow corridors near the shoreline, in waters generally less than 50 m deep, spent short periods of time (mean 37.0 min during 12 hr periods, SE=7.9, n=18) on the surface, and swam directly to feeding areas where they established relatively circumscribed ranges for periods up to four months. The results we obtained adds to the evidence of evolutionary divergence since the two species were separated by the last Panamanian uplift. These differences are likely correlated with resource availability and habitat use.

INCIDENTAL CATCH OF KEMP'S RIDLEY SEA TURTLES (*Lepidochelys kempi*), BY HOOK AND LINE, ALONG THE TEXAS COAST, 1980 - 1992

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Kemp's ridley sea turtles (*Lepidochelys kempi*) have been reported as by-catch in a variety of marine fisheries, both commercial and recreational (Manzella et al., 1988, Fontaine et al., 1989, and Magnuson et al., 1990). This paper focuses on reports of Kemp's ridleys caught or snagged by hook and line along the Texas coast during 1980 - 1992. Emphasis is placed on the upper Texas coast during 1992, for which an unusually high number of hook and line captures of Kemp's ridleys was reported.

METHODS

Data sources included the Sea Turtle Stranding and Salvage Network (STSSN) data base maintained at the NMFS Southeast Fisheries Science Center's (SEFSC) Miami Laboratory, Miami, FL, and data bases maintained by the NMFS SEFSC Galveston Laboratory. The combined data included wild and head started Kemp's ridleys, both live and dead, for 1980-1992. Information on Kemp's ridleys included call-in reports from the general public, various local, state and federal agencies, X-rays by veterinarians, and necropsies performed by veterinarians, Texas A&M University, and STSSN participants, either in the field or in the laboratory.

Data were grouped into two geographical zones along the Texas coast, herein referred to as the Upper Texas Coast (UTC) and the rest of the coast (Rest). The boundary between the UTC and the Rest was set between Bolivar Peninsula and Galveston Island, at latitude 29° 20' N and longitude 94° 45' W. The UTC was defined as the coastline from this boundary north and east to Sabine Pass, and the Rest as southward to the Texas-Mexico border.

Curved carapace length (CCL, in cm), was the length most often reported, so it was used in our analyses of size distributions. When only the straight carapace length (SCL) was reported, the following conversion equation was used to obtain SCL from CCL (Manzella and Williams, 1992), $CCL = 1.06 \times SCL$.

Records were grouped into 10 cm CCL class intervals, with the largest turtles assigned to the >50.0 cm size class. Only one report of a Kemp's ridley associated with hook and line was for a turtle with CCL < 20.1 cm. It was hooked in the eye near Port Aransas, TX. Therefore, only turtles with CCL 20.1 cm or larger were included in analyses of size distributions, comparing hook and line vs other reports. All statistical analyses were conducted on frequencies of reports, using chi-square. The critical region of rejection of the null hypothesis (of independence) was at $\alpha = 0.05$.

RESULTS

From 1980 through 1992, 1,471 Kemp's ridley sea turtles were reported along the Texas coast. Of these, 118 (8%) were associated with hook and line, and 39 (33%) of these were reported during 1992. Of the 39, 30 (77%) were from the UTC.

Of the 118 hook and line associated Kemp's ridley reports, 101 (86%) indicated that the turtles were usually unharmed and released alive, upon removal of the hook by the fisherman. However, 11 (9%), though alive, were held for veterinary care, and 6 (5%) were found stranded dead (fish hooks were discovered by necropsy). One wild Kemp's ridley was taken to a veterinarian who removed a hook from the left side of the mouth, but an X-ray detected two more hooks in its esophagus, all hooks were removed and the turtle was later released with a satellite tag.

When all years were combined, the proportion of hook and line associated reports was significantly dependent on the zone in which the turtles were reported. More, 62 (52.5%), were reported from UTC than the Rest, 56 (47.5%). When 1992 was omitted, the proportion of hook and line associated reports was independent of zone, suggesting that 1992 was an unusual year for hook and line captures of Kemp's ridleys along the UTC. Also, the proportion of hook and line associated reports was higher for UTC during 1992 (47%) than for all previous years (8%).

By zone, the proportion of reports associated with hook and line vs other reports was dependent on type of turtle (head started vs wild). Hook and line related reports had a significantly higher proportion of head started turtles (69% for UTC, 56% for Rest) than did other reports (20% for UTC, 40% for Rest). All head started turtles reported as being associated with hook and line had been in the wild for at least one year, a period we consider more than adequate for their adaptation to the wild. We do not believe a head started Kemp's ridley could survive a year in the wild without such adaptation.

The proportion of Kemp's ridleys associated with hook and line was dependent on size, both for wild and head started turtles, when all years were combined. The size class most often associated with hook and line was 30.1-40.0 cm. Size distributions were similar for head started and wild Kemp's ridleys caught on hook and line.

DISCUSSION AND CONCLUSION

Most Kemp's ridleys, both wild and head started, associated with hook and line were 30.1-40.0 cm CCL. Presence of this size class of turtles, especially in shallow waters of the UTC, may reflect opportunistic feeding. Shaver (1991) indicated that only Kemp's ridleys with a CCL 20-60 cm contained fish or shrimp, although she believed that the fish were probably dead at time of ingestion and shrimp trawl by-catch related. The preferred baits used by surf fishermen on the UTC are cut mullet (*Mugil* spp.) and shrimp (*Penaeus* spp.). These also are naturally abundant species on the UTC. Such baits may be particularly attractive to Kemp's ridleys 30.1-40.0 cm in CCL, thus increasing their vulnerability to capture on hook and line.

The reason for the increased number of Kemp's ridleys associated with hook and line along UTC is not known. It may reflect an increase in Kemp's ridleys as a result of their protection through use of turtle excluder devices (TEDs) by commercial shrimpers. Also, in 1992, many bays south of Galveston had low salinities (e.g., 0-4 ppt in Matagorda Bay; Britt Bumgardner, Texas Parks & Wildlife Department, personal communication July 1992). Such low salinities may have forced crabs and other prey out of the bays and shallow coastal waters offshore. This may have increased the concentration of food for turtles on the UTC in 1992. The UTC may have represented prime feeding habitat for Kemp's ridleys in 1992.

For all years combined, the proportion of head started turtles associated with hook and line (63%) was higher than that of wild Kemp's ridleys (37%). Because all head started Kemp's ridleys are tagged (Fontaine et al. 1989), we believe they are more likely to be reported than untagged wild ridleys (see also Eckert et al. 1992). Regardless, our analyses suggest that both wild and head started Kemp's ridleys are vulnerable to capture by hook and line, and the impact of this type of capture may be underestimated by the available data bases. It is possible that some live Kemp's ridleys released after capture by hook and line may suffer from ill effects of hooks lodged in the esophagus or stomach.

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EGGSHELL CALCIUM UTILIZATION IN DEVELOPING LOGGERHEAD EGGS

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The role of environmental factors in incubation of turtle eggs has been studied extensively (Miller, 1982; Mrosovsky, 1982; Packard and Packard, 1989; Ackerman, 1990; Wyneken et al., 1988; Mortimer,1990) and utilization of eggshell calcium for embryonic growth and metabolism has been documented (Bustard et al., 1969). These eggs rely on exchange of water and gases mediated by the shell and its associated membranes. This investigation addressed the effects of incubation medium on the mobilization of eggshell calcium.

METHODS

One hundred loggerhead eggs (20 from each of 5 laying females) were collected at Melbourne Beach, Florida in June 1992. The 41st - 60th eggs were taken in each case to minimize possible variance in eggshell composition between first and last eggs. Maximum diameters for all eggs were recorded and total surface area was calculated for each egg. 10 eggs (2 per clutch) were terminated within 12 hours of collecting for analysis of fresh egg samples. The remaining 90 eggs were incubated at 28.5 C in air (95-99% humidity) and sand (4-5% hydration by weight); 9 per clutch in each medium. 10 eggs from each medium were terminated at 30 and 45 days; the rest were allowed to hatch. Six 9mm samples were taken from each eggshell: six from a transect on the fresh eggs, 3 from the upper hemisphere and 3 from the lower hemisphere of incubated eggs. Ca ion content of the samples was measured using gas flame analysis on a Perkins-Elmer M2000 Atomic Absorption Spectrophotometer; calcium content of each egg and hemisphere was calculated. Analysis of variance was performed using the GLM procedure of PC-SAS to compare calcium content of eggs at $t=0$ through hatching and in the two media. Appropriate means separation procedures were applied.

RESULTS AND DISCUSSION

The difference in calcium content of fresh eggshells was significant between females (Figure 1). Despite a small sample size ($n=2$) for this specific analysis the results are supported by persistence of the clutch mean separation throughout the experimental groups. These differences may be due to variation in shelling efficiency, number of previous layings that season, or variation in egg retention time. By hatching time, mobilization of eggshell calcium is significantly greater in sand than air (Figure 2). While the amount of calcium lost in sand incubation is almost 3 times greater than that in air, there is a key difference in the mobilization response (Table 1). In air 66% of the total loss occurs in the first 45 days while in sand the same period accounts for only 15% of the total loss. The extreme difference in total calcium loss between air and sand suggests a higher availability of calcium to the embryo in the latter medium. Analyses to test this are underway. There is no significant differential mobilization from different eggshell areas (Figure 3), however studies in progress on the associated membranes may indicate whether differential uptake occurs.

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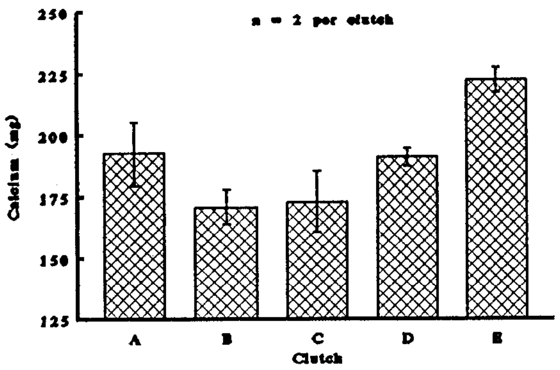

Figure 1. Between female variation in calcium content of fresh eggshells.

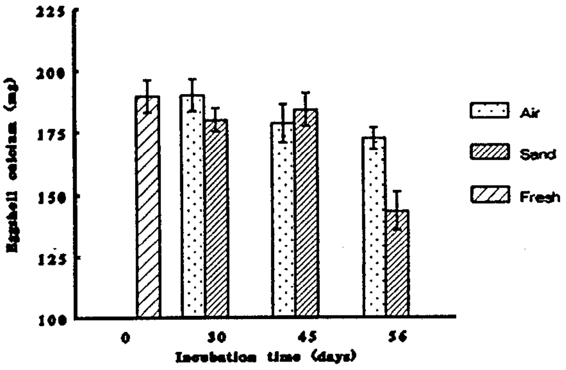

Figure 2. Eggshell calcium content thru incubation (eggs incubated in air and sand).

Table I. Eggshell calcium loss thru incubation.

Mean total calcium lost

Air	Sand
17.2 mg	46.2 mg

Percentage of calcium lost

T	Air	Sand
0-45	66%	15%
45-56	33%	85%

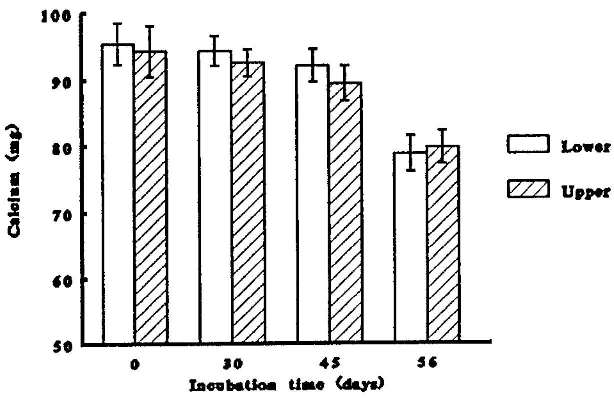

Figure 3. Eggshell calcium content by position (upper and lower hemispheres).

ESCUDO DE VERAGUAS AND PENINSULA VALIENTE, A NEW PROTECTED AREA IN PANAMA

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Escudo de Veraguas is a 550 acre island located in the Panamanian Caribbean Coast in Bocas del Toro province. The Peninsula Valiente is located in front of the Escudo de Veraguas.

The Escudo de Veraguas island is of sedimentary origin. The Peninsula Valiente presents oligocene rocks. In all the vast sea region that surrounds the island and the peninsula, there are rich coral banks and *Thalassia* prairie. On the island's west beach, hawksbill and leatherback turtles nest (Chang, 1987). It is reported that the nesting of leatherback turtles (Meylan et al., 1987) at Chiriqui beach is the second most important assemblage for this species in the Western Caribbean.

The area is important for nesting, foraging, mating, and season preparation for hundreds of sea turtles that go to nest at Tortuguero, Costa Rica (Meylan et al., 1985). Fifty three marked turtles at Tortuguero were captured in Panama of which eighteen were from Peninsula Valiente.

Every sea and terrestrial region has been declared by the Guaymi Congress as a reserve and Indian towns's patrimony. CECA has been advising Escudo's and Peninsula Valiente's implementation of a management at subsistence level through the project to create an extensive Biosfera's Reserve in the Caribbean of Panama.

METHODS

The basic information was gotten through a literary revision of the scientific work conducted at Bocas del Toro. Activities such as observation of coral and *Thalassia* banks, and surveys of the coastal community, nesting beach and the foraging areas have been carried out.

RESULTS AND DISCUSSION

The analysis gives evidence of the great value of Escudo de Veraguas and Peninsula Valiente for conservation of sea turtle habitat. Today, the coral reef and *Thalassia* prairie are not threatened at the moment.

Leatherback turtles have been observed foraging around Bahia Azul (Blue Bay), Escudo island and the Bocas del Toro's coral reef. Nesting of this species occurs at Chiriqui beach.

Green turtles are still observed although captures are is declining. The population is decreasing because of hunting pressure. In summary, the creation of protected areas at Escudo de Veraguas and Peninsula Valiente through the Guaymi Congress presents management guidelines by which the Indian communities have the majority mandate. However, the Panamanian state has been promoting tourist activity in the Escudo island and the Chiriqui beach, and also has proposed the sale of the island. This threat could ruin the ecosystem in an irreversible way.

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NEW HOPES FOR THE LOGGERHEAD TURTLE ON ZAKYNTHOS: ACQUISITION OF THE MOST DENSELY NESTED AREA IN THE WORLD

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Three species of marine turtles are found in Greek waters: the loggerhead, the green turtle and the leatherback. Of these, only the loggerhead is known to nest on Greek beaches. Extremely important nesting areas for this species were discovered in 1977 on the island of Zakynthos in the Ionian Sea (Margaritoulis, 1982).

Sea turtle nesting is proved to occur also at Peloponessus, Crete and scarcely on some other areas. After a survey of the biggest part of the Greek coastline (12,000 over 16,000 km) conducted by STPS (1988-1991) there is a concrete knowledge of the situation on the nesting sites in Greece (Margaritoulis et al, in press). The regular monitoring of all the important nesting beaches conducted by STPS permits the application of various conservation tactics depending on the threats e.g. fencing against predation on Peloponessus, public awareness to reduce the effect of tourism on Zakynthos (see Dimopoulos, 1991) etc.

Sea turtle nesting in Greece is not evenly distributed in the different nesting areas. Zakynthos is proved to be the most densely nested area in Greece receiving about 60% of known nesting activity and it is considered the most important loggerhead nesting area in the Mediterranean.

Nesting on Zakynthos occurs mainly on six discrete beaches (about 4 km in total) of Laganas Bay. The total number of nests fluctuates from about 850 to 1,800 and nesting density ranges from about 200 to 430 nests per km per year, the highest in the Mediterranean. High nesting concentration on Zakynthos is attributed, on the one hand, to loss of habitat and, on the other, to lack of any serious nest predation. Nevertheless, nesting density is not equally distributed over the available space.

SEKANIA, THE MOST DENSELY NESTED BEACH FOR THE LOGGERHEAD

Former nesting sites on Zakynthos are now used less frequently due to noise, lights and intense human activity. Nesting is concentrated on the most isolated beach, Sekania which receives, on average, more than 52% of all nests deposited on Zakynthos. Nesting density on Sekania may reach in a "good season" 2,300 nests per km, perhaps the highest nesting density for this species anywhere in the world. Sekania is a remote beach, situated in the eastern part of the Bay, about 3 km from the nearest paved road. It is divided in two sectors by a low rocky promontory. The available nesting area stretches for about 450 m, the greater part belonging to the eastern sector which is characterized by a width of some 30-40 m. To the back of the beach, steep hills with dense Mediterranean maquis vegetation act as a barrier. No buildings are seen from Sekania. At night the beach is totally unaffected by lights and noise from the developed sites in Laganas Bay. The only access from land is an unpaved private road, usually in a very bad condition. The approach from the sea is also difficult because the water is very shallow and scattered with reefs and rocks, especially at the western sector.

THE MAIN THREATS

The single most important threat for the loggerhead nesting areas on Zakynthos is the uncontrolled development of tourism. The area of Sekania like almost all of the areas adjacent to nesting beaches on Zakynthos is privately owned. In order to stem the destruction of the sea turtles' nesting areas on Zakynthos the Greek state has implemented restrictive legal measures. However, this legislation is not enforced and the failure of the state to compensate the landowners affected by restrictions has exacerbated uncontrolled development of private land adjacent to the nesting areas, thus increasing the pressure on the loggerhead (Charalambides, 1990). This problem has been averted so far in Sekania due to the rough geomorphology of the land surrounding the beach and thus the high capital costs required for its development. Nevertheless, it seems that the only way to ensure Sekania in the future will be to control land use behind the beach. Given the inability and unwillingness of the Greek state to enforce the existing legislation there appears to be no permanent solution to the grave dangers, posed by development, other than the acquisition of the land adjacent to the beach by environmental NGO's in order to fully ensure the conservation needs of the area.

Another important threat facing Sekania is the heavy soil erosion from the steep hills behind the beach. This phenomenon is attributed to a fire three years ago which destroyed much of the vegetation on the hills. Eroding soil covers the sand and when dry forms a thick crust of clay too hard for the emerging hatchlings to break through. In 1992 East Sekània presented the lowest recorded hatching success since 1984 which has been attributed mainly to the clay that covered parts of the beach following heavy rains in late September. A secondary effect of soil erosion is the colonization of clay covered parts of the beach by vegetation which narrows increasingly the available nesting area.

As mentioned already, nest predation on Zakynthos, compared to other nesting sites of Greece, is minimal (Margaritoulis. 1988). In 1992 an effort was made to estimate the number of hatchlings taken by predators at Sekania. It was found that only about 2% of the total emerged hatchlings were taken on their way to the sea by rats, martens and gulls.

ACQUISITION AND MANAGEMENT OF SEKANIA

WWF-Greece is in the process of arranging the acquisition of the land adjacent to Sekania beach (approximately 30 hectares) in order to gain control of access to the beach. This is only the first step to ensure protection of the most important single nesting beach for the endangered loggerhead sea turtle in the Mediterranean. An integrated management plan will be needed for the stabilization and rehabilitation of the eroding hills. Furthermore an extensive cleanup of the clay and debris covering parts of the beach will be necessary.

Immediately upon purchase, the area will be placed under constant supervision to inhibit access to the beach. Especially in the busy summer season wardens will be placed for 24 hours/day protection. The estimated cost of purchase, rehabilitation and protection of Sekania will near 4 million USD. The EEC has earmarked approximately 1 million USD for the project. A one year fund raising campaign will be started in October 1993 by WWF Greece to raise the remaining 3 million USD needed.

Last but not least, in order to ensure Sekania's future it will be necessary to have the area declared a zone of "absolute protection" according to existing Greek legislation (law 1650 for the protection of the environment). However, it is clear that the purchase of Sekania should not be used as an alibi for the abandonment of plans to create a Marine Park in the Laganas Bay of Zakynthos and neglect conservation efforts at the other 5 beaches of the bay. Instead, with Sekania as the core area, the Marine Park should be established as soon as possible.

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GREEN SEA TURTLE DEVELOPMENTAL HABITAT IN SOUTH TEXAS

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Juvenile and subadult green turtles occurring on foraging grounds in South Texas waters have been the subject of a habitat utilization study since 1991. A total of 82 captures were made of 49 green turtles from jetty and grassbed habitats in lower Laguna Madre adjacent to South Padre Island, Texas. Morphometric and capture statistics as well as data on growth and site fidelity were presented. Straight carapace length for all turtles at first capture was 38.9 cm and ranged from 22.2 to 81.5 cm. Average size of turtles foraging among grassbed habitats was significantly greater than that for cohorts from jetty environments. The captured lot exhibited an average annual growth rate of 6.0 cm. Capture and sightings data indicate strong fidelity for specific jetty zones along Brazos Santiago Pass and grassbeds of Mexiquita Flats.

SEA TURTLES, TED's, THE ESA REAUTHORIZATION, AND YOU

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On November 3, Bill Clinton and Al Gore, who are widely believed to be much more sympathetic to the environment than the two previous administrations, were elected. On December 1, regulations requiring TED's in all Southeastern U.S. shrimp trawls year-round by December, 1994, inshore and offshore, were finalized. Mexico has already indicated their intention to stop the harvest of all species of sea turtles. On December 31, Japan officially stopped international trading in hawksbill turtle shell. I don't know about you but I felt I had a lot to celebrate this Christmas. But does this mean we can all go home and relax? What lies ahead for sea turtles and sea turtle conservation over the next few years? This presentation explored the future of sea turtle conservation in light of recent events.

SEA TURTLES POPULATION STUDY AND NESTING ACTIVITY IN ISLA CAJA DE MUERTOS, PUERTO RICO

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INTRODUCTION

The Isla Caja de Muertos Natural Reserve is a subtropical dry forest (Holdridge, 1947) with sandy beaches. The main island has a total area of 188.36 km^2. A small barren island called Morrillito lies to its northwest and Cayo Berberia lies to its east.

Isla Caja de Muertos is located 4.8 NM south of Ponce, Puerto Rico, at 17° 55' N and 66° 33' W. This natural reserve is 2.75 km long and 1.85 km wide with an area of 412.22 ha.

The study of the sea turtle population and nesting activity on Isla Caja de Muertos started on January 26, 1992. In this first year, the presence of two species, the hawksbill (*Eretmochelys imbricata*) and the green turtle (*Chelonia mydas*) were determined.

RESULTS

Between January 26 and November 30, 144 emergences were registered, of which 75 were nests and 69 were false crawls. During the season of August to November, there were 55 nests and 58 false crawls. The crawl count was estimated in 1992. Our 18-week study showed that the peak of the season was between September 22 and October 12 with 18 nests.

Playa Larga is located at the southwest of the island and is 825 m long. Only 275 m are suitable for nesting. Of the remaining 550 m, there is 175 m of beach with steep slopes and 375 m of beach covered by debris.

During the study period from August to November, nine turtles were tagged. The turtles found on their way to the sea were not tagged to avoid disturbance. Three nests were poached, two at Playa Uvero and one at Playa Larga. Two turtles were stranded; a hawksbill was found upside down and alive and a green turtle was found dead.

Healthy seagrass beds near the coral reefs make Cayo Berberia an important foraging area for green and hawksbill turtles. For many years Berberia has been used as slaughterhouse by local fishermen despite the prohibition since 1973. Visits to Cayo Berberia started on May to gather data of the illegal catch and how frequently it occurs. During the visits to Berberia fishermen wouldn't approach the island, but it is possible that turtles were caught and slaughtered inside boats and that carcasses were thrown overboard.

DISCUSSION

Hawksbills nest all year round at Isla Caja de Muertos. Conservation efforts should be continued to document poaching activities outside the green turtle nesting season.

A constant presence of personnel is a necessity to deter poaching. Special camp facilities on inaccessible beaches will be provided by the biologists. Their continued presence on the beach permits a maximum number of turtles to be tagged and allows the gathering of more information.

All nests were opened to release trapped hatchlings and to determine hatching success. The hatching success for hawksbills was 69%. The hatching success for green turtles was 68.4%. Hopefully, this program will control the illegal catch of sea turtles in the south coast of Puerto Rico in the future and maintain the population of hawksbills in this Natural Reserve.

A GENETIC STUDY TO DETERMINE THE ORIGIN OF THE SEA TURTLES IN SAN DIEGO BAY, CALIFORNIA

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The juvenile and adult sea turtles that occur year-round in San Diego Bay are thought to be part of the Mexican population of black turtles, *Chelonia agassizi*. Some of the turtles, however, have the shape and color more typical of *C. mydas* and may be from Hawaii or elsewhere in the Pacific (McDonald & Dutton, 1992). For others, particularly the juveniles, it is difficult, based on color and morphology, to distinguish the two forms. These are preliminary results of a genetic study to determine the origins of the San Diego Bay turtles.

METHODS

The D-loop region of mitochondrial DNA (MtDNA) extracted from blood samples was amplified using the polymerase chain reaction (PCR) with primers developed by Allard et al. (in press). D-loop nucleotide sequences were determined for four San Diego Bay turtles and compared with those from five Hawaiian green turtles (*C. mydas*) nesting in the French Frigate Shoals, and three Mexican black turtles (*C. agassizi*) from the Michoacan nesting colony. These sequences were also compared with a D-loop sequence reported for an Atlantic green turtle (Allard et al, in press).

RESULTS AND DISCUSSION

The D-loop, believed to be the fastest evolving region of MtDNA, was relatively conserved among the East Pacific Chelonia populations examined in this preliminary survey. The Hawaiian green turtles and the Mexican black turtles are more closely related to each other (sequence divergences 0.3 - 2.5%) than to the Atlantic green turtle populations with sequence divergences ranging from 7.2 - 9.0%. The San Diego Bay turtles appear to be more like the Mexican turtles, although some differences that were found suggest that they may not have originated at the Michoacan nesting beach. Further sampling from other rookeries in Baja California and its offshore islands will be needed to resolve this question.

ACKNOWLEDGEMENTS

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THE DIET OF THE GREEN TURTLE IN AN ALGAL-BASED CORAL REEF COMMUNITY-HERON ISLAND, AUSTRALIA

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The diet of the green sea turtle (*Chelonia mydas*) has been the focus of many investigations throughout the world; however, the majority of the reports on the diet of the green turtle are frequently qualitative descriptions of stomach samples. Much of these data are based upon very small sample sizes and are limited to a single temporal sample. Although these studies have provided information on what green turtles eat, they are of limited ecological value. However, even within these limitations, the data clearly indicate that green sea turtles are euryphagous, facultative herbivores that display an admirable ability to survive on a wide diversity of sea grasses, algae, mangroves, and animal material. However, some green turtle populations are stenophagous herbivores feeding upon only one species of sea grass (Bjorndal, 1979,1980) while others may feed upon dozens of species of algae while still consuming sea grass (Garnett et al., 1985; Forbes, 1993).

Green turtles are known to be selective grazers in sea grass communities were they select for young plants with higher nutritive values and lower epiphyte and lignin levels (Bjorndal, 1979,1980; Ogden, et al., 1980; Mortimer, 1981). It has been proposed that diet selection may not be limited to the selection of a particular plant part or growth stage but may include preferences for species with low frequencies of occurrence (Read, 1991) or preference for an individual species over other readily available species of the same genus (Ross, 1985). In contrast, other workers suggest that green turtles select their diet as a function of availability rather than preference (Ogden, 1976; Mortimer, 1981; Garnett et al. 1985). On a much broader scale, it has been proposed that green turtles will preferentially feed upon sea grasses rather than algae when both are available (Bjorndal, 1979, 1980; Mendonca, 1983).

Few studies have examined the components of the green turtle's diet quantitatively. Even fewer studies have taken an ecological approach to the diet of the green turtle by quantitatively assessing both the available forage crop and the components of the diet. Examination of both the diet and the available forage would allow diet selection indices to be formulated and would provide for a clearer understanding of the feeding ecology of the green turtle. The results presented here represent a portion of a comprehensive study designed to examine the diet and feeding ecology of green sea turtles feeding in an algal-based reef community.

STUDY SITE

The study site for this investigation was the reef surrounding Heron Island, one of 15 coral cay islands situated atop the 20 coral reefs which comprise the Capricorn-Bunker group of islands within the Capricornia Section of the southern Great Barrier Reef, Queensland, Australia (23° 26' S, 151° 55' E.) Heron Island is situated approximately 80 km northeast of Gladstone, Queensland.

Heron Island Reef is an elongate lagoonal platform reef approximately 26 km in circumference, 11 km long and 5 km wide at its greatest breadth. The reef extends over 27 km^2 and is dominated by a large deep lagoon in the eastern half of the reef.

METHODS

Turtles were located by patrolling the reef habitats with a 4.2 m boat occupied by two observer/divers and one driver/observer. Upon sighting of a turtle, the turtle was pursued in the boat until a diver could be placed in a position to dive upon the turtle from the boat. The turtles were captured by hand and brought to the surface where they would then be placed into the boat. This technique is described by Limpus and Walter (1980).

All habitats were searched with equal time and effort based upon the constraints of tides and weather. Boat patrols for turtles occurred from first light until dusk, weather and tides permitting. Sampling occurred in all weather including heavy rain and winds up to 20 knots. Attempts were made to capture all turtles sighted in the study area regardless of age class, sex or difficulty of capture, i.e., depth of water. Turtles were returned to the island for handling.

Stomach contents were retrieved by gastric lavage (Forbes and Limpus, 1991, 1993). Following the gastric lavage procedure, all turtles were released back to the reef. The relative importance of a diet component to the total lavage sample was assessed by determining the component's volume in the sample. Volume was determined utilizing the principles of microstereology (Weibel, et al, 1966) and a modification of Channells and Morrissey (1981) quantification technique utilizing a Weibel graticule as described by Forbes (1993).

Available algal forage was determined quantitatively during each turtle sampling session using the radial plot photographic technique described by Forbes (1993).

RESULTS AND DISCUSSION

During the study period of March 1988 to March 1990, a total of 518 green turtles were captured, lavaged and the stomach contents analyzed. The age class distribution included 124 adults (sexually mature as determined through laparoscopic examination of the gonads) (24%), 264 subadults (65 cm CCL up to sexual maturity) (51%) and 130 juveniles (< 65 cm CCL) (25%.) Sex distributions were 254 females (49%), 181 males (35%) and 83 undetermined gender (16%).

The pooled diets of all turtles examined contained a total of 38 species of Rhodophyta (red algae), 21 species of Cholorohyta (green algae) and 10 species of Phaeophyta (brown algae). Algal species comprised more than 99% of the diet in most instances. Animal matter was present in some samples but typically represented less than 1% of the diet volume and was therefore considered incidentally ingested during feeding with the exception of the hydrozoan jelly, *Physalia* sp. and unidentified gelatinous mollusk egg cases that were intentionally consumed.

The most common genera of algae consumed include but are not limited to the phaeophytan genus *Turbinaria*, the chlorophytan genera *Caulerpa*, *Codium*, *Enteromorpha* and the rohodophytan genera *Gelidiella*, *Polysiphonia* and *Laurencia*.

The algal turf assemblage, which contains a heterogeneous mixture of primarily phaeophytan and rhodophyta algae, is exploited heavily by the Heron Reef green turtles. In some instances, the turf is exploited to the exclusion of more readily available species growing in monospecific stands. This reliance on the turf assemblage does not preclude sudden dietary shifts when certain algae such as the chlorophytan *Enteromorpha* spp. become available.

The reason(s) for these dietary preferences and diet shifts are currently being examined as another aspect of this project and these results will be published elsewhere.

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CONSERVING SEA TURTLES AND OTHER NATURAL RESOURCES: WHAT FERDINAND MARCOS AND MANUEL NORIEGA CAN TEACH US

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STATEMENT OF PROBLEM

Biological conservation is often confused with ecology, field biology, or even general biology. However, instead of being a form of scientific pursuit, conservation is the management of people and their environments - it is nothing less than politics. Scientific codes are not relevant in politics, and dire problems can result when the disciplines are mixed.

DEFINITIONS OF KEY TERMS

"Biology" is the *science* which deals with living things and their processes; "science" is systematized knowledge, or facts and truths, which are organized in theories.

"Biological conservation" is "Active *management* to ensure the survival of the maximum diversity of species, and the maintenance of genetic variety within species. The term also implies the *maintenance* of biosphere functions, e.g. biogeochemical cycling, without which the basic resources for life would be lost. Biological conservation embraces the concept of long-term *sustained resource use or sustained yield* from the biosphere..." (Allaby, 1985:158; italics added).

"Politics", to Aristotle, dealt with the structure, organization, and administration of the state; it can also be defined as "the use of intrigue or strategy in obtaining any position of power or control".

BIOLOGICAL CONSERVATION VERSUS BIOLOGY

Clearly, an activity which involves management, maintenance and sustained use is concerned with the governing of people, the structuring, organizing and administering of their activities; and frequently this will be done from a position of power or control. *Ergo* biological conservation is within the realm of politics. In contrast, biology is a scientific pursuit, and science tries to distance itself as much as possible from politics, in its "search for the truth".

BIOLOGICAL CONSERVATION AND PEOPLE

The definition of biological conservation means that both resources and people must be considered as important, not just one or the other, and not one and then the other, but both together. Hence, people at many levels must be involved in conservation activities. Conservation programs conceived, designed, executed and directed from "on high" are not perceived as relevant, meaningful, or acceptable to the community where they are to be carried out. The users of resources must be involved in the conservation of these resources, from all organizational levels. There are countless examples of failed conservation projects, where resource users and local communities have NOT been included in the projects. The long term success of conservation projects is independent of the mass of resources or expert man-hours spent on the project; ironically if there is a relationship between success and expenditure, it seems to be inverse (Frazier, 1990). This is yet another reason for emphasizing the political nature of biological conservation.

THE PROBLEMS OF CONFUSING BIOLOGY WITH BIOLOGICAL CONSERVATION

Biologists who practice conservation under the guise of science, often misrepresent both fields, reducing the efficiency of both. This is not to say that conservation activities and biological studies should not go hand-in-glove, but it must be clear that the hand moves the glove, and not *vice versa*.

Those who practice conservation must acknowledge that it is a political exercise, and they must be aware of and *accountable to* the political consequences of their activities. This contrasts to the responsibilities of a biologist, or any other practicing scientist: to be objective, systematic and to view human affairs as only a part of the natural world, not the focus of it.

There are many, and different facets to this problem, but the greatest danger in confusing these two disciplines is in the international arena. A partial list of syndromes, with abbreviated explanations, follows:

Syndromes Involving Conceptual Premises:

1) Machiavellian = the end justifies the means; usually applied to short-term objectives and not concerned with long-term ramifications or processes.

2) Unctuous Greenbacks (Money Talks) = the most expedient way to resolve problems is to buy them out, cover them over with money.

3) Goose and Gander Laws = double standards, lack of consistency, subjective priorities; frequently used to manipulate people.

4) Washington Knows Best = opinions and directives emitted from political centers are always right; it is not important to consider views of people with less political power or resources.

5) First World Superiority = what comes from overdeveloped countries is best (e.g. equipment, technology, ideas, concepts, perceptions, and realities).

6) The Noble Savage (the antithesis of # 5) = whatever the natives (savages) do is best; they, their traditions and manners are in perfect harmony with their environment and Nature.

7) The Sanctified Doctrine of Conservation = whatever is done in the name of the Lord Conservation is righteous and justified; this implies all the trappings of a religion.

Syndromes Involving Personal Relations:

These syndromes involve an institutional representative interacting with a conservation practitioner; the latter then acquires exaggerated access to resources and information.

8) Clientelism = institutional representatives channel institutional (governmental or nongovernmental), funds and resources to supporters, in order to achieve personal gain.

9) Tribalism = favoritism for members of the same tribe (a functional tribe can be of either kith or kin).

10) Good Scouts (knows the Lay of the land, and will take you to Her, Him or It) = special contacts learn to dispense personal favors for institutional representatives, and are thus given favored status by these representatives and their institutions.

11) Auto-Anointed Apostles = evangelical, guileful conservation practitioners learn to manipulate and deceive uninformed, or naive, institutional representatives, thus acquiring resources.

12) Canonized Oreos = institutional representatives select contacts with the appropriate physical credentials (e.g. race, nationality, residence) and acceptable mannerisms; these cultural converts bridge between two or more cultural realities, providing a unique channel of communication; the control of information creates a focus of power (and corruption).

13) White Knights = Practitioners of conservation -especially those with coveted social characteristics- are idealized and conferred power and resources.

14) Marcos-Noriega, the Invincible Duo = the creations of kingmakers are characterized by the concentration of resources (notably money) in personalities useful to outside agents, who provide the resources. As a result, power proliferates in people whose objectives are self-serving, and frequently contradictory to the needs and desires of the communities in which they live. In the end, the concentration of resources and power creates despotic autocrats and incompetent authorities, whose activities become ruinous, not only to their own communities and natural resources, but also to the external agents who created them.

Policies which are characterized by these syndromes obviously endanger the long term conservation of sea turtles and other natural resources; the clearest, and most extreme, cases are those included in the "Marcos-Noriega Syndrome".

HOW CAN THESE PROBLEMS BE AVOIDED?

It must be clear that *Homo sapiens* is a highly political animal, and even seemingly apolitical activities are charged with political elements. Several steps are useful in reducing damage from the political consequences of conservation activities.

"Know thyself" (and thy institution):

It is essential to know the TRUE objectives of the people and institutions which are involved in conservation activities. Institutions (including those involved with biological conservation) can be grouped into three categories, according to their functional objectives:

- task oriented: meet measurable objectives in defined tasks;
- image oriented: create or maintain an image;
- power oriented: consolidate power (e.g. influence) and resources (e.g. money).

Clearly, the stated objectives of institutions rarely include the last two functional objectives, but these two modes are remarkably common among institutions in general.

Insist on a Civil Service and Institutional Accountability:

Insist that civil servants serve the public that pays for their employment and that institutional representatives be accountable for their actions - not diffuse their responsibilities in an impersonal institution. Do not become part of the Good Scout or Clientele populous by stimulating and supporting these syndromes.

Insist on Quality Control:

As in Science, a conservation activity must be objectively evaluated for its quality. Quality must be a first priority of conservation, not a byproduct.

Support True Training and Capacitation:

One of the worst problems in the tropics is the lack of trained personnel; careful planning, dedication and competent mentors are required to resolve this. Commonly, the response to this problem is typified by the unctuous greenbacks syndrome, and this simply aggravates the problem. While money and resources are critically needed, they must be used intelligently and not simply employed to create an image of commitment; the true commitment to solving this problem comes with the investment of time and attention.

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PUBLIC LAW 101-162 FOR THE INTERNATIONAL CONSERVATION OF SEA TURTLES: A STATUS REPORT

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Section 609 of Public Law 101-162 bans imports of shrimp from 14 countries with commercial shrimp trawl fisheries in the Gulf of Mexico, Caribbean, and western Atlantic Ocean unless the Department of State certifies by May 1 of each year either: (1) that a country has adopted a program governing the incidental capture of sea turtles in the commercial shrimp trawl fishery comparable to that of the United States; or (2) that the fishing environment in a particular country does not pose a threat of the incidental taking of sea turtles.

Since 1990, the Department of State, with technical assistance provided by the Department of Commerce, National Marine Fisheries Service, has conducted discussions with each of the affected countries and received specific written commitments from eleven countries that these countries will require the use of turtle excluder devices (TEDs) on all commercial shrimp trawl vessels operating in the Gulf of Mexico, Caribbean, and western Atlantic Ocean by May 1, 1994. Each of these eleven countries also committed to require the use of TEDs on a significant number (30-50 percent) of these same vessels by May 1, 1993. French Guiana failed to provide the necessary commitment in writing to the Department and, as a result, imports of shrimp from French Guiana were banned effective May 1, 1992. The Department has certified that the fishing environment in two countries, Costa Rica and Guatemala, does not pose a threat to sea turtles covered by Section 609 because these countries have no commercial shrimp trawl vessels operating off their Caribbean coasts.

With the commitments to require the use of TEDs in hand, the focus of efforts to implement Section 609 has shifted to providing training and technical assistance to assist the affected countries adopt the use of TEDs in their commercial shrimp fleets. Training includes background and history on the development of the TED and the U.S. sea turtle regulatory program; hands on practical sessions to learn the construction and installation of TEDs; and at-sea vessel demonstrations on the basics of TEDs use, deployment, retrieval, etc. This training has been carried out by the gear technicians of the National Marine Fisheries Service in Mexico (several sessions), Panama, Suriname, Honduras, and El Salvador, with future training programs planned for Venezuela, Colombia, Nicaragua, Trinidad and Tobago, and Guyana.

UPDATE: Since the February Symposium at Jekyll Island, TEDs training programs have been completed in Venezuela, Nicaragua, and Colombia. On May 1, 1993, the Department of State certified that 10 of the 14 affected countries had met the requirements of the law for the current year. Four countries, Honduras, Trinidad and Tobago, Suriname, and French Guiana, did not receive certifications on May 1 and U.S. imports of shrimp from those countries were banned as of that date. Honduras and Trinidad and Tobago have since met the requirements of the law for the current year and the shrimp ban has been lifted for these two countries. Shrimp imports from Suriname and French Guiana remain subject to the ban. In order to receive a certification on May 1, 1994, each of the affected countries must complete its program to require the use of TEDs on all commercial shrimp trawl vessels operating in the Gulf of Mexico, Caribbean, and the western Atlantic Ocean.

GALAPAGOS SEA TURTLES: AN OVERVIEW

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The Galápagos Archipelago, a territory of the Republic of Ecuador since 1832, straddles the equator in the Pacific Ocean approximately 1,000 km off the coast of Ecuador between longitudes 89° W and 92° W. The archipelago is volcanic in origin and consists of 17 major islands. Four species of sea turtles have been recorded in its waters. The most common is the east Pacific green turtle (*Chelonia mydas agassizii*). Two morphotypes are recognized: the typical dark form, known locally as tortuga negra (black turtle), and a rare form with a yellowish carapace and a yellow-orange plastron, known locally as the yellow turtle or tortuga amarilla.

The hawksbill turtle (*Eretmochelys imbricata*), local name carey, is occasionally found on some of the feeding grounds. Of the 2,345 turtles tagged on the feeding grounds between 1975 and 1980, only 4 (0.2%) were hawksbills. Nevertheless, they have been reported from most of the major islands within the archipelago (Green and Ortiz-Crespo, 1982). While most of the hawksbills reported, including the four tagged ones, were subadults, Pritchard (1972) has documented both an adult female and an adult male. While no nesting records for *Eretmochelys* in Galápagos exist, the species does nest on the coast of mainland Ecuador (Green, 1978). Since the hawksbills in Galápagos are predominantly immature and since the currents usually flow east to west, Galápagos hawksbills are probably part of the mainland population.

The leatherback turtle (*Dermochelys coriacea*) is an extremely rare visitor and, as such, has no local name (Green and Ortiz-Crespo, 1982). More-recently, S. Morreale and F. Paladino (pers. comms.) documented a two-week sojourn by a leatherback in the archipelago. The olive ridley (*Lepidochelys olivacea*), the most abundant sea turtle off mainland Ecuador (Green, 1978), is also rare in the Galápagos but has been reported several times in recent years (R. Pitman, pers. comm.). Prior to Pitman's recent observations, the species had not been reported from Galápagos waters since Joseph Slevin captured two individuals during the California Academy of Sciences Expedition in 1906 (Green, in press).

Turtles at eight nesting beaches (Quinta Playa and Bahia Barahona, Isabela Island; Las Bachas, Santa Cruz Island; Las Salinas, Baltra Island; Bartolomé Island; Espumilla, Santiago Island; and Playa Sardina, San Cristóbal Island) and four feeding grounds (Elizabeth Bay, Isabela Island; Punta Espinzoa, Fernandina Island; and Turtle Cove and Puerto Nuñez, Santa Cruz Island) were measured, weighed and tagged. The turtles at the feeding grounds were captured either by nets or by hand. Hand methods included diving from a skiff or from land, SCUBA and snorkeling. The captured turtles were either taken aboard a specially constructed skiff or onto nearby land before being released into the water a short time later. Each turtle was tagged with a numbered, monel metal cattle-ear tag (Size 49, National Band and Tag Co., Newport, Kentucky, USA) inserted into the trailing edge of the right foreflipper and a numbered, colored plastic tag (Jumbo Rototag, Dalton Supplies, Henley, England) inserted into the trailing edge of the right hindflipper. This double-tagging method was used to compensate for tags loss encountered by turtle investigators elsewhere (Green, 1979).

Between 1975 and 1980, 4,371 female and 10 male green turtles were tagged at the nesting beaches and 2,341 green turtles (1,236 females, 601 males (determined by external characteristics such as tail length), 480 immatures, and 24 yellow turtles) and 4 hawksbills were tagged at the feeding grounds for a total of 6,722 green turtles (5,607 females, 611 males, 480 immatures, and 24 yellow turtles) and 4 hawksbills.

SIZE AND MASS

Galápagos green turtles are among the smallest green turtles in the world. The straight carapace length (SCL) of nesting females ranges from 66.7 cm to 106.6 cm, with a mean of 81.4 cm; mass ranges from 45.5 kg to 172.7 kg, with a mean of 81.9 kg. Only females nesting on the Pacific coast of México are smaller and weigh less than the Galápagos females (Green, in press). This trend for smallness in Galápagos green turtles is also reflected by clutch size, eggs, hatchlings, and in the adult males. Males on the Galápagos feeding grounds have SCLs ranging from 64 cm to 94 cm, with an average of 77 cm.

REPRODUCTION

While both copulation and oviposition have been recorded in every month, a definite breeding season exists. Sporadic for much of the year, copulation starts to increase noticeably in late September, peak in mid-December, and become sporadic again by February. Oviposition occurs primarily between December and June with a peak in February/March. Thus, copulation has virtually ceased by the time of maximum egg-laying activity.

Nesting occurs on all major islands except Rábida, Pinzón, Genovesa and, possibly, Fernandina. The most important beaches are Quinta Playa and Bahia Barahona on southern Isabela, Las Salinas on Baltra, Las Bachas on northern Santa Cruz, and Espumilla on Santiago. An estimated 1,200-3,250 females nest annually in the archipelago (Green, in press). Most nesting females emerge between 1900 hours and midnight, usually within two hours either side of high tide, rarely by daylight or at low tide. The whole nesting process takes from 1.75 hours to 10 hours, with an average of 3.5 hours. Oviposition requires just 20 minutes with a recorded range of 7-48 minutes.

Galápagos green turtles lay between one and seven clutches in a single season with an average of about three clutches per female. The internesting interval ranges from 8 to 27 days, with an average of 15 days. Clutch size ranges from 26-144 eggs with an average of 84 eggs. Only on the Pacific coast of México, where the average is 65 eggs, is the recorded clutch size smaller (Alvarado and Figueroa, 1987). The incubation period ranges from 45-75 days with an average of 55 days.

Hatching success varies from beach to beach. On beaches such as Las Salinas or Las Bachas, where little or no egg predation occurs, or where inundation by high tides is generally not a factor, 70-80% of the eggs hatch. Predation by a scarabaeid beetle, *Trox suberosus*, however, has largely been responsible for a hatching rate at Quinta Playa of about 40%. Nest destruction by feral pigs on Espumilla has, in the past, resulted in a hatching rate of only 1%.

Thus far, only 85 females, or 2.6% of the total number tagged on Galápagos beaches, have been recovered on Galápagos beaches in subsequent years. The remigration interval (the period between inter-season beach recoveries) ranges from 2-6 years, with over 50% of the intervals being of 3 years. Remigration of males also occurs, most commonly after one year.

MIGRATION

Tag returns have demonstrated that, as with green turtle populations elsewhere, the Galápagos breeding colony, or at least part of it, undertakes long-distance migration to, and is therefore recruited from, distant and widespread feeding grounds. Galápagos-tagged turtles have been recovered from Perú, mainland Ecuador, Colombia, Panamá, and Costa Rica (Green, 1984). The minimum distances travelled ranged from 1,120 to 2,163 km, and the times between the last recorded sighting and recapture, from 98-3,183 days. One female, recaptured off the coast of mainland Ecuador after nesting on Quinta Playa in 1977 and re-released, subsequently renested on Quinta Playa in 1981. This represents one of the few documented instances of two-way migration anywhere in the world. Three of the recoveries were males. The migrations of these males (two to Perú and one to Costa Rica, minimum distances of 1,300 to 2,150 km) are among the longest on record for males.

FEEDING, GROWTH AND AGE AT SEXUAL MATURITY

Galápagos green turtles feed predominantly on algae. At least 30 different species of algae have been identified as food items, including *Ulva*, *Padina*, *Gelidium*, *Callithamnion*, and *Gracilaria*. The depth at which turtles feed in Galápagos ranges from less than one meter to 25 m. Growth rates of Galápagos green turtles are extremely slow. Juveniles and subadults with an SCL of 40-50 cm grow an average of 0.4 cm per year and those with an SCL of 50-60 cm, about 0.45 cm per year. The rate becomes even slower as the turtle approaches sexual maturity. Subadults with an SCL between 60 and 66.7 cm (the size of the smallest nesting female recorded thus far in Galápagos) grow at only 0.15 cm per year. Many of the turtles show no measurable annual increase in the SCL. Based on the above growth rates, it may take some turtles at least 50 years to reach sexual maturity.

BASKING

Basking in Galápagos green turtles was first recorded as long ago as June 1684 by both Dampier (1699) and Cowley (in Slevin, 1959). It appears to have been a common behavior because many of the early visitors have commented on it. Basking still occurs in the archipelago, but it is not as common as it once was, possibly because fewer turtles occur today. It occurs in many of the islands, especially in the lagoons, where I have commonly observed turtles resting on rocks; mud banks; among mangroves and other bank vegetation; against the trunks of fallen trees; at the edge of the lagoon touching bottom in shallow water; or at the surface. I once counted over 30 basking turtles in a lagoon at Elizabeth Bay. Basking also occurs on the beaches.

YELLOW TURTLES

The yellow turtle, known locally as tortuga amarilla, is a rare form with a yellowish carapace and yellow-orange plastron. Of 2,341 green turtles tagged on the feeding grounds between 1975 and 1980, only 24 (1%) were yellow turtles. Adult-size individuals of the two types are easily told apart, but smaller yellow turtles are sometimes difficult to distinguish from juvenile black turtles. Yellow turtles in Galápagos may be an aberrant form of the black turtle where the gonads fail to mature. They could also be juveniles of green turtle populations in Polynesia.

ACKNOWLEDGEMENTS

The numerous people involved with the Galápagos sea turtle project have been fully acknowledged in Green (in press). I would, however, like to reiterate my thanks to Craig McFarland, former director of the Charles Darwin Research Station, for advise and encouragement; to Mario Hurtado for assistance in the field and, in the later stages, for help in coordinating the field work; and to W.G. Reeder, director of the Texas Memorial Museum, for providing me the opportunity to complete the project. I would also like to thank Espey, Huston & Associates, Inc. for logistical support during the preparation of this manuscript and for supporting my attendance at the symposium. The research was supported by National Geographic Society grants 1432, 1666 and 1814 to Craig McFarland and by a donation from Theodor Pitcairn to the Smithsonian Institution.

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POST-NESTING MOVEMENTS OF HAWKSBILL SEA TURTLES FROM BUCK ISLAND REEF NATIONAL MONUMENT, ST. CROIX, USVI

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Understanding the post-nesting movements of hawksbill sea turtles is vital to their protection, yet little is known about this time in their life history. The objectives of this study were 1) to determine if hawksbills nesting at Buck Island Reef National Monument remain in the area after completing nesting for the season, and 2) to trace the annual movement patterns of radio-marked turtles.

METHODS

Nesting turtles were approached during oviposition and pulse-coded or satellite transmitters (Microwave Telemetry Inc., Columbia, MD) were attached to the leading edge of the carapace with fiberglass-based auto body filler. Turtles tagged with pulse-coded transmitters were monitored for presence/ absence information 24 hours a day with a computerized tracking system located on Buck Island (range = 5mi.). Turtles with satellite transmitters were tracked by NOAA satellites; latitude and longitude data were downloaded to Service ARGOS and accessed by computer.

RESULTS AND DISCUSSION

Three of 7 pulse-coded transmitters put on turtles remained functional long enough to assess the post-nesting presence or absence of the turtles around Buck Island. All of these turtles were last heard from less than 24 hours after laying their last nest of the season.

Post-nesting locations from satellite transmitters were received from 3 of 11 transmitters. One of these turtles (02151) was tracked for 10 months (10/91-8/92), another (02156) for 1.5 months (9/92-10/92), and a third (02153) yielded only one location (10/92). Turtle 02151 travelled east and west between the British Virgin Islands and Puerto Rico for 3 months, then became resident off the coasts of St. Thomas and St. John (Fig. 1). Seventy-five percent of all locations were off of these two islands. Turtle 02151 made occasional short duration excursions to St. Martin, Puerto Rico, St. Croix, Anegada, and Culebra, but always returned to St. Thomas and St. John. Turtle 02156 moved just south of western Puerto Rico one day after her last nest of the season. She subsequently was located near the coast of the Dominican Republic, northwest of St. Vincent, The Grenadines, and off the northern coast of Venezuela, in the region of Cubagua and Isla de Margarita (Fig. 2). An alternate location for 02156's St. Vincent location placed her just west of Jamaica and south of Cuba. Turtle 02153 was heard from only once and was located at Anegada, British Virgin Islands.

It is clear that hawksbills nesting at Buck Island Reef National Monument leave the area after completing their nesting effort for the season and move to areas where harvest is a concern. Protective measures for this population should extend beyond the nesting beaches and the waters immediately offshore. Data from this study indicate that the hawksbill surface interval may be too short to allow for effective satellite tracking using the current technology.

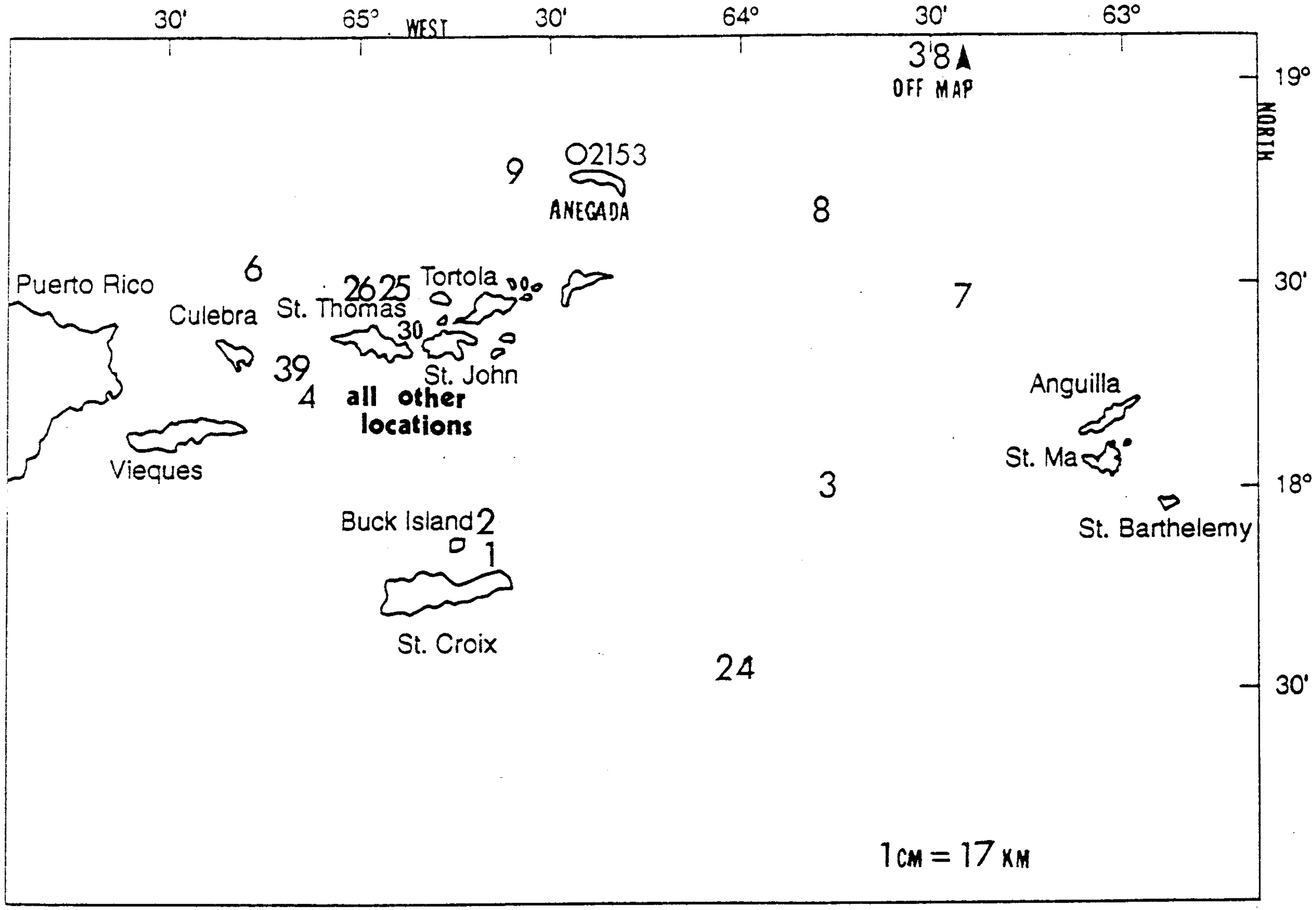

Fig. 1.Post-nesting locations of turtles 02151 and 02153, tagged at Buck Island Reef NM., St. Croix, USVI.

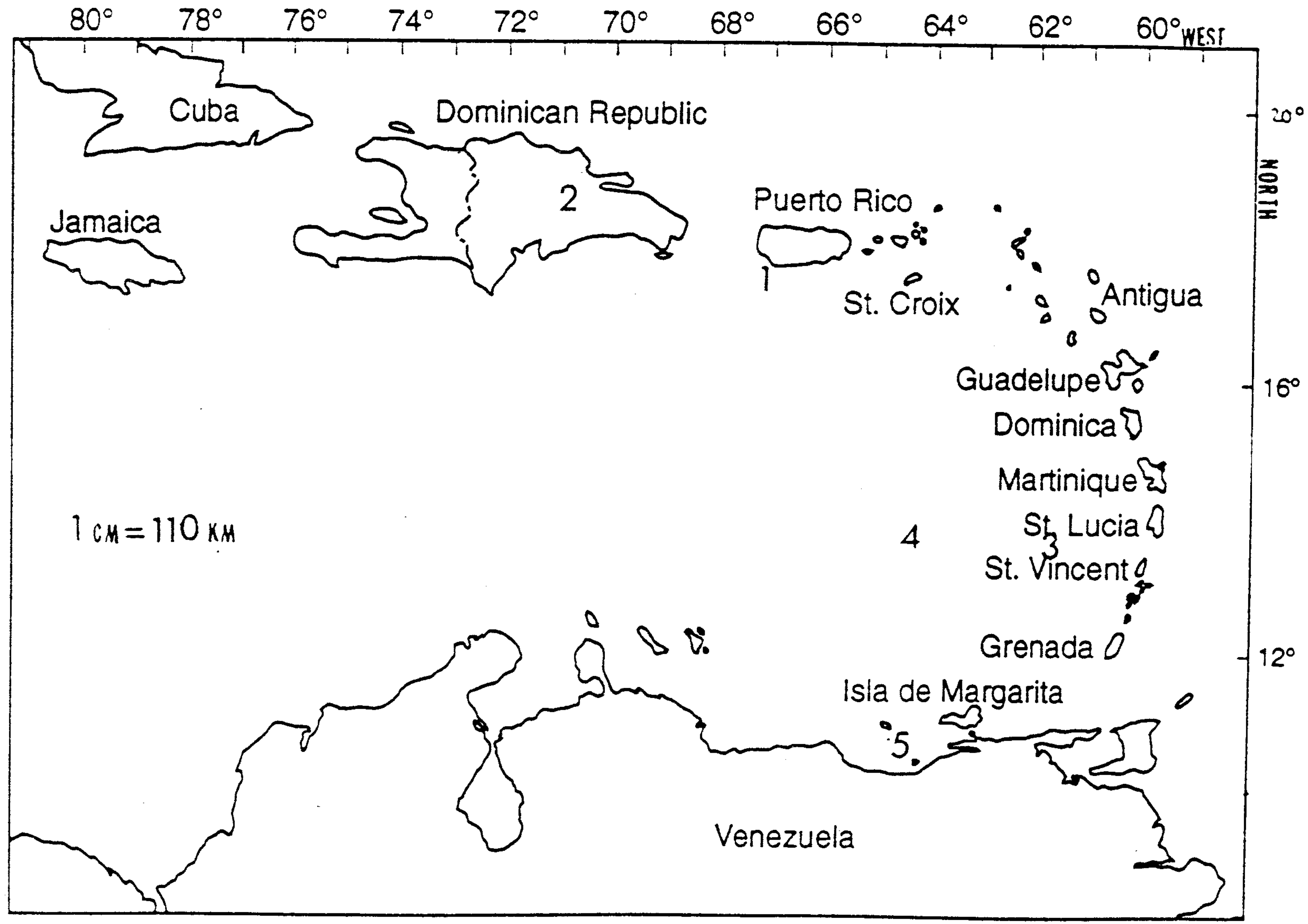

Fig. 2. Post-nesting locations of turtle 02156, tagged at Buck Island Reef NM, St. Croix, USVI.

RESULTS OF THE SEA TURTLE SURVEYS IN THE PENINSULA DE PARIA (SUCRE STATE, VENEZUELA) IN 1992

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As in previous years (Guada, 1991; Guada and Vernet 1988, 1991, 1992; Guada et al., 1989), the Peninsula de Paria coasts have been surveyed in order to evaluate and confirm the presence of nesting sea turtles in the area.

METHODS

Local fishermen were contracted in order to transport us to several beaches. The presence of tracks, nests, rests of eggs, and signs of predators were recorded. In the inhabited beaches, we conducted brief interviews.

RESULTS

The surveys spanned a northern area between Rio Caribe and Cipara and a southern area near Macurito and Manzanillo. On the northern peninsula 10 beaches were surveyed. In total, four nesting beaches were found (El Tigrillo, Tortuga, Purgo, Querepare). Only one beach (Cangua) had been reported previously as a sea turtle nesting beach (Pritchard and Trebbau, 1984). At some of the other beaches, nesting was recorded for the first time (San Juan de Unare, El Guamo; Table 1). At the south of the peninsula, seven beaches were surveyed (Table 2), three of them unknown before and located within the boundaries of the Peninsula de Paria National Park (Manzanillo, Cerezo, Obispo). One of these, Manzanillo, seems to be significant in terms of sea turtle usage. Los Garzos beach is the most important nesting place in the national park.

In light of these results, we can say that a good part of the beaches in the north of Peninsula de Paria are used simultaneously by several species of sea turtles, although in the larger beaches as Cipara, El Guamo, Querepare, Cangua, nesting of leatherback turtles predominates. Predators have not been registered as a important factor of nest loss. The robbing of the eggs and the killing of the female sea turtles are the main menace to the survival of the species. It must be mentioned that an undetermined number of turtles die day after day due to drowning in gill nets (called "filetes") used by fishermen. For example, there are reports of 16 leatherback turtles that died in one fishing net (Guada & Vernet, 1988). Two female leatherback turtles tagged in 1989 (Guada et al., 1989) died in nets of local fishermen in the same nesting season.

At the moment, the Fauna Service (PROFAUNA) of the Ministry of the Environment and Natural Renewable Resources (MARNR) is evaluating the data gathered since 1988 (Guada 1991; Guada and Vernet 1988, 1991, 1992; Guada et al, 1989) in order to consider the declaration of a Wildlife Refuge or a Fauna Reserve in the northern Peninsula de Paria (A. Quijada, personal communication). By May or June of 1993, field work to get information to support the declaration will have been conducted.

The incorporation of a sea turtle nesting beach at the southern peninsula (Lambato) within the national park has been proposed (Guada, 1992). In the same document, the incorporation of a marine area in the north coast of the Peninsula de Paria National Park was proposed in order to have more tools to control and regulate the sea turtle captures in the fishing nets and the access to the beaches. However, along all the coast of the national park there is a scarcity of personnel and equipment (boats, outboard motors and others) to do monitoring and protection of the sea turtle nests. In the south of the Peninsula de Paria (including the national park) most nests are stolen and many of them are predated by an undetermined carnivore (Canidae or Procyonidae). As an additional problem, some nesting beaches have shown accumulation of dust and oil contamination (Vera, 1992).

After five years of field work, information about sea turtle nesting distribution and numbers continues to be scarce. More dedicated field work is needed to fill the gaps. At the same time is urgent to promote the environmental education toward the sea turtle conservation in the area.

Acknowledgements: in Cipara we received lodging from A. Garcia and through M. Batista we were transported in boat by A. Flores and E. Campos. V. Reinoza (park ranger from the Peninsula de Paria National Park) worked with us during the surveys in the southern area and we were transported in that sector by J. Salazar and R. Aguilera. L. Sobil offered us lodging in Uquire beach within the national park.

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Table 1. Sea turtle presence on beaches surveyed in the northern Peninsula de Paria, during the 1992 field work.Cm: (*Chelonia mydas*), EI: (*Eretmochelys imbricata*), Cc: (*Caretta caretta*), Dc: (*Dermochelys coriacea*), N: (Non identified, Ei or Cc), U: (Unknown).

BEACH	SPECIES	TRACKS	NESTS
Cipara	Dc	-	3
San Juan de Unare	Dc	-	2 (robbed)
	U	1	-
El Tigrillo	Cm	-	1 (robbed)
	U	-	5 (robbed)
Los Caballos	-	-	-
El Guamo (1)	Cm	-	1 (robbed)
	Ei	1	1
	Dc	-	7 (robbed)
	N	-	1
Tortuga	U	-	2
Purgo	U	-	4 (robbed)
Querepare	Ei	1	-
	Dc	-	12 (robbed)
	N		
	U	1	4 (robbed)
Cangua	Dc	-	4 (robbed)
	N	-	3 (robbed)
San Juan de Las Galdonas	-	-	-
Medinita (2)	Cm	-	2 (robbed)
	Ei	-	3
	U	-	3

(1) A killed leatherback turtle was found (curved carapace length: 158.2 cm.).
(2) This beach was mentioned as Mapurite in Guada and Vernet (1991). However, other fishermen said that its true name is Medinita. Mapurite is other beach to the west.

Table 2. Sea turtles presence in the beaches surveyed in the southern Peninsula de Paria, during the 1992 field work.Cm: (*Chelonia mydas*), Ei: (*Eretmochelys imbricata*), Cc: (*Caretta caretta*), Dc: (*Dermochelys coriacea*), N: (Non identified, Ei or Cc), U: (Unknown).

BEACH	SPECIES	TRACKS	NESTS
Macurito	Ei	-	3 (2 robbed, 1 predated
	NI	-	1 (robbed)
Lambato	Cc	-	2 (robbed)
	NI	1	-
Los Garzos	NI	-	10 (robbed)
Obispo (1)	Cc	-	2 (robbed)
	Ei	1	-
Obispo (2)	NI	-	1 (old)
Cerezo	U	-	1 (robbed)
Manzanillo	Ei	1	-
	U	1	7 (robbed)

TESTING THE IMPORTANCE OF VISUAL CUES IN RACCOON PREDATION OF LOGGERHEAD SEA TURTLE NESTS

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Raccoon predation of sea turtle nests in the southeastern United States is a major management problem. During the 1990 sea turtle nesting season at Hobe Sound National Wildlife Refuge, 108 nests were staked and monitored until their fate was determined. Fifty-seven of these nest were treated as controls. The other fifty-one nests were raked to eliminate visual signs of their presence. Most nest predation occurred within the fist ten days of incubation. Comparison of the predation rates using Chi-Square analysis showed no significant difference in predation for raked and unraked nests. Additional data showed that the distance nests were deposited from the dune vegetation line significantly affected predation rates.

IS HEADSTARTING HEADED IN THE RIGHT DIRECTION?

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We use matrix modelling techniques to evaluate the population-level effects of the Kemp's ridley headstarting project. Past analysis of a matrix model for loggerhead sea turtles indicated that increasing survival in the first year of life had little impact on population growth (Crouse et al, 1987). Since the reproductive value of a turtle increases as it ages, and size classes can include turtles of many ages, it makes sense that populations are more likely to increase when we focus our efforts on size classes of older turtles rather than single age groups. We predicted that at current levels, headstarting could not significantly contribute to the Kemp's ridley population, even if headstarted juveniles had the same survival and growth rates as wild juveniles. Lack of information on Kemp's ridleys encouraged us to find a more complete data set for a similar species; a complete life table for freshwater yellow mud turtles (*Kinosternon flavescens*) in Nebraska (Iverson, 1991) gave us a model to test our theories about the effects of headstarting on long-lived, late maturing turtle species.

METHODS

We analyzed both stage-based and age-based population models for Kemp's ridley and yellow mud turtles. Data for these models was obtained from the literature. Estimates were made for size-specific survival in Kemp's ridleys based on data for same-sized loggerheads. We also estimated a post-TED mortality decrease of 30% for subadult and adult turtles, based on strandings data (Murphy, pers. comm.; Crowder et al, in review). We calculated parameters for our stage based models using equations from Caswell (1989). We used age-based Leslie matrices to calculate population projections through time. For Kemp's ridley projections, we used the number of female head-starters released each year from 1978-1991, then assumed a release of 2000 females every year following. We always assumed that headstarted turtles had the same survival and growth as wild turtles after release.

RESULTS

The number of years to maturity greatly affects the population recovery for Kemp's ridleys (Figure 1). Even if Kemp's mature in 8 years (which is unlikely), headstarting will not contribute significantly to the adult female population for 20 years after initiation of the program. If headstarters do prove to be healthy nesters, with an eight year maturity schedule there could be as many as 1000 additional females in 2008 (30 years after the start of the program), but only 450 additional females in 2008 if they mature in 12 years. In yellow mud turtles, an increasing population can be augmented by headstarting (Figure 2). A headstart program similar to the current Kemp's project which releases 20 female mud turtles each year results in an addition of 5 adult females after 25 years. Programs which take 3% of the eggs laid each year have a greater impact: there could be a 9% increase in adult females in 25 years, or even an 18% increase if all those eggs were hatched female. However, it is important to remember that in a growing population, three percent of the eggs becomes a greater number going into headstarting each year. Finally, if adult survival is decreased by as little as ten percent headstarting cannot save the population (Figure 3). None of the three headstart programs can compensate for losses in the valuable adult stage.

DISCUSSION

It seems unlikely that headstarting could be a viable management tool for turtle species recovery. The expense, manpower, and uncertainties involved with headstarting, coupled with these projection results, should be considered carefully when funds for sea turtle research and conservation are limited.

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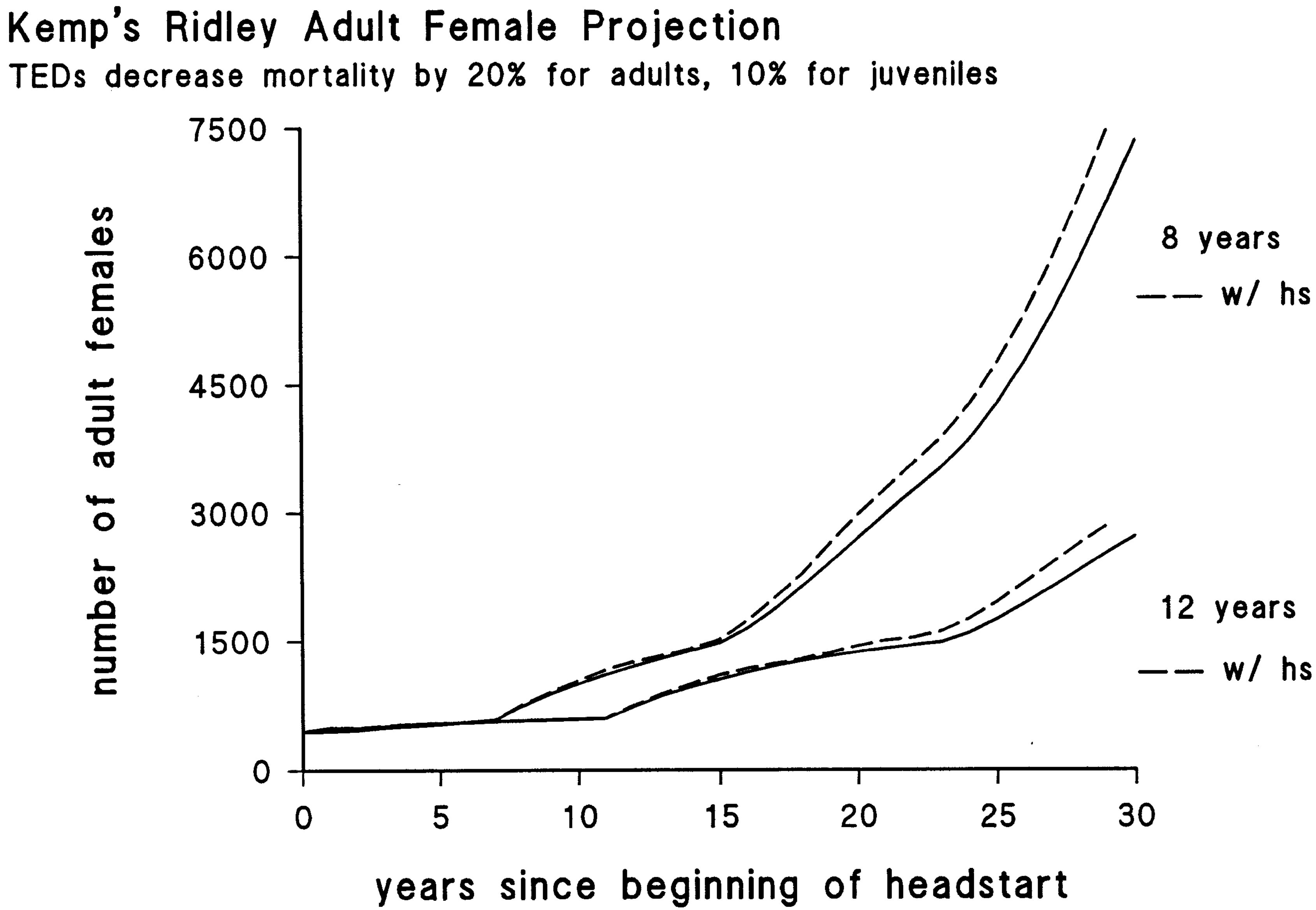
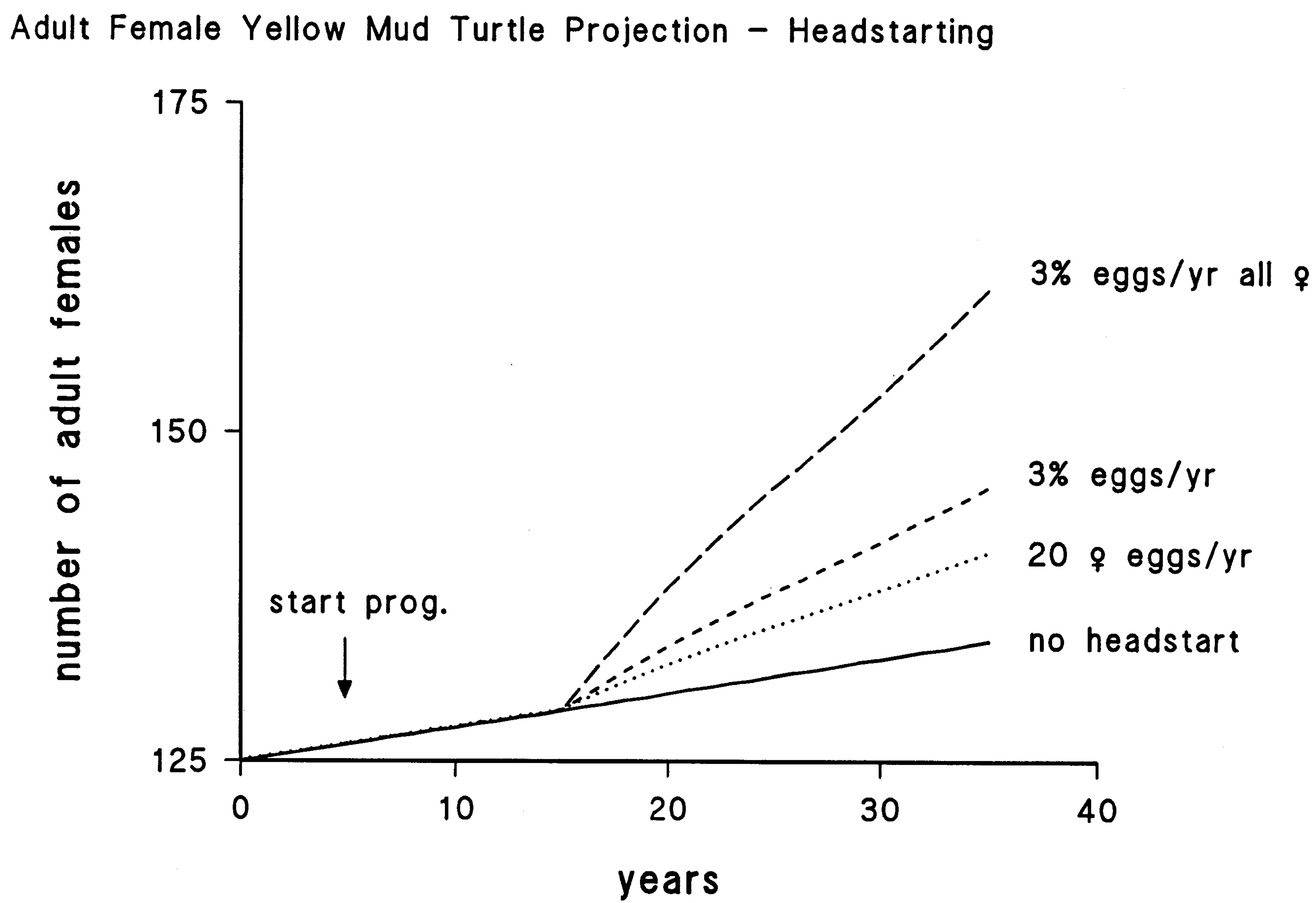


Kemp's Ridley Adult Female Projection
TEDs decrease mortality by 20% for adults, 10% for juveniles
7500
6000
4500
3000
1500
0
number of adult females
0
5
10
15
20
25
30
years since beginning of headstart
8 years
w/ hs
12 years
w/ hs

Figure 1.



Adult Female Yellow Mud Turtle Projection – Headstarting
number of adult females
175
150
125
0
10
20
30
40
years
start prog.
3% eggs/yr all ♀
3% eggs/yr
20 ♀ eggs/yr
no headstart

Figure 2.

Adult Female Yellow Mud Turtle Projection – Headstarting w/ Adult Survival –10%

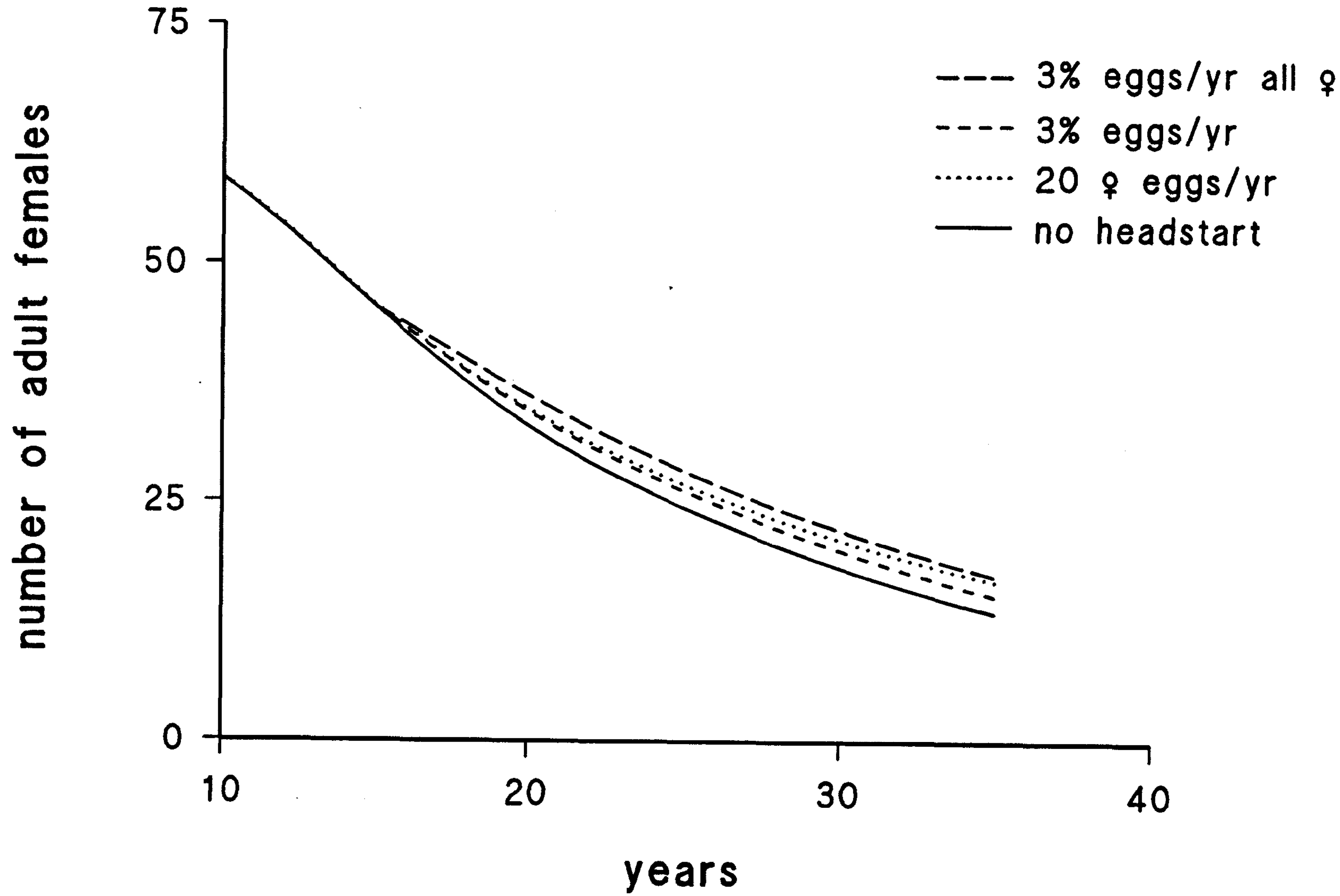


Figure 3.

DEVELOPMENT OF MONOCLONAL ANTIBODIES AGAINST SEA TURTLE IMMUNOGLOBULINS

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Monoclonal antibodies (mabs) specific for immunoglobulin (Ig) are critical reagents for use in a variety of diagnostic immunoassays for monitoring the health of sea turtles. As part of our ongoing studies of immune system function in sea turtles we have produced a battery of mabs against green turtle Ig classes.

Green turtle, *Chelonia mydas* globulins were purified from pooled plasma by salt precipitation followed by chromatography on Sephacryl S-300 and DEAE anion exchange columns. Proteins were eluted from the DEAE column in steps of increasing salt concentration. Proteins eluted in two peaks corresponding to 0.125M and 0.25 M NaCl. Protein in the 0.25 M peak appeared to have 2 major components on reducing SDS-PAGE: a 23Kd and a 70 Kd band suggestive of Ig light chain and u heavy chain respectively. Protein from the 0.125 M NaCl peak had three components: 23 Kd, 38 Kd, and 65 Kd (putative light, 5.7S heavy and 7S heavy chains respectively).

Proteins separated on the Sephacryl S-300 column eluted in two major peaks: a small early peak containing IgM and a large late peak containing a mixture of 5.7S and 7S IgG. Fractions were examined using SDS-PAGE and those of similar protein composition were pooled. The resulting fraction pools were designated IgM-rich, 5.7S-rich, and 7S-rich.

Splenocytes from Balb/c mice immunized with the DEAE fractions were fused with SP2/0 mouse myeloma cells and grown in selective medium. Hybridomas were screened against 5.7S-rich, 7S-rich, and IgM-rich fraction pools in an enzyme-linked immunosorbent assay (ELISA). ELISA positive supernatants were further screened by Western Blot. Those hybridomas producing mabs with specificity for putative Ig light-chain, 5.7S, 7S, or IgM heavy chains were saved.

Further screening of these hybridomas revealed that several mabs cross-react with Igs from other sea turtle species tested, *Caretta caretta*, *Lepidochelys olivacea*, and *L. kempi* and have potential for use in these species for serodiagnostics and health monitoring.

We are in the process of validating these reagents by screening their ability to detect rising titers in turtles inoculated with specific antigens.

NEST-SITE FIDELITY OF THE FLORIDA GREEN TURTLE

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During the summers of 1991 and 1992 nest-site fidelity of the Florida green turtle (*Chelonia mydas*) was studied at the Archie Carr National Wildlife Refuge along the southernmost 12 km of Brevard County, Florida. Interseasonal recaptures for 10 known remigrants revealed a mean interval of 1.9 km separating return sites. A mean of 1.8 km separated consecutive nest sites for intraseasonal recaptures, however the modal distance between consecutive nests is 0.2 km. Values for these within-season recaptures are similar to those reported by Carr and Carr (1972) for the Tortuguero nesting population. The mean separation distance between consecutive nestings for the Florida population was compared to that of a sample of randomly selected intervals. The 1.8 km mean was significantly smaller than that of the random sample (Mann-Whitney U Test; $p = .0001$). Although there is some variation between individuals, more often than not the distance separating consecutive nest sites is quite small, in many instances less than one kilometer.

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AT-SEA CAPTURE OF KEMP'S RIDLEY SEA TURTLES IN THE NORTHWESTERN GULF OF MEXICO

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Directed, at-sea capture of Kemp's ridley (*Lepidochelys kempi*) sea turtles from nearshore waters at Sabine Pass and lower Laguna Madre, Texas during summer and fall 1992 is summarized. Significance of these capture successes, including that of a headstart individual released off Galveston in June 1991, plus anecdotal information on sightings of preyearlings/yearlings and hook-and-line capture of ridleys are evaluated. Results of fall and winter capture efforts help define ridley utilization of nearshore gulf habitats during cool-water periods. Radio- and sonic-tracking data characterize short-term ridley movements in the lower Laguna Madre. Fecal pellet analyses provide an insight to food preferences of ridleys captured along the upper and lower Texas coast. The importance of Sabine Pass as an index habitat for the Kemp's ridley was assessed.

LONG INTERVAL REMIGRATION IN EASTERN AUSTRALIAN *Chelonia*

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Heron Island (Bustard 1972, Moorhouse 1933) has become the focal point of long term studies of *Chelonia mydas* nesting biology in eastern Australia. Effectively every turtle that nests on Heron Island has been tagged each breeding season since 1974. However, remigration recaptures from the first 7 years of these studies were uncommon (14 remigrants) because of loss of their monel tags (Limpus 1992). Since 1983 most nesting female *C. mydas* at Heron Is. have been double tagged with titanium tags in the front flipper axillary tagging positions (Limpus 1992) and in the first 7 years of use of titanium tags there were 581 migrant recaptures - a dramatic improvement in rate of recaptures. Some preliminary results from these recaptures are discussed. All recapture rates are presented as raw data, uncorrected for tag loss.

In addition to the annual total tagging census at Heron Island, nesting turtles have been sampled (tagged and/or checked for tags) over a 2 week period during mid season in most summers at other islands of the Capricornia section of the southern Great Barrier Reef (GBR): at Wreck, North West and Lady Musgrave Islands which lie approximately 13, 24 and 60 km distant from Heron Island. At Raine Is. in the northern GBR, a sample, usually 1000-2500, of the nesting turtles are tagged (single titanium tags) each summer in early December.

An examination of remigrant recaptures of *C. mydas* previously tagged nesting at Heron Is. in each of the last 4 nesting seasons, 1989/90 to 1992/93 (Fig. 1) demonstrates that most remigrants returned to the same rookery as they had nested at in a previous season. However, at least 15% of remigrants changed rookery and were recorded nesting within a 60 km radius of the original rookery. The number of remigrant recaptures varied widely among the seasons and was a function of the size of the annual nesting population. There was a significant difference in remigration interval among the consecutive breeding seasons ($F_{3,561} = 59.8$, $p < 0.0001$). Much of this latter variability resulted from variability in the size of the year cohort tagged in individual past years. Most remigration recaptures occurred at intervals of ≥ 5 yr after the previously recorded nesting season.

A more consistent pattern of remigration tag recovery is evident when the data is examined in terms of cumulative recoveries from individual tagging year cohorts. The remigration recoveries from the first 4 years of titanium tagging at Heron Island, 1983 to 1986, are summarized in Fig. 2 and 3. The modal remigration interval has been 5 yr. However, substantial numbers of remigrants are being captured at intervals >5 years. Even after 8-9 years, the cumulative recoveries have not reached asymptotic levels. A sample of comparable remigration data from *C. mydas* at Raine Island in the northern GBR is summarized in Fig. 4. Here also, the modal remigration interval is 5 years.

A number of the females tagged nesting at islands in the northern and southern GBR have been captured in their respective eastern Australian feeding areas and examined for annual breeding condition via laparoscopy. For these recaptured *C. mydas* and for other females living in the same feeding areas, it is typical for the female to wait 5 or more years between breeding seasons. Females which have a past breeding history and which currently have not bred in 6 consecutive years are not uncommon. For these latter turtles, the condition of their ovaries indicates that they still are capable of breeding.

The low frequency of short remigration interval (2-4 years) cannot be attributed to a failure to record turtles that returned to Heron Island or to turtles changing rookeries. The feeding area laparoscopic studies indicate that east Australian *C. mydas* do not normally breed at short remigration intervals. Long remigration intervals are real with *C. mydas* that breed in the Great Barrier Reef. Pending further years of data collection, for *C. mydas* tagged during the 1983 to 1986 breeding seasons at Heron Is., the interim mean remigration interval = 5.78 yr (s.d. = 1.481, range = 1 - 9, n = 518).

Why the difference in remigration interval between eastern Australia and elsewhere (Carr *et al.* 1978)? Some of this is undoubtedly the result of reduction of tag loss in the eastern Australian studies which has improved the probability of recapturing turtles still wearing tags after long intervals. However, it is now time to consider other possible causes, including the following. *C. mydas* stocks in the Australian region have not suffered from major population declines in historic times while, in places like the Caribbean, turtle stocks have been regionally depleted. Is remigration interval one of the demographic parameters that can be expected to vary and contribute to increased fecundity when a turtle population is depleted? There is also the possibility that remigration interval is a function of the genetic stock.

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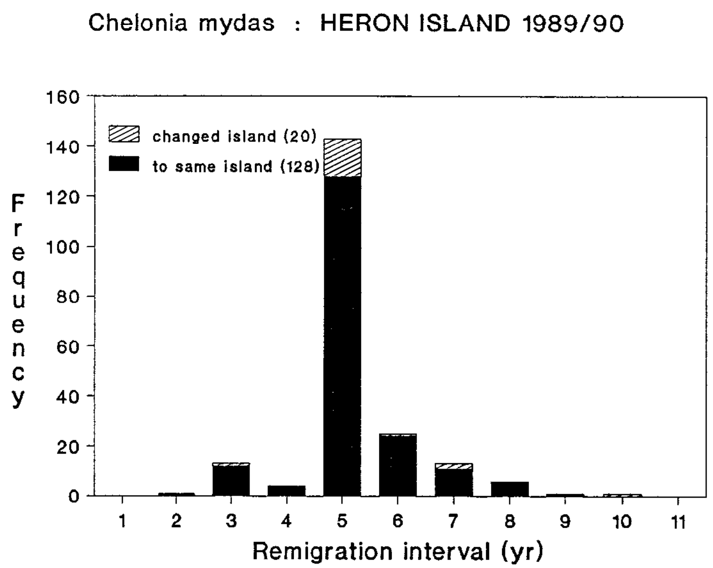

Figure 1a

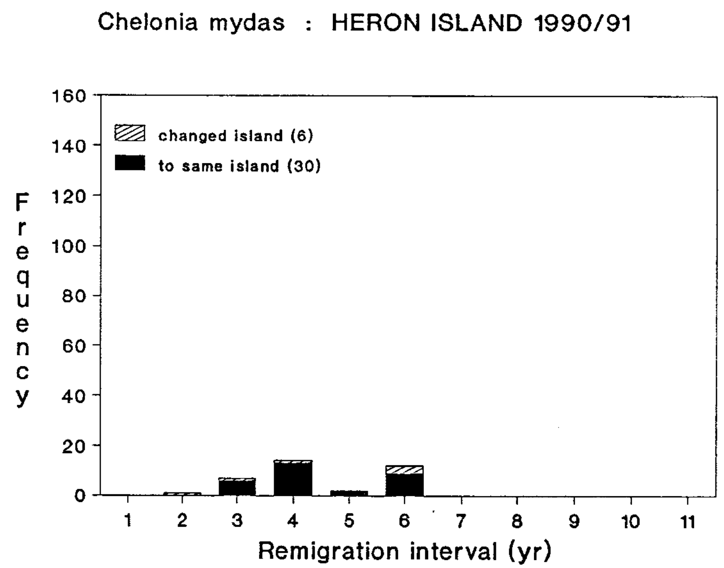

Figure 1b

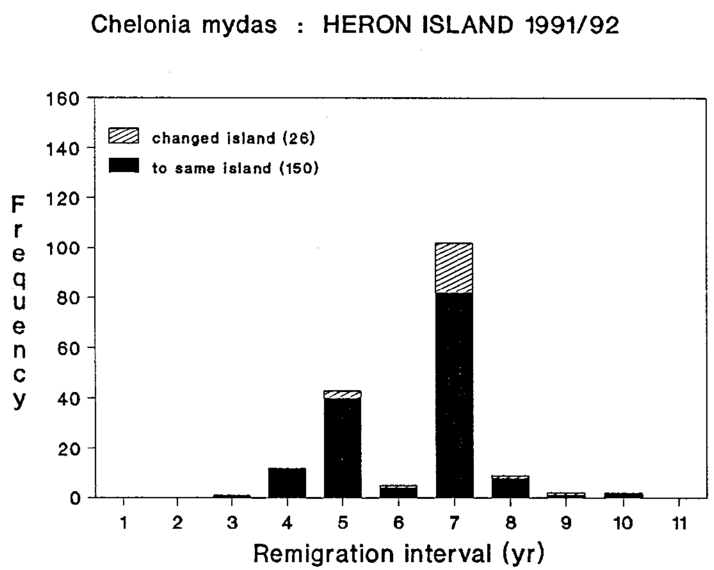

Figure 1c

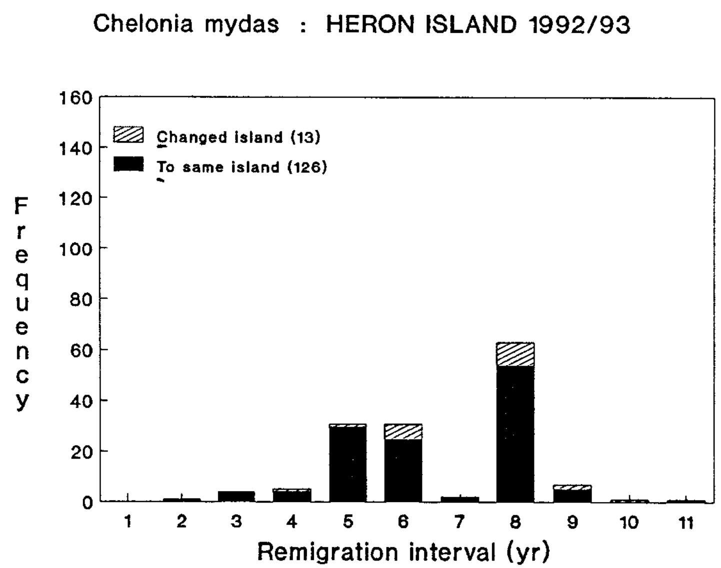

Figure 1d

Chelonia mydas : HERON ISLAND
Remigration by year cohorts

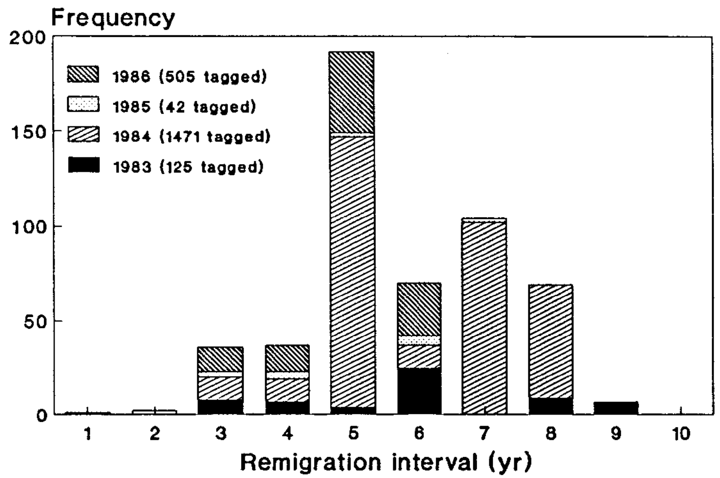

Figure 2

GREEN TURTLE REMIGRATION : HERON ISLAND
Cumulative recaptures by year cohort

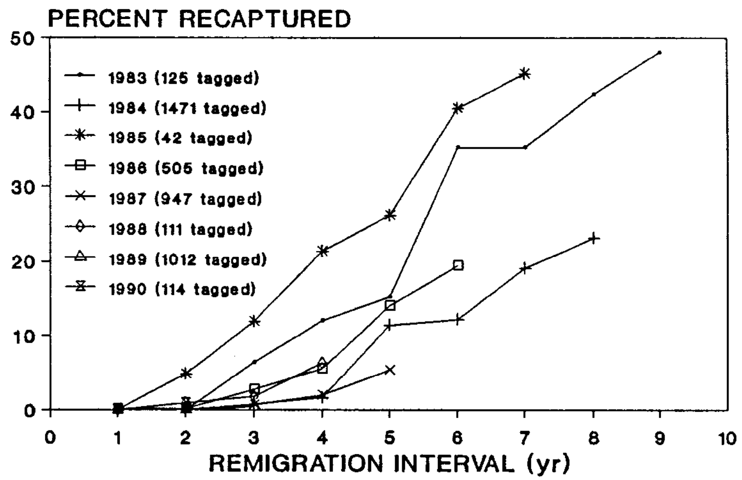

Figure 3

Chelonia mydas : RAINE ISLAND
Remigration by year cohorts

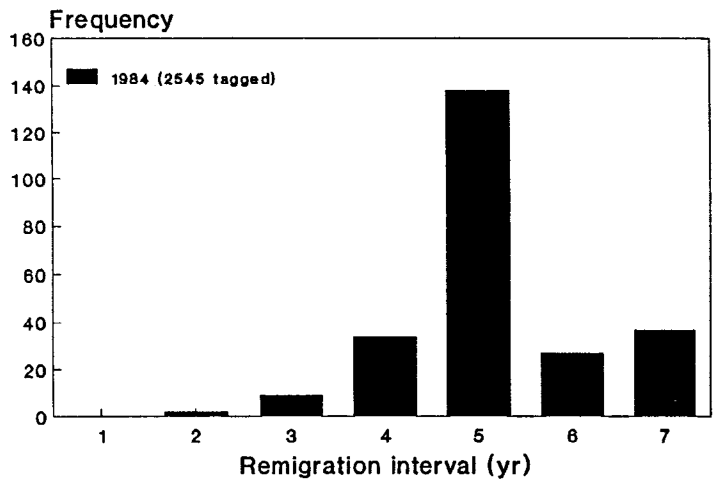

Figure 4

CURRENT DECLINES IN SOUTH EAST ASIAN TURTLE POPULATIONS

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At all turtle rookeries worldwide, wherever there have been large-scale egg harvests spanning many decades, significant population declines are now in evidence. Some of the best documented of these population declines (and associated declines in egg production) are found in the south east Asia region:-

Leatherback turtle (*Dermochelys coriacea*)

- MALAYSIA
  - Terengganu (Fig. 1)
    - >95% decline in nesting turtles over 40 years since 1956 (calculated from egg production data supplied by Terengganu State Fisheries Department).
- INDONESIA
  - Vogelkop, Irian Jaya
    - This population which was only discovered to science in 1981 is the last remaining large breeding population in the western Pacific. It is currently subjected to intense egg harvest and may be in decline (Yamasaki, 1991)

Green turtle (*Chelonia mydas*)

- MALAYSIA
  - Sarawak Turtle Islands (Fig. 2)
    - >90% decline in egg production over 60 years since 1927 (de Silva, 1982; Morovsky, 1983, Unpublished records of the Sawawak Forestry Department).
  - Sabah Turtle Islands, Sulu Sea
    - 50% decline in egg production over 11 years from 1967 to 1978 (de Silva, 1982).
  - Terengganu
    - 57% decline in egg production over 22 years from 1956 to 1978 (Siow and Moll, 1982).
- INDONESIA
  - Berau Islands
    - More than 80% decline in egg production over 51 years from 1934 to 1984 (Schulz, 1984).
  - Pangumbaham, Java (Fig. 3)
    - ~90% decline in egg production over 34 yr from 1955 (Hardjosentono, 1976; Sutikno, 1991; Subagio, 1991).
- PHILIPPINES
  - Philippine Turtle Islands, Sulu Sea
    - Greater than 75% (possibly as high as 90%) decline in egg production for the 33 years from 1951 to 1984 (Domantay, 1953; unpublished Task Force Pawekan Reports, 1982-1985).

These egg harvests all had their origins in the distant past. The present reality is that there has been a human population explosion in the region and the demand for turtle eggs as food now exceeds the capacity of the turtle populations to meet these demands. In addition, since World War II there has been substantial increases in logistical support for transporting large numbers of eggs to previously distant markets.

Unfortunately, the management concepts of most of these egg harvests were formulated in the 1950s when the international scientific community had a poor understanding of the functioning of turtle populations.

Similarly turtle harvest can be excessive. During 3 yr of Japanese occupation of the Philippines Turtle Islands, it was estimated that "no less than 20,000 to 25,000 heads of egg-layers" were butchered at these islands (Domantay, 1953). In recent years Bali has become the focus of the largest kill of turtles in the region. The current annual number of turtles imported from the extremities of Indonesia into Bali is 25,000 (mostly large *C. mydas*. Fig. 4). What with the additional turtles that die during capture and transportation to Bali, it likely that Bali accounts for in excess of 30,000 turtles annually. In addition, *C. mydas* are eaten in coastal villages throughout the remote areas of Indonesia and Philippines and this will represent additional tens of thousands of turtles killed annually. Tag recoveries are now demonstrating that the turtles being captured in feeding areas in eastern Indonesia and sent to Bali originate from rookeries in Sabah, Papua New Guinea, and western and eastern Australia as well as Indonesian rookeries. Schulz (1989) described the near total harvest of nesting turtles from the southern Aru Islands to supply the Bali market. The best estimate of the situation is that more *C. mydas* are being killed in the ASEAN region than the regional populations can support on a sustained harvest basis.

The sorry state of the hawksbill turtle in the south east Asian region is but a repeat of the same problems.

While some of these depleted populations are now given some protection by their respective governments, all the governmental management agencies in these countries are in need of support to implement and maintain positive changes for the conservation of their marine turtle stocks. I recommend that, in collaboration with the respective government agencies, an international task force be established to promote and implement the utilization of marine turtle resources at a sustainable level within the ASEAN region. Its functions should include facilitation and coordination to increase international aid moneys for turtle conservation in ASEAN countries and the encouragement of turtle research specialists to focus attention on recovery processes for depleted turtle populations. Skilled researchers and managers in the developed countries are challenged to seek the means whereby they can increase turtle research and monitoring and management development in the ASEAN countries. At the same time the governmental custodians of the declining turtle populations are urged to implement substantial reductions in harvest levels on their marine turtles.

The turtles, during their migrations, do not recognize international boundaries. They are a shared international resource and their conservation is a regional conservation problem that will require the cooperation of all countries concerned.

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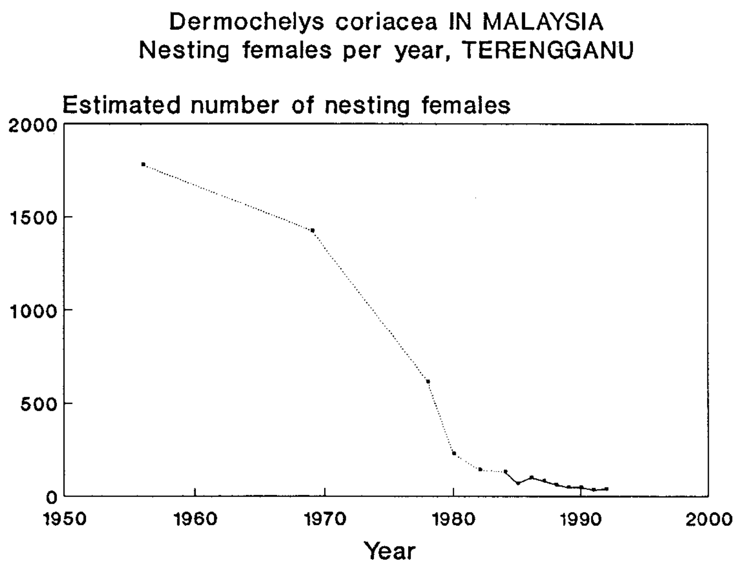

Figure 1

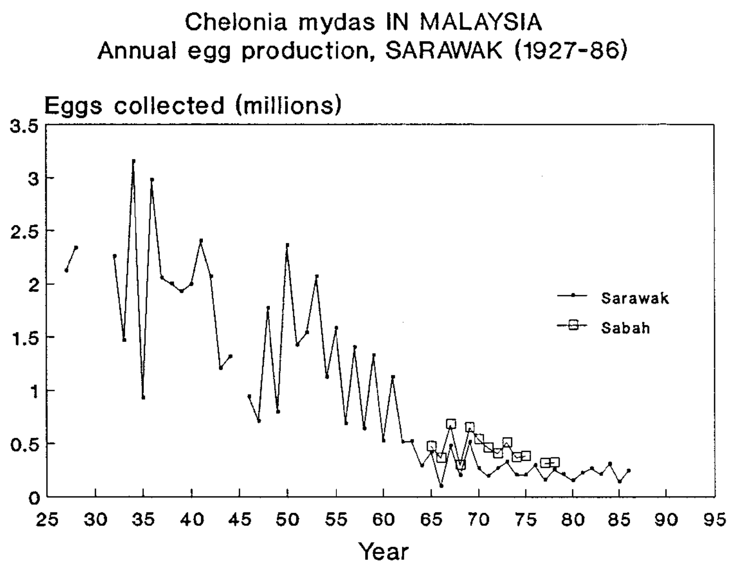

Figure 2

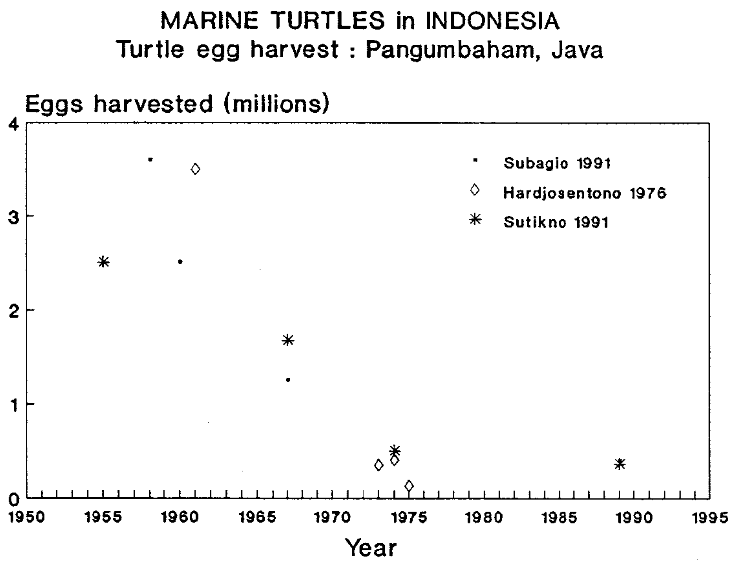

Figure 3

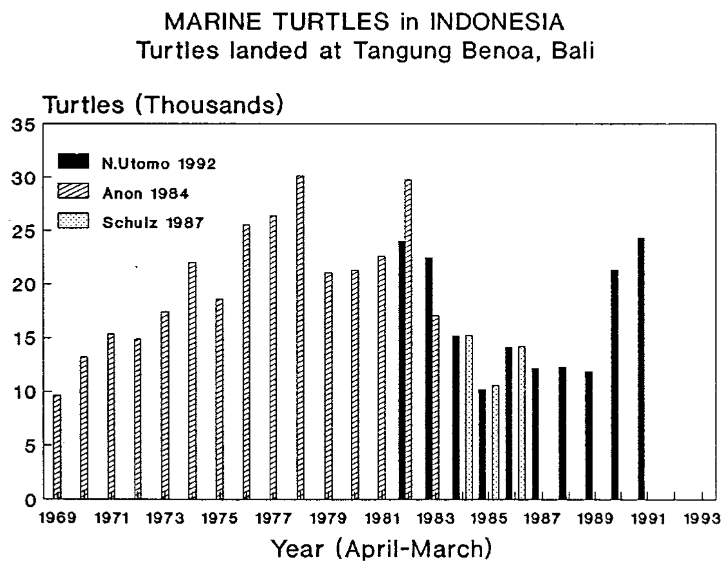

Figure 4

ORIENTATION INTO WAVES BY FREE-SWIMMING GREEN TURTLES

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After emerging from underground nests, hatchling green turtles (*Chelonia mydas* L.) scramble across the beach, enter the sea, and begin a migration towards the open ocean. How turtles guide themselves away from sea and toward the open ocean is not fully understood. Previous experiments with hatchling turtles tethered in a floating cage indicated that turtles may use waves as an orientation cue while migrating offshore (Lohmann et al., 1990; Salmon and Lohmann, 1989). However, the restraint of the tethering system might conceivably have altered the normal orientation behavior of the turtles or precluded use of other, as yet unidentified, cues.

To test the hypothesis that migrating hatchlings use wave cues to maintain their seaward headings, we released turtles at offshore locations 4.6-11.1 km from the east coast of Florida during both "normal" weather conditions (when waves moved directly toward the east coast of Florida) and during unusual weather conditions when waves moved in atypical directions. Hatchlings swam into approaching waves in all experiments, even when doing so resulted in orientation back toward land (Fig. 1).

These data suggest that green turtle hatchlings normally maintain seaward headings early in the migration by using wave propagation direction as an orientation cue. Because waves and swells reliably move towards shore in shallow coastal areas, swimming into waves usually results in movement toward the open sea (see Lohmann and Lohmann, 1992, for further details).

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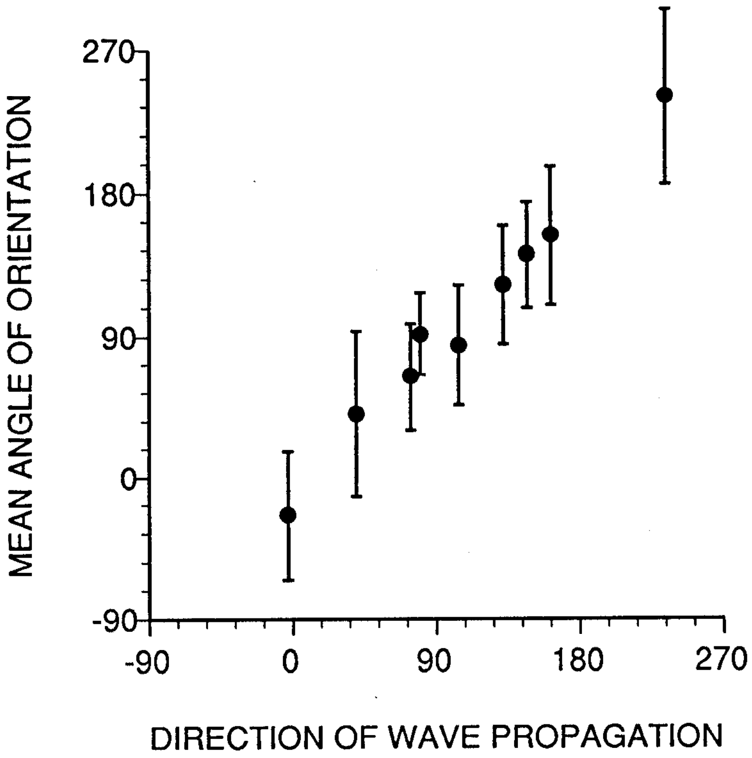

FIG. 1. The mean orientation angles in degrees of all groups of turtles plotted with respect to the direction of wave propagation. Error bars indicate angular deviation. Circle-circle correlation analysis indicates that orientation angle and direction of wave propagation are signigicantly related ($p<0.001$).

DETECTION OF OCEAN WAVE DIRECTION BY SEA TURTLES

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During their offshore migration, hatchling sea turtles maintain a course toward the open sea by swimming directly into oceanic waves (Lohmann and Lohmann, 1992; Lohmann, 1992; Salmon and Lohmann, 1989). The mechanism underlying wave detection, however, has not been determined. Turtles do not detect wave direction visually because hatchlings orient to waves in complete darkness (Lohmann et al., 1990; Wyneken et al., 1990). Moreover, because hatchlings surface only intermittently while migrating, wave detection appears to occur while turtles are swimming underwater.

Objects in a water column beneath the surface of the ocean describe a circular movement as waves pass above. In principle, turtles swimming underwater might therefore detect wave direction by monitoring the precise sequence of accelerations they experience in the water column (Lohmann and Lohmann, 1992). For example, a hatchling encounters a different sequence of accelerations depending on whether it is swimming with or against waves. A turtle swimming toward approaching waves experiences a sequence of upward, backward, downward, and forward accelerations each time a wave passes above; in contrast, a hatchling swimming in the same direction as the waves move would encounter a sequence of upward, forward, downward, and backward accelerations. The nervous system of the turtle would need only to distinguish between these sequences to differentiate orientation against and with wave propagation direction.

To determine if loggerhead hatchlings (*Caretta caretta* L.) can use such a mechanism to detect wave direction, we constructed a wave motion simulator to reproduce in air the circular movements that a swimming turtle would normally encounter beneath small ocean waves. The accelerations produced by the simulator were of slightly smaller magnitude than those which hatchlings presumably encounter beneath typical waves on the east coast of Florida.

Hatchlings suspended in air and subjected to acceleration sequences simulating waves approaching from their right sides made clear and repeated attempts to turn right. In contrast, simulated waves from the left elicited left-turning behavior. Acceleration sequences simulating waves from directly in front of the animal elicited virtually no turning in either direction.

The results demonstrate that hatchling sea turtles can determine the direction of ocean waves by monitoring the sequence of accelerations that occur as waves pass above. Although sea turtles are the first animals shown to detect wave direction in this way, such a mechanism may be widespread among other open sea migrants such as fish and cetaceans.

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OIL SPILLS, SEA TURTLES, AND OPA 90

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Sea turtle populations coexist with oil and gas exploration and development activities worldwide. The potential risk for turtles encountering oil at sea or on the beach ranges from negligible to very high. Sea turtles also consume and become fouled in oil and tar balls, and about 1% of yearly U.S. strandings are associated with oil (e.g. Teas and Martinez, 1992). In laboratory studies we have previously demonstrated that respiration, diving patterns, and blood chemistry were significantly affected by oil exposure (Lutz et al., 1986). Salt glands may temporarily fail, and skin structure and sensory organs are disturbed (Bossart, 1986). Turtle egg development may be altered or arrested by oiling, and hatchlings are especially vulnerable to impacts (Fritts and McGehee, 1981). Long term effects of chronic exposure to oil remain completely unknown. The Oil Pollution Act of 1990 (OPA 90) requires that oil spill contingency plans be defined for protected marine species in U.S. waters by the end of 1993. Are trustee agencies and specialists prepared to respond to spills that threaten sea turtles or their habitats?

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EMERGENCE PERIODICITY OF *Caretta caretta* IN BROWARD COUNTY, FLORIDA, 1990

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Burney *et al.* (1990) found a significant relationship between nesting densities and moon phase. There was a tendency for greater nesting activity near full and new moon periods, and lower activity during the quarter moons. Since both new and full moons had a similar apparent effect on the nesting pattern, it was hypothesized that semilunar tidal periodicity, rather than moon light, was the more direct cause. This hypothesis has been tested using data from the 1990 Broward County Sea Turtle Conservation Project, funded by the Broward County Department of Natural Resource Protection.

METHODS

Daily nest and false crawl counts were made during dawn patrols of all Broward beaches (38.6 km) from 20 April to 2 September, 1990. The number of total crawls was used as an index of daily turtle emergence activity. These data were smoothed with a three-point centered moving average. To prevent the seasonal pattern from dominating the subsequent analyses, data before 30 May and after 27 July (representing the rapidly ascending and descending legs of the seasonal pattern) were removed from the study. The remaining peak-season data showing possibly lunar and tidal related periodicity was compared to transformed moon and tide parameters.

Moon phase was quantified from the moon age derived from a public domain astronomy program (Kepler). Moon age varies from 0 to 1, with values of 0 and 0.5 corresponding to new and full moons, and 0.25 and 0.75 indicating the first and third quarter stages, respectively. For comparison to the total crawl pattern, moon age was transformed into a periodic function by multiplying it by 4 and subtracting the integer of each value from values with even integers and the integer value plus 1 from numbers with odd integers. The absolute values of the results gives a moon phase parameter which varies from 0, for new and full moons, to 1 for both quarter moons. This transformation was calculated in Lotus 123 with the following cell formula, where MA indicates the cell address of the untransformed moon age value.

```
@ABS(@IF(@int(MA*4)=(@INT(MA*4/2)*2),(MA*4)-@INT(MA*4),(MA*4)-(@INT(MA*4)+1)))
```

The time of the nocturnal high tide, which increases approximately 50 minutes each day, was also transformed to allow comparison with the total crawl pattern. This transformation expressed the number of hours the nocturnal high tide occurred either before or after a chosen centering time. For high tide times occurring before midnight, the transformed value was the absolute value of the difference between the high tide time and the centering time. For times after midnight, the absolute value of the high tide time plus 24, minus the centering time was taken. The Lotus cell formula, where HTT and CT represent the cell addresses for the nocturnal high tide time and centering time, respectively, was as follows. Centering times after midnight should be entered as 24+CT (ie. 2 am = 26).

```
@IF(HTT < 16, HTT+(24-CT),@ABS(HTT-CT))
```

These, as well as other tidal parameters, were compared to the total crawl pattern both visually and by linear regression and correlation analyses.

RESULTS AND DISCUSSION

Figure 1 compares the peak-season total crawl pattern with the moon phase parameter. As reported previously (Burney and Mattison, 1989; Burney et al., 1990) peaks in turtle emergence occur near minima in the moon phase parameter (ie. near new and full moons), but for the first three cycles, crawl peaks also occur near the quarter moons. This quarter-moon effect was seen to a lesser degree in 1989, and is more pronounced in the 1991 data which is still under analysis. This may possibly indicate some progressive change in the nesting population, with one component more likely to emerge during tide conditions associated with new and full moons, and another component preferring the different tide range and timing associated with quarter moons. However, tide height, range and flooding and ebbing rates were not significantly correlated with the total crawl pattern. Figure 2 shows the correlation of the moon and crawl patterns from Figure 1. The relation is inverse and nearly significant at the 0.050 level.

Figure 3 illustrates the relation of the crawl and transformed high-tide time patterns, when the latter was centered on 2200 hrs (10 pm). All other times were tried, but the pattern centered on 2200 hrs gave the best fit. The significant inverse correlation of these parameters is illustrated in Figure 4. There seems to be a preference for emergence on nights when the times of the high tide occur earlier in the night, and an avoidance of emergence when the high tide occurs near dawn. This may suggest that turtles prefer nights with an early high tide because it assists them to the beach, cuts crawling distance and allows plenty of time to complete nesting before dawn. The outgoing tide would then assist the turtle as she swims away from the beach. Tide ranges were also higher on nights with earlier high tide times (the moon phase and tide parameters are closely correlated with each other) and it is impossible to separate the possible influence of tide range and timing.

Knowledge of the nature and causes of sea turtle emergence and nesting periodicities, allowing the prediction of periods of high activity, may improve the efficiency of labor-intensive conservation efforts such as nest relocation or tagging projects.

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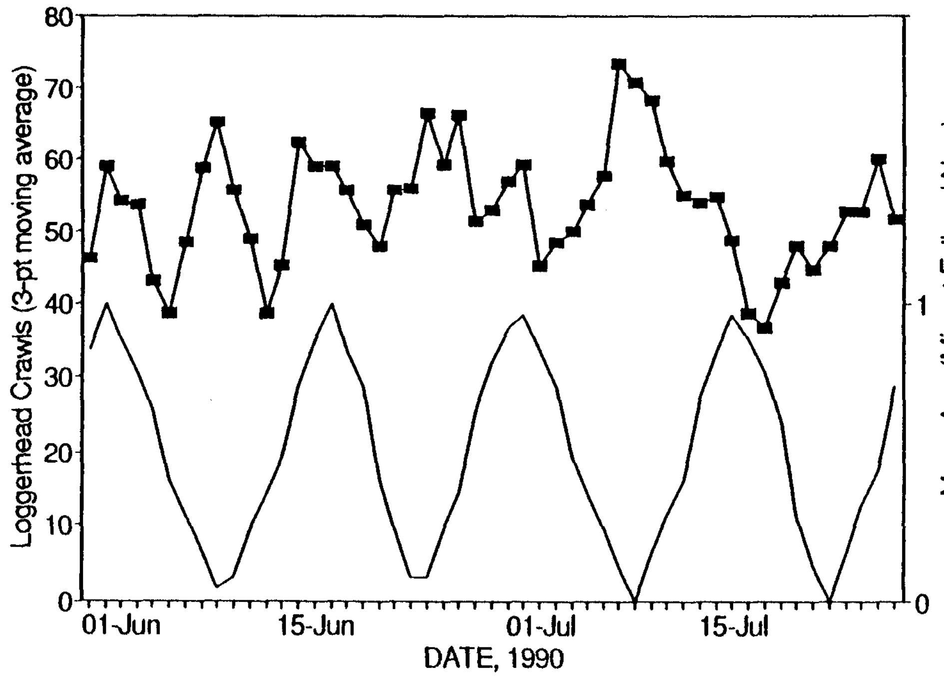

Figure 1. Comparison of the pattern of smoothed total peak-season loggerhead crawls (upper curve) with the transformed moon age parameter (lower curve), which is minimum at new and full moons, and maximum at quarter moons.

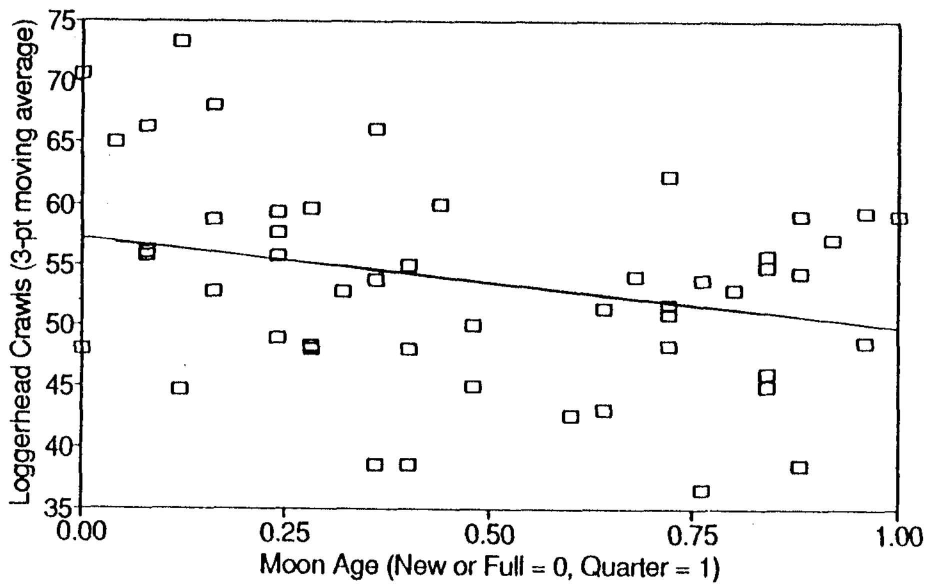

Figure 2. The correlation of daily smoothed loggerhead total crawls and the transformed moon age parameter. r = -.2731; P = .052.

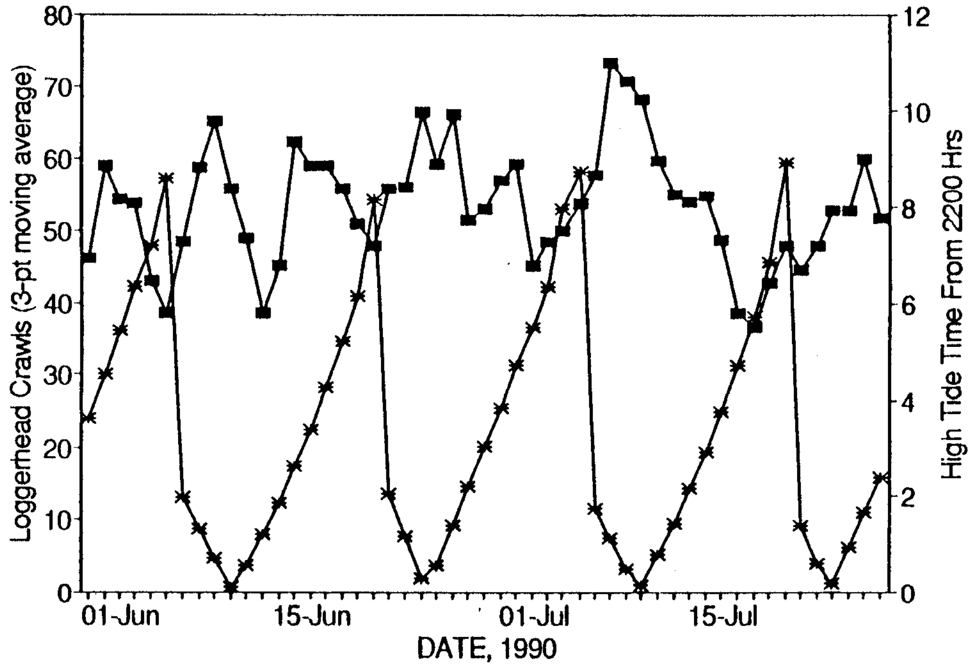

Figure 3. Comparison of the pattern of smoothed total peak-season loggerhead crawls (upper curve) with the times of the nocturnal high tide, expressed as hours before or after 2200 hrs (10 pm).

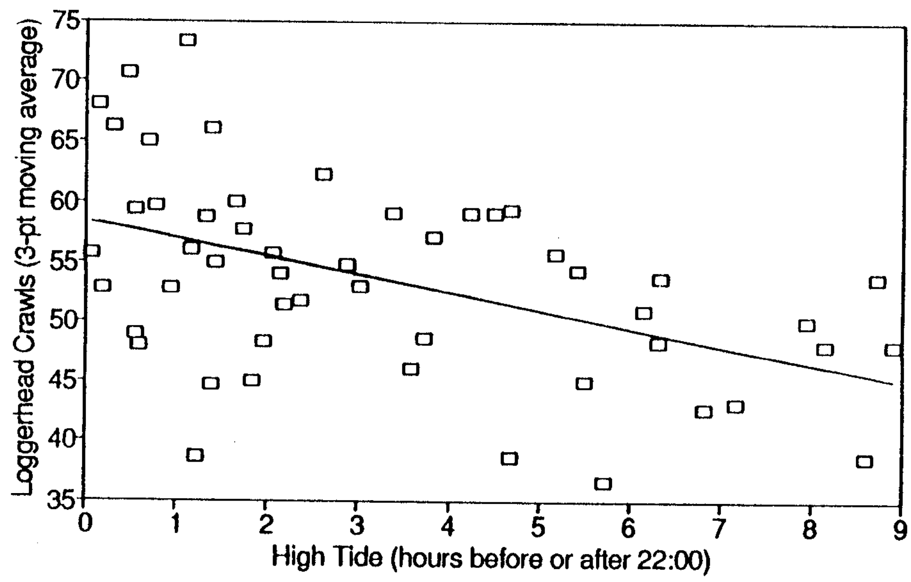

Figure 4. The correlation of daily smoothed loggerhead total crawls and the timing of the nocturnal high tide, expressed as hours before or after 2200 hrs. r = -.4876; P = .0004

TRENDS IN THE SPATIAL DISTRIBUTION OF SEA TURTLE ACTIVITY ON AN URBAN BEACH (1981-1992)

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Broward County, in southeast Florida has 38.6 km of heavily developed coastline, including tall condominiums, hotels, and businesses. In spite of this dense development, the distributional patterns of loggerhead sea turtle nesting show striking similarity during the past 12 years. Total nest counts have increased significantly over this time, both within and outside the developed areas (Burney and Mattison, 1992). Three questions were addressed in this study. Do sea turtles choose nest sites randomly in Broward County, Florida? Are observed nesting patterns consistent from year to year? Does the density of beach front development influence nest site selection?

METHODS

Daily beach surveys were conducted during sea turtle nesting seasons since 1981. Nests surveyed from 1981 through 1986 and those surveyed from 1990 through 1992 were mapped using Florida DNR beach survey markers numbered from 1-84 (north to south, North County line to Port Everglades). Counts from 1981-86 survey years were initially mapped in 2000 foot beach zones (markers 1 & 2 = beach zone 1, 42 zones total), while 1990-92 counts were mapped in 1000 foot zones (84 zones total). Data from 1990 through 1992 were then converted to the initial map beach zones for comparison. The total number of nests deposited each year, in each zone, were then tabulated and plotted.

RESULTS AND DISCUSSION

Figure 1 compares the mean nesting patterns from each zone as a percent of the total for all zones for each year for years 1981-86 and 1990-92. Beach/nest location data was not available from 1987-89. Some zones were consistently utilized for nesting, while others were consistently avoided. Figure 2 shows the significant ($p < .001$) correlation of the nest distributions in Figure 1. Figure 3 presents correlation coefficients of the 1990-92 nesting patterns compared to those of other years in the study. The 1990 and 1991 distribution patterns were significantly correlated with all years in the study, while the 1992 pattern was correlated with data since 1985 but not with earlier years of the study. Figure 4 illustrates the average zonal nesting in all years (1981-1992), and specifically identifies shore structures or beach features characteristic of low and high nest density locations.

The data strongly suggests that nesting in Broward County, Florida has been non-random and consistent throughout the period examined. Salmon (1992) also found that turtles deposited nests non-randomly in an urban setting (Boca Raton, Florida), with a significant positive correlation between nesting density and the height of objects behind the nesting beach. Turtles clustered their nests in front of objects that presented a high silhouette, such as tall condominiums. Unfortunately, due to ambient light levels these areas are also those in which hatchlings were misoriented.

High nesting density in Pompano Beach, Galt Mile and in zones 41-42 (Figure 4) may be associated with high profile buildings as suggested by Salmon (1992), however the relationship is possibly more complex in Broward County where the most densely nested beach (Hillsboro Beach) is characterized by low-profile residences. This is the type of profile that produced lower nesting densities in Boca Raton. Unlike the City of Boca Raton, enforcement of beach front lighting restrictions throughout the remainder of the County does not exist yet. The low density nesting zones in Broward County are historically associated with fishing piers, inlets and the section of Ft. Lauderdale beach directly adjacent to State Road A-1-A.

It appears that multiple factors including silhouette profile, pedestrian and vehicular traffic, and the lighting associated with fishing piers may account, in part, for nest distribution in Broward County. If conservation efforts to recover sea turtle populations are successful, understanding how beach front development may affect "attractiveness" of a beach to nesting sea turtles may also allow better management of an increasing nesting population.

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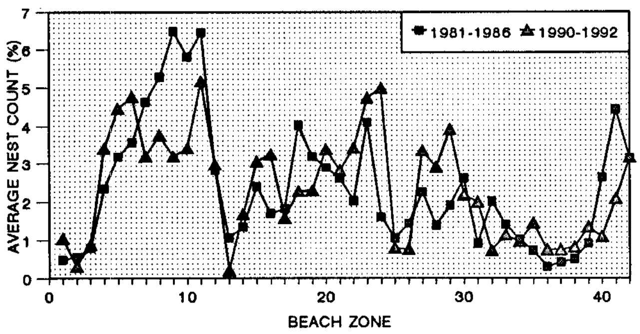
NESTING PATTERN COMPARISON
NORTH BROWARD COUNTY, FLORIDA
PORT EVERGLADES TO PALM BEACH LINE



NOTE: AVG NEST COUNT % = NUMBER OF NESTS IN EACH ZONE, EACH YEAR DIVIDED BY TOTAL NESTS IN REGION (x 100).

Figure 1

COMPARISON OF NESTING DENSITIES

r = 0.650, P < 0.001

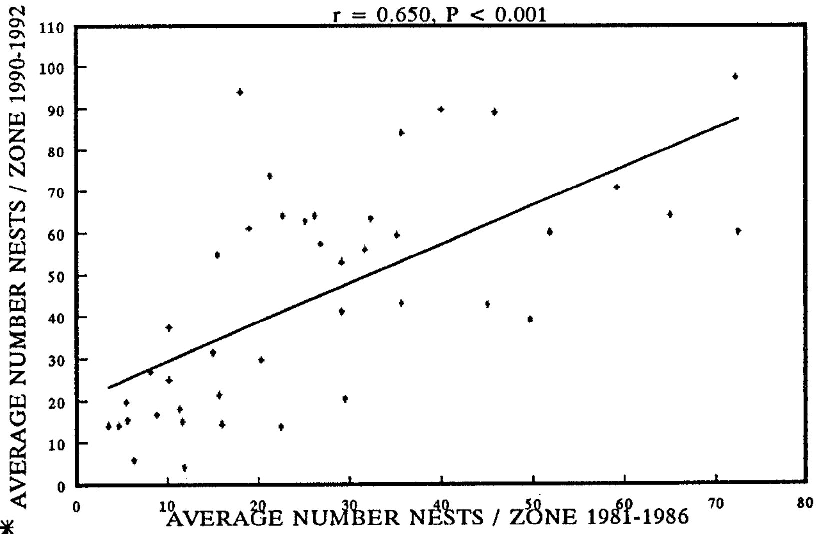


Figure 2

NESTING PATTERN CORRELATIONS

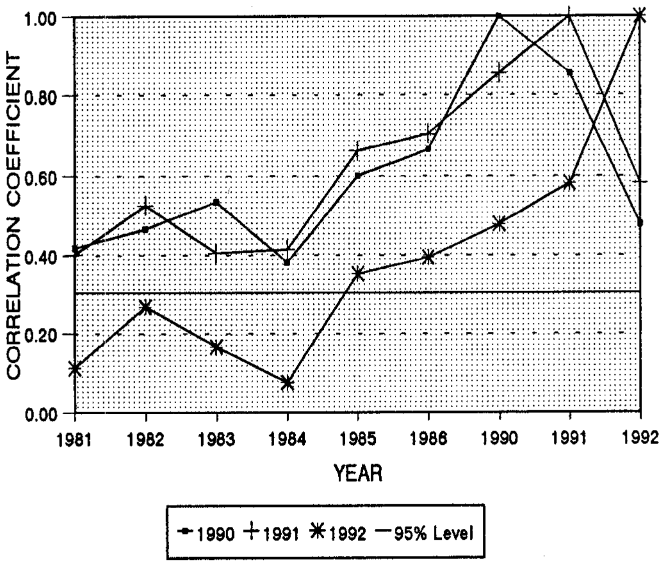


Figure 3

BEACH DISTURBANCE SITES

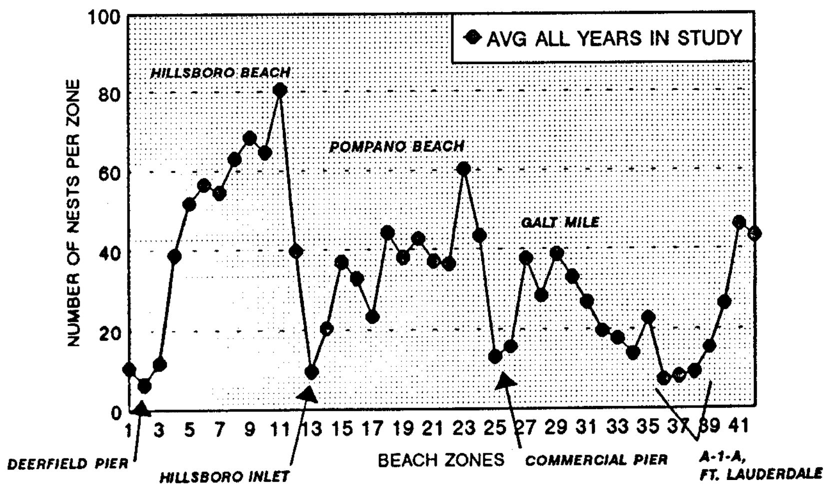


Figure 4

FEEDING ON NOVEL FOOD IN GREEN (*Chelonia mydas*) AND HAWKSBILL (*Eretmochelys imbricata*) HATCHLING SEA TURTLES

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A series of behavioral studies utilizing green, hawksbill and loggerhead hatchlings were done in the fall of 1992 at Xcacel, Quintana Roo, Mexico. We evaluated two or more of the species' activity levels, antipredator behaviors, foraging and learning to find food capacities, *ad libitum* feeding and reactions to novel foods. Here we report the reactions of green and hawksbill turtles to the inaccessible presence of a novel piece of food. Previous studies indicate that olfactory stimuli are important in locating and identifying food (Manten, Karr and Ehrenfeld, 1972). Also, familiarity with a food item determines the preference for it in various species of turtles (Burghardt and Hess, 1966; Grassman and Owens, 1981; Mahmoud and Lavenda, 1969).

METHODS

A total of 12 hatchling sea turtles, 6 hawksbill turtles, 30 days post hatch, and 6 green turtles, 16 days post hatch, were used. Each group was placed in an experimental tank and allowed to habituate to it for 30 min. Their last feeding was approximately 22 hours prior to the experiment. A floating lid was suspended by strings in the middle of the tank and a piece of raw fish fillet was placed in the lid. The hatchlings were raised on commercial trout pellets until being placed in the fish-in-the-lid test, making the fish fillet a novel food. The lid allowed the odor of the fish to spread to the water but prevented the turtles from actually being able to eat it. Video tapes were analyzed for latency of feeding attempts and cumulative duration of feeding during the 10 min. test.

Following the fish-in-the-lid test, a piece of fish fillet was simply suspended in the water for 8 min. and the videotapes were analyzed for latency and cumulative duration of feeding on the fish for each species. A second test like the first one was given to the green turtles on the next day to see if the experience of consuming the fish increased their willingness to feed.

RESULTS

All of the hawksbills showed feeding attempts within the 10 min. period of the fish-in-the-lid test. Five of the 6 hawksbills were vigorous and persistent in their efforts to feed and all 6 fed promptly and continuously when the fish was placed directly in the water. Only 2 of 6 green turtles showed strong feeding activity on the first test trial and one showed a moderate degree of feeding. The other 3 turtles showed no feeding behavior for the 10 min. test. When the fish was offered in the water, all of the green turtles fed on it, although none was as vigorous (in terms of cumulative time spent feeding) as the least vigorous hawksbill. On the second fish-in-the-lid test with the green turtles all 6 attempted to feed within 3 min. of the start of the test period.

DISCUSSION

Both species of turtle use olfactory cues to guide their feeding behavior. We conducted control trials where the feeding lid was empty or where inert items (two white plastic clothes pins) were placed in it. Although both species showed approach and visual inspection on these control tests, there were no gaping approaches characteristic of attempted feeding. Moreover, the hawksbills were indiscriminate, attempting to feed on the fish even though they had never before eaten fish. The green turtles were more cautious, some animals showing attempts at eating the novel food and others not. The green turtles were given one experience of eating the fish and approximately 24h. later showed that the eating experience increased their willingness to feed on the fish. These results suggest that hatchlings of these species are opportunistic and flexible in their food preferences, unlike some fresh water species (e.g., Burghardt and Hess, 1966).

We conducted some informal feeding tests using the "tar" that accumulates on beaches throughout the world. The tar was put in a mesh bag and suspended in the water. Two of 6 hawksbills showed feeding attempts but none of the green did. Apparently, opportunistic feeding habits of the hawksbills may not be to their advantage. As we develop better methods for studying the behavioral characteristics of sea turtles, we will be able to better protect and conserve them, and perhaps gain new insights into their adult behavior.

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DESCRIPTION OF A MIGRATORY FLEET OF GREEN TURTLES

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Green turtles migrate seasonally through the waters of Bocas del Toro Province, Panama, en route to the nesting beach at Tortuguero, Costa Rica. Tag returns from fishermen in Bocas of Tortuguero-tagged females originally suggested the identity of the migrants. Genetic analyses have subsequently corroborated the hypothesis, as have the recaptures at Tortuguero of turtles netted and tagged by us in Panama. A morphometric comparison of male and female members of this migratory contingent was presented. Adults show sexual size dimorphism with respect to carapace length, carapace width, plastron length, weight and tail length. The maturity status and reproductive condition of captured turtles were determined by laparoscopy and histological examination of testicular biopsies. Females have follicles of several size categories in the ovary, including fully developed ones; eggs are often present in the oviduct and are occasionally shelled. Most migrants are engaged in mating activity at this site, which is 240 km away from the nesting beach.

PREDICTING SEXUAL MATURITY OF MALE GREEN TURTLES FROM MORPHOLOGICAL DATA

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Sexual maturity in male turtles is usually defined by the presence of spermatozoa in the seminiferous tubules of the testis. Using data from histological examinations of testicular biopsies collected during laparoscopies of 39 male green turtles, we examined the efficacy of using the following six parameters to predict sexual maturity: straight carapace length, straight carapace width, plastron length, relative tail length, absolute tail length and morphology of the epididymis. Our data suggest that absolute tail length is the external characteristic that is most useful as a predictor of maturity. A pendulous epididymis was also found to be a reliable indicator of maturity, but observation of this structure in living turtles requires laparoscopic examination.

LEATHERBACK MIGRATIONS ALONG DEEPWATER BATHYMETRIC CONTOURS

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The leatherback turtle, *Dermochelys coriacea* is recognized for its widespread occurrence from the Tropics to the Arctic and for its impressive trans-oceanic movements. Yet, detailed information about the specific routes by which these turtles travel can only be inferred from sporadic tag recoveries. Our study represents the first documentation of the precisely defined, long-distance migration pathways of leatherback sea turtles.

We monitored migratory movements of post-nesting female leatherbacks from the Pacific and Caribbean coasts of Costa Rica between 1991 and 1993. Six turtles, two in the Pacific and four in the Caribbean, were outfitted with satellite transmitters using techniques that had been employed successfully in a previous study of the migrations of cheloniid turtles in New York (Morreale and Standora, 1992). Turtle movements were tracked for periods ranging from 17 to 79 days and over distances of up to 2300 km from the nesting beach.

The four turtles in the Caribbean traveled along two distinct pathways. Despite differences in dates of departure from the nesting areas of up to several weeks, nesting cohorts followed along nearly identical pathways. On the Pacific coast, the second turtle began its migratory movement 13 days and nearly 400 km behind its nesting cohort. Within 24 days, after 700 km of open ocean travel, both turtles were located less than 20 km apart.

Each satellite location datum was evaluated for its signal quality and its plausibility, based on previously established criteria (Standora and Morreale, 1991). The precise locations, directions, and rates of travel were compared with several relevant environmental factors to determine possible controlling influences on the turtles' movements. The observed patterns of travel could not be ascribed to prevailing ocean currents or surface water temperatures. Rather, movements of all six turtles were consistent in that they paralleled deepwater bathymetric contours ranging from depths of 200 to 3500 m. Moreover, most of the turtles' movements were confined within relatively narrow bands beyond the continental shelf where the bottom was steeply sloping. When a turtle's path intersected the vast, relatively flat abyssal plain, it veered along the outer slope. When an abyssal plain could not be avoided, it quickly was crossed at its narrowest point.

By collecting data on long-distance movements of leatherbacks, we were able to make some inferences about their ecology. Nesting cohorts appear to share nearly identical pathways, along which they undergo post-nesting migrations. The observed strong tendency to travel in water of depths between 200 and 3500 m may be reflective of the feeding behavior or the physiological capabilities of the leatherback. The confinement of travel routes to narrow bands within the pelagic zone where the bottom is steeply sloping, in addition to being a possible means of navigating in open water, may have important implications for the conservation of this endangered animal. Not only might it be important to preserve the nesting beaches and the foraging areas, but also to protect the connecting migratory corridors.

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EXPERIMENTAL USE OF CRYOSURGERY TO TREAT FIBROPAPILLOMAS IN THE GREEN TURTLE, *Chelonia mydas*

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INTRODUCTION

The occurrence of fibropapillomas in the green turtle, *Chelonia mydas*, has been well documented in the Hawaiian Islands, Florida and elsewhere worldwide. The incidence of these tumors and subsequent mortality in Hawaii has increased dramatically over recent years. Numerous theories have been advanced regarding the causative agent, i.e., parasites, viruses, environmental pollutants. However, the etiology of these tumors remains to be determined (Balazs and Pooley 1991).

Kaneohe Bay on the Island of Oahu, Hawaii, harbors a large population of immature and adult turtles. The first known case of fibropapillomas at this location was confirmed in 1958. Currently, 50-90% of these turtles are found to have tumors, depending on the study site sampled in Kaneohe Bay. Strandings of emaciated, weak and/or dead tumored turtles have been increasing throughout the Hawaiian Islands. Many turtles survive lengthy periods with severe tumor infections. Death usually occurs when tumors obstruct vision, become extensive in the mouth or throat area, or affect the internal organs (Balazs 1991).

This study was initiated to determine if cryosurgery was a viable method of treating fibropapillomas for turtle rehabilitation and release, and also for practical use in field treatment and release.

BACKGROUND OF CRYOSURGERY

Cryosurgery is the application of cold to tissue resulting in the destruction of that tissue. The concept is not new. An Englishman is credited for the first use of an ice-cold brine for the treatment of human breast and skin cancer in 1851. In 1961, liquid nitrogen was first used in human medicine followed by its use in veterinary medicine in the 1970's (Hoyt and Seim 1981). The main use of cryosurgery is for the removal of both malignant and benign tumors.

Several different types of refrigerant are generally used. Liquid nitrogen, which reaches a temperature of -195.8° C (-320.5° F) is the most desirable. Nitrous oxide, which reaches a temperature of -89° C, can also be used. Nitrous oxide is generally used with a probe and confined to small tumors less than 1 cm in diameter. This study used liquid nitrogen as the refrigerant.

Cell death usually results from two applications of a refrigerant that cools the cell temperatures to -15° C to -20° C. Optimal results are obtained with a rapid freeze and a thaw to room temperature. Three or four freeze thaw cycles may be indicated for large or very dense tumors.

The mechanisms of cell death are accomplished in several stages (Seim 1980):

Cell Dehydration - Ice crystals are formed in the extra cellular fluids resulting in a hyperosmolar condition. Fluids flow out of the cells, resulting in cell death from high concentrations of electrolytes.

Ice Crystal Formation - Ice crystals also form within the cells. These crystals melt during a slow thaw and recrystallize forming larger crystals that damage and rupture the cell walls. This condition does not occur during a rapid thaw.

Protein Denaturation - The lipid-protein complexes within the cells are denatured, thereby damaging the cell membrane.

Thermal Shock - The direct result of rapid low temperature change by itself damages the cells.

Delayed Phase - Occurs several hours after the freeze cycle, and is related to vascular restriction of blood flow.

Besides cell death with resulting tumor death and disappearance, cryosurgery may have additional benefits. Human tumor cells can induce specific tumor antigens which can in turn stimulate the immune system to produce cytotoxic tumor cells. These cells in turn destroy additional tumor cells. Cryosurgery of tumors in mice stimulated an immunological response, thereby, resulting in slower and/or reduced tumor formation (Neel 1980). Such an effect remains to be demonstrated with fibropapillomas in the green turtle, but would represent a significant finding if it occurred.

MATERIALS AND METHODS

The basic cryosurgical materials consist of:
Liquid nitrogen storage container - These containers vary in size from 10 - 50 liters. The liquid can be stored for one month or longer, depending on the type. It is possible to obtain such units from cattle breeding associations that handle semen.

Hand held cryosurgical spray containers - They are available from several manufacturers and come with various interchangeable tips that vary the amount of liquid and vaporized nitrogen to be sprayed on the tumor.

Probes - These are metal tips placed directly on or in the tumor growth. Nitrogen spray is circulated through the probe where it is super cooled and vented through a tube. Probes are used on small tumors (1 cm or less) and around areas such as the eyes where excessive spraying of nitrogen may damage normal tissue.

A Temperature Monitor - This consists of a temperature gauge with one or two needle thermocouples. The needles are placed in various locations to ensure proper freezing temperatures are reached.

Liquid Nitrogen - This may be purchased through a cattle breeders association or a supplier of oxygen or welding gas.

A green turtle with extensive tumors was selected for cryosurgical study. This turtle had a carapace length of 54.7 cm and weighed 19.5 kg. A total of 62 tumors were present ranging in length from less than 1 cm to greater than 10 cm. Seven different tumors were selected for freezing, ranging in total length from 1 cm to 6 cm. The locations were: left eyelid, right eyelid, neck, shell, left front flipper and left rear flipper. A lidocaine nerve block was injected at the base of the tumors to eliminate pain. This was especially important for the eyelid tumors, as this area was very sensitive to the touch.

Temperature monitoring needles were used in most of the tumors to assure proper freezing levels. It was difficult to use the monitor in certain areas around the eyes because of the sensitivity of the area and difficulty in keeping the needles in place. When the probes were not used, the amount of freeze was monitored by visual observation of the ice ball and digital palpation. Two freeze cycles were employed using the rapid freeze, room temperature thaw technique.

The turtle was maintained in a sea water tank and the results monitored by photographs every week until tissue necrosis was complete. After approximately four months, the turtle was released into the wild.

An additional turtle was captured in Kaneohe Bay, Oahu, with a carapace length of 56.6 cm and weight of 30.4 kg. Two tumors were frozen (one eyelid tumor and one front flipper tumor) and the turtle was released. This turtle was recovered approximately five months later and the results evaluated by photography.

RESULTS

Tumors up to 5 cm in length could be frozen successfully with the hand held spray container. The general sequence of post-freezing tumor necrosis in the green turtle was:

Immediate - Swelling and erythremia of tissue 1 - 2 hours post freeze.

One week - Tumor appeared soft and jelly-like with little loss of tissue.

Two weeks - Some necrosis of tissue started, but not extensive.

Three weeks - Loss of tumor tissue clearly evident.

Four weeks - Necrosis of tissue continuing. Loss of one-half of tissue may be evident.

Five weeks - Tumor necrosis might have been completed without evidence of scar formation. Other tumors only appear three-quarters complete.

Eight weeks - Tissue necrosis complete. Scar formation evident.

Eyelid tumors seemed to be more resistant to freezing. These two tumors had to be refrozen because of persisting tumor tissue after two months. The growths were smaller, but not significantly reduced in size. This "resistance" may be due to incomplete freezing temperatures resulting from difficulty in using the temperature monitor and the fear of freezing vital eye structures.

The result of the field freeze in the one turtle was similar to the experimental captive turtle. The tumor lesion was completely healed and gone after five months. The eyelid tumor did not appear any larger, but appeared to be about the same size after five months.

SUMMARY OF ADVANTAGES AND DISADVANTAGES OF FIBROPAPILLOMA CRYOSURGERY

Advantages:
Equipment can be used for field treatment.

Procedure can be used on large (5 cm) growths as well as small growths.

Very little bleeding or trauma involved.

Procedure may produce an immunologic effect, thereby reducing additional tumor formation.
Treatment is "cost effective".

Disadvantages:

Eyelid tumors, which are the most damaging to the turtle, may require additional freezes or thermal monitoring.

Some experience is required by the cryosurgeon.

Must use care around vital structures such as the eyes.

Basic cause of tumors not corrected. Regrowth may occur. Long term (years) benefits need to be evaluated.

DISCUSSION

Several interesting observations resulted from the study. The total time from the initial freeze until complete tissue necrosis and scar tissue formation was longer than that in domestic animals. In canine and feline fibropapilloma-type tumors, tissue necrosis is complete in 1 - 2 weeks. Complete healing with scar formation occurs in 3 - 6 weeks (Goldstein and Hess 1976). In this study 5 - 8 weeks were required for complete tissue necrosis. Perhaps sea water retarded the separation and dehydration of the dead tissue.

The use of cryosurgery for the treatment of ocular squamous cell carcinoma in cattle resulted in a 95% cure rate. It was stressed that the lowest cure rate occurred when temperature monitors were not used (Farris and Fraunfelder 1976). This may be the cause of the lack of success with the green turtle eyelid tumors. Smaller needle monitors may be indicated.

The use of cryosurgery in the treatment for green turtle fibropapillomas shows promise. The method can be used in rehabilitation centers and in field tag and release projects. The freezing of small "starting" tumors as well as growths up to 5 cm may be lifesaving for many turtles.

Additional trials in captivity are needed in order to properly evaluate the possible occurrence of cryosurgery stimulating the immune system to destroy other tumor cells.

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THE HAWKSBILL NESTING POPULATION AT COUSIN ISLAND, REPUBLIC OF SEYCHELLES: 1971-72 TO 1991-92

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Cousin Island in the Republic of the Seychelles is a nature reserve administrated by the International Council for Bird Preservation (I.C.B.P.). It is the site of the longest-running intensive monitoring program of nesting hawksbill turtles (*Eretmochelys imbricata*) conducted anywhere in the world. Between 1971 and the present, virtually all the sea turtle nesting emergences that occurred at the island were recorded. In 1973, a tagging program was initiated. Tagging efficiency has fluctuated somewhat from year to year, with an average of 57% of all ovipositions intercepted annually. Between 1971 and 1986, the data were compiled by a series of expatriate wardens, most of whom were posted on the island for one or two years. The junior author of this paper (Roby Bresson) was employed in the collection of data since 1973 and has been in charge of the project since 1987. The results of data obtained between 1971 and 1983 have been reported in the following publications: de L. Brooke and Garnett (1983), Diamond (1976), Frazier (1984), Garnett (1978), Mortimer (1984) and Wood (1986). The present paper summarizes the data collected between 1971 and 1992, including those previously unpublished data gathered at Cousin during the past 10 years.

RESULTS

To date, more than 460 turtles have been tagged and well over 2,000 nesting emergences by these marked animals have been intercepted by the tagging personnel. A total of 104 tagged turtles were encountered on the beach during two or more nesting seasons. Individual turtles were monitored over periods of up to 16 years. The predominant remigratory intervals recorded were 2-years and 3-years (n = 186 remigratory intervals).

Figure 1 shows the relative numbers of ovipositions occurring at Cousin Island during each of the past 21 years. A regression showed a statistically significant increase in numbers of ovipositions over time ($p < 0.01$; $y = a + bx$; $r^2 = 0.5576$; $n = 21$). A regression also showed a corresponding increase in numbers of marked animals over time ($p < 0.01$; $y = a + bx$; $r^2 = 0.4271$; $n = 19$). There was no correlation between the percent tagging efficiency and the numbers of marked animals recorded each year, so the apparent increase in nesting animals is not an artifact of observer bias.

Between 1976 and 1982, an average of about 35% of turtles encountered on the beach were "remigrant" turtles--that is, they had been tagged during a previous nesting season. Between 1983 and 1992, the proportion of remigrant turtles increased significantly--ranging from 40 to 55% of those turtles encountered.

DISCUSSION

We believe that the apparent increase in nesting females (Figure 1) is attributable to a decline in turtle poaching in the immediate vicinity of Cousin Island during the past 12 years. Such a decrease in human predation would allow a higher proportion of turtles to survive and to breed in subsequent seasons (as "remigrant" turtles). Thus, the increase in nesting activity that we recorded is probably not due to an increase in the absolute numbers of nesting females in the population, but rather reflects an increase in the average reproductive output per turtle over time. A similar phenomenon has also been reported for green turtles (*Chelonia mydas*) nesting at Aldabra Atoll, in the Seychelles (Mortimer, 1985; 1988). We are optimistic that in the long term, this increase in reproductive output will result in true population growth.

The increase in nesting activity that we recorded at Cousin is especially interesting in light of the very high levels of hawksbill harvest--approaching 100% of all nesting turtles (Mortimer, 1984)--that continues at most other islands in the Granitic Seychelles. Perhaps nesting site fidelity in hawksbill turtles is so strong that complete protection of turtles at a nesting beach and in the waters immediately adjacent to it might be enough to maintain a breeding population of this species.

These data from Cousin Island are encouraging, and should give resource managers and politicians in Seychelles and elsewhere a reason to enforce laws protecting hawksbill rookeries. The question that remains, however, is whether in the long term a population as small as that nesting at Cousin Island (an average of 40 to 60 nesting females per year) possesses enough genetic diversity and can produce enough surviving offspring to maintain itself over time, should other hawksbill rookeries in the area be exterminated.

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EVALUATION OF THE PRACTICE OF SPLITTING SEA TURTLE EGG CLUTCHES UNDER HATCHERY CONDITIONS IN MALAYSIA

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In the 1960's, Balasingam concluded that splitting the egg clutches of leatherback turtles (*Dermochelys coriacea*) into complements of 50 eggs each increased the rate of hatching success in the hatchery at Rantau Abang, Terengganu. Although he published his conclusions (Balasingam, 1967) he never demonstrated whether the apparent increase in hatching success was statistically significant. Since then, most Malaysian hatcheries have continued the practice of splitting egg clutches.

Ideally, conditions in an artificial hatchery should duplicate those of the natural nest, and manipulation should be avoided except where benefits have been clearly demonstrated. In the present study, we conducted controlled experiments to determine quantitatively whether or not splitting egg clutches into smaller complements increases egg clutch survivorship in a hatchery.

METHODS

We conducted experiments on two species at two sites: 1) On leatherback turtle eggs at the Rantau Abang, Terengganu hatchery during the 1990 season; and 2) On hawksbill turtle eggs (*Eretmochelys imbricata*) at the Pengkalan Balak, Melaka hatchery during the 1991 season.

Throughout the nesting season, egg clutches brought to these hatcheries for burial were alternately assigned to one of two treatment groups: 1) The "Controls" which were buried in their entirety in a single egg hole; and 2) The "Experimentals" which were split into two or more equal parts (each containing about 40 to 60 eggs), and each part was buried in a separate hole in the beach hatchery.

Detailed records were kept of the stages at which mortality occurred in each clutch. For each species, the Mann-Whitney U test ($\alpha = 0.05$) was used to test observed differences between the survivorship in clutches exposed to the two treatments.

RESULTS

For both species, the average rates of egg survival were higher in the "Experimental" (i.e. split) egg clutches than in the "Control" group. The rates of emergence success (i.e. % live hatchlings produced) in leatherback eggs were 55.2% in the split clutches (N = 24) and 44.9% in the control clutches (N = 28); while for hawksbill eggs they were 52.7% in the split clutches (N = 83) and 47.0% in the control clutches (N = 111). However, there was no statistical difference between the % emergence success of split and control clutches in either species.

Mortality during the pipping stage was significantly lower for split egg clutches of both species. Mortality of late stage embryos within intact eggs was significantly lower in the split egg clutches of the hawksbills, but not in those of the leatherbacks. The number of dead hatchlings encountered in the hawksbill nests was also significantly lower in the split clutches; no dead hatchlings were reported in the leatherback nests.

DISCUSSION AND CONCLUSIONS

We conclude that splitting egg clutches is a management tool that can be used to slightly improve the survivorship of eggs buried in beach hatcheries. However, we are at some loss to conclusively explain the mechanism responsible for the enhanced survivorship we observed.

There is evidence that excessively high sand temperatures may exist in the hatcheries at both Rantau Abang (Chan and Liew, pers. comm.) and at Pengkalan Balak (Mortimer and Zaid, 1992; Mortimer, Zaid and Safee, MS in prep.). In a previous report (Mortimer et al., 1992), we suggested that under excessively warm conditions the production of metabolic heat during pipping might be lethal to some turtles. A reduction in the numbers of eggs in a nest reportedly lessens the production of metabolic heat (Kraemer, 1979). Thus, we concluded that smaller complements of eggs in a nest could lessen the production of metabolic heat, thereby decreasing mortality in late stage embryos and young hatchlings. Further support for our theory includes the fact that significantly higher rates of hatching success was observed in eggs incubated in the cooler temperatures within styrofoam boxes at both Rantau Abang (Chan, 1989) and at Pengkalan Balak (Mortimer and Zaid, 1992).

However, a closer analysis of the survival rates of hawksbill eggs incubated in the styrofoam boxes at Pengkalan Balak in 1991 (Mortimer, Zaid and Safee, MS in prep.) indicates that even within styrofoam boxes, smaller egg clutches enjoyed higher rates of hatching success than did the larger clutches. Thus, we must conclude that temperature alone does not explain the reduction in the mortality of late stage embryos and hatchlings that we observed in the split egg clutches. Other reasons why eggs incubated in smaller clutches or in styrofoam boxes enjoy higher survival rates may include the following: 1) There is a shorter distance for gas to diffuse between the edge and the center of the clutch; and 2) The process of pipping might be facilitated by better mobilization of minerals from the eggshell resulting either from closer contact with the substrate in the beach or from better moisture control in the styrofoam boxes.

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AERIAL ESTIMATES OF SEASONAL DISTRIBUTION AND ABUNDANCE OF SEA TURTLES NEAR THE CAPE HATTERAS FAUNAL BARRIER

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The coastal area immediately adjacent to Cape Hatteras, NC is a major migratory pathway for loggerhead (*Caretta caretta*), leatherback (*Dermochelys coriacea*), and Kemp's ridley (*Lepidochelys kempii*) sea turtles. During spring, turtles migrate from the south past Cape Hatteras to summer in northern waters. Juvenile loggerheads and ridleys enter estuaries such as Chesapeake Bay, Long Island Sound, and Cape Cod Bay, while the leatherbacks travel as far north as Newfoundland and possibly farther. When water temperatures fall in the autumn, turtles return to south of Cape Hatteras to overwinter. During their migration, turtles are concentrated in the Cape Hatteras region, probably because of the narrowness of the continental shelf in the area. During the summer months, some turtles may take up residency off the North Carolina coast, but the density is lower than during migration. The objectives of the current study were to define the migration and temporal and spacial distribution and abundance of sea turtles in the area to determine habitat usage and number of turtles which utilize the area.

METHODS

The VIMS Sea Turtle Research Project conducted aerial surveys covering the area between Cape Henry to Cape Hatteras (Diamond Shoals Light) from 1985 to 1989 to estimate abundance of loggerhead turtles in the area. These data were divided into a northern (from Oregon Inlet to Chesapeake Bay) zone and southern (Oregon Inlet to Cape Hatteras) zone for analysis. In 1991 we initiated surveys from approximately Oregon Inlet to Hatteras Inlet. Three areas were surveyed; from 55.5 km to 18.5 km north of Cape Hatteras (northern zone), from 18.5 north to 18.5 km south of Cape Hatteras (middle zone), and from 18.5 to 55.5 km south of Cape Hatteras (southern zone). Following our established protocol (Musick 1986; Musick et al. 1987; Musick et al. 1989), surveys were flown at an altitude of 152 m, and at a speed of 130 km/hr. Two observers, one on each side of the airplane, scanned the sea surface and recorded the occurrence of turtles and other sea creatures. Using our established methods (Musick et al. 1992), the effective visual swath being surveyed can be determined, and with transect length allows calculation of density estimates of turtles at the surface using line-transect analysis.

Loggerhead and leatherback sea turtles are easily recognized from the air, thus we directly calculated the density of these two species from the survey data. But small size and cryptic coloration make ridleys difficult to detect from an airplane. Assuming ridley and loggerhead turtles strand in proportion to the population size of each species in the area, we applied the ratio of stranded ridleys to stranded loggerheads to our aerial survey population estimates of loggerheads to calculate the density of ridleys in the area.

Since only turtles at the surface of the water are observed on aerial surveys, a correction factor can be used to account for submerged turtles. If the amount of time a turtle spends at the surface is known, an adjustment factor can be calculated as the inverse of the proportion of time spent at the surface. By multiplying this factor by the relative density accounts for the submerged turtles, a estimate of population density may be obtained. The diving data required to calculate the adjustment factor for loggerhead and leatherback turtles was obtained by satellite telemetry.

Satellite telemetry has been successfully utilized to gather location data of sea turtles since 1985. Satellite telemetry was utilized to track 10 loggerheads and three ridleys, which was used to describe movement, migratory patterns, and habitat use.

RESULTS

Density estimates of surfaced loggerheads for the 1985 - 1989 surveys ranged from 0 (in December) to 1.261 turtles km^{-2} (in early May). Diving data from three satellite telemetered loggerheads showed that the turtles migrating south along the North Carolina coast stayed at the surface 10.6% of the time, providing an adjustment factor of 9.4. Applying the adjustment factor yields population density estimates for loggerheads up to 11.853 turtles km^{-2}. Density estimates of surfaced loggerheads in the 1991-1992 study ranged from 0 to 0.264 turtles km^{-2}. In the northern zone the estimates ranged from 0 (in January and early April) to 0.264 turtles km^{-2} (in early July). In the middle zone, estimates ranged from 0 (in June) to 0.192 turtles km^{-2} (in early April), and in the southern zone estimates ranged from 0 (in June) to 0.180 turtles km^{-2} (in early April). Applying the adjustment factor of 9.4 yields population density estimates up to 2.482 turtles km^{-2}.

Leatherbacks were observed in May, July, August, October, and November. Few leatherbacks were observed on any of the surveys and surfaced turtle density ranged up to 0.072 turtles km^{-2}. No dive data is available for leatherbacks off North Carolina's coast, however a leatherback turtle tracked in the Caribbean was at the surface 13.1% of the time (Keinath and Musick, in press), yielding an adjustment factor of 7.6 providing population density estimates for leatherbacks in the 1985 - 1989 study up to 0.433 turtles km^{-2} and up to 0.547 turtles km^{-2} in the 1991 - 1992 study.

During some years the flounder trawl fishery interacts with turtles migrating south in the autumn, and incurs high mortality on sea turtles which wash up dead along the coast. The ratio of stranded ridleys to loggerheads range up to 0.2500, with means for the ratios of 0.0732 (calculated as the mean on all years from 1980 to 1991) and 0.0501 (calculated as the mean of all months pooled by year), or an overall mean of 0.0617. This provides mean population estimates for ridleys of 0.1531 turtles km^{-2}, and a maximum population estimate of 0.6205 turtles km^{-2}.

In general, population densities of loggerheads reached a maximum from Cape Hatteras south in April with a secondary peak in November. North of Cape Hatteras population densities were highest in May with a secondary peak in November. We feel that high density estimates observed on 6 August 1985, 4 July 1986, 29 July 1988, and 8 July 1992 may have been due to changes in the turtles' surfacing behavior rather than to real increases in standing stocks. The coastal region from Cape Hatteras to Cape Henry is subject to periodic upwelling caused by prolonged southwesterly winds in July and August (Hicks and Miller, 1980; Ingham and Eberwine, 1984; Norcross and Austin, 1988; Wells and Gray, 1960). This phenomenon pulls in cold bottom water from offshore and establishes a strong thermocline. Loggerheads tend to occur in waters of 18 C or higher (Lutcavage and Musick 1985), tend not to swim through a strong thermocline, and spend more time on the surface (Keinath and Musick, Unpub. data).

Although Kemp's ridleys are hard to detect by aerial survey relative temporal and geographic trends in ridley population abundance probably closely reflects those of loggerheads (but absolute abundance is much lower). Both stranding patterns and tracking studies suggest that ridleys migrate through the Hatteras migration corridor at the same time as loggerheads. In summer, however, there probably is a difference between the species because ridleys prefer to forage in shallow areas within estuaries such as Chesapeake Bay (Byles, 1988; Lutcavage and Musick, 1985) and Core Sound (S. Epperly, Pers. Com.) whereas loggerheads use deeper channel areas in estuaries (Byles, 1988; Lutcavage and Musick, 1985) and occur along the coast.

Sea turtles migrate from the south around Cape Hatteras during May to northern summer feeding areas. They return in fall to the south of Cape Hatteras, rounding the Cape during October and November. This movement is probably mediated by water temperature. Kemp's ridleys, as well as some loggerheads appear to overwinter as far south as Florida, while some loggerheads either become pelagic in the North Atlantic or stay along the outer shelf over live bottom under the Gulf Stream off North Carolina over the winter.

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LOCAL GUIDES IN THE LEATHERBACKS OF GUANACASTE MARINE NATIONAL PARK: SUSTAINED DEVELOPMENT AND SEA TURTLE CONSERVATION

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The Leatherbacks of Guanacaste Marine National Park was created in 1991 in an effort to protect the nesting beaches (Playa Grande and Langosta) of one of the world's most important leatherback colonies. This Park is the result of many years of struggle and effort, during which the problems affecting the leatherback turtles have changed once and again.

Before any protection measures were carried out at all, the locals had already developed a whole economy around the sea turtle resource. Costa Rican Pacific Coast locals do not eat turtles, but the eggs are highly prized because of alleged aphrodisiac powers. Unfortunately, the market has now expanded to supply eggs to other communities, so it is no longer just a local resource.

During the early 1980's, the tourism industry began to expand in Costa Rica, and many tourists were drawn to Tamarindo, a nearby tourist resort just to the south of Playa Grande. To the astonishment of many tourists, as well as local hotel owners, egg poaching was open and generalized, despite laws against this practice in Costa Rican legislature. Locals reportedly staked out certain sectors of the beach to reserve "their" turtles. Eventually, and through local tourism industry support, the Tamarindo Wildlife Refuge was created in 1987 in an effort to protect not only the turtles, but also the Tamarindo mangrove swamp and the wildlife it supports. Guards were hired, beach patrols were organized, and the struggle against the poachers had begun.

But new problems were to arise. Due to the scenic beauty of these important leatherback beaches, and the late concern for the conservation of the area, developers were on the way. Major tourist developments were planned, with discos, marinas and condos. All the noise, lights and development was sure to alter the environment and jeopardize the future of the sea turtles. The establishment of the National Park provided the government with more efficient tools to control the developers. At present, the Park consists of only 50 meters above the high tide line, although efforts are currently underway to purchase another 100 meters in order to establish a greenbelt behind which development will be allowed following the recommendations of a management plan.

Recently, however, a new threat is present, and this is ecotourism. Costa Rica is now a hot spot for the ecotourism industry, and the Costa Rican Tourism Bureau is promoting the country internationally on a major scale, in spite of the fact that many places, such as the Leatherback Park, are not prepared for the great number of tourists that will come. During the 1991 season it became evident that something had to be done about the ecotourist problem. People visited the Park by the hundreds with no control at all. In some cases visitors were on guided tours, but the guides, for the most part, were largely ignorant of the turtle's needs. Flash photography was common, as well as lights, bonfires, noise, and every sort of turtle harassment possible, not to mention unguided tourists. After a night of tourist activity it was common to find dead hatchlings, crushed to death by the tourists. Uncontrolled ecotourist activity may result in even more damage to the turtle population than poaching ever was.

Therefore, it seems that we have taken this valuable resource away from the locals, who have utilized it for generations, just to hand it over to the messy tourist industry, which may cause irreversible damage in the a short term, Likewise, most locals do not even receive any economic benefit from these turtle tours. It is mostly a business run by foreign tour agencies or English speaking Costa Ricans. Under the current circumstances, it is no wonder the local people have not fully supported the creation of the Park.

Previous experience on conservation issues worldwide has shown us that without local support conservation efforts fail, and local support is only obtained when those locals who once utilized the resources are included in the new conservation programs in ways which they can sustain their personal economies. This is known as sustained development, and it is the modern conservation philosophy.

Although many ways can be thought of to include locals in the leatherback conservation efforts in the Leatherback National Park, the most urgent need is to control the tourists and provide jobs to locals on a short term. This is how the local guide program started. The Chorotega Foundation, a local NGO, funded by the Dutch Government, financed the first training course for local guides in the Leatherbacks of Guanacaste Marine National Park. More than twenty students showed up, all from neighboring communities. Most were at one point in their lives poachers, or at least have poachers in their families. The idea is to train them so that they may offer a professional and safe turtle tour, for the sake of the turtles, while making some extra money for themselves without having to carry out a destructive activity such as egg poaching.

Training started in September 1992 with English lessons followed by sea turtle biology lessons and lessons on the proper management of tour groups. By November and December the guides would be present at the Park Booth and would ask for a tip for their services. The objective was originally to train these guides for the whole season (October - March) in order to screen out those guides who were not suitable and have a team of reliable guides for the 1993 season. During this period the guides met every two weeks to talk about their experiences and to design an efficient work plan for the 1993 season. By December 1992, the guides formally established a Local Guide Committee, and the goal is to be legally represented with credentials. The purpose of this is to make the use of guides mandatory on the beach by the 1993 season. This way, tourists who were not on organized tours would have to contract a local guide.

During this season, however, we did run into some problems implementing this plan. From mid December to February 1993, the hundreds of tourists have just been too much to handle. Since the use of guides was not mandatory, due to legal reasons, many people refused to use them, and the same problems of previous years were emerging once again. Therefore, in January 1993, the Park Administration began to require local guides for walk-in tourists (not on organized tours). The guides would charge 500 colones to foreign tourists (about $3) and 200 colones to Costa Ricans. One serious problem was the lack of a legal framework, as well as a generalized ignorance of the tourists on the need to implement any regulations at all on the beach. We received complaints as expected, but they were not because people neglected the importance of using local guides, but because of the lack of prior information on this regulation, as well as a lack of communication between the Park Administration and the Park Service Central offices. Some complaints included Costa Ricans who considered that they were being overcharged. Others complained because the local guides were not bilingual, or because they were not knowledgeable enough. Another complaint was just plain disorganization, especially as tour groups sometimes had to wait at the entrance for a guide to be available or because the Park was saturated at the moment (no more than 150 people at a time). Although we reckon these complaints are valid, they can easily be solved. The guides just need more training and time to loosen up. We can not expect to have professional turtle guides in only two months. The program also needs more support and control by the government authorities. On the other hand, this is the first year tourist regulations are strictly enforced, and based on this year's experience improvements may be done for the 1993 - 1994 season. As for right now, we already have a Local Guide Committee with excellent young people. Just as we expected, through the guide program, the Park finally has local support. Some of the most important ecotourism agencies in Costa Rica, such as Sun Tours and Costa Rica Expeditions, are even willing to contract local guides, even though their groups are accompanied by professional naturalist guides. It is urgent that these young men and women be granted credentials and that their committee be granted some kind of legal status in order for them to operate professionally by the following season. We are expecting more tourists to come in the 1993 - 94 than ever before, and the use of local guides may be the solution for safe turtle tours and an incentive to locals, as proof that natural resources may be more profitable to them if they work towards their conservation.

A SEA TURTLE RECOVERY ACTION PLAN FOR ST. KITTS AND NEVIS

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The Sea Turtle Recovery Action Plan for St. Kitts and Nevis (Eckert and Honebrink, 1992) is the fifth in a series of 39 such Action Plans produced by the Wider Caribbean Sea Turtle Conservation Network (WIDECAST). WIDECAST is a regional project of the UNEP Caribbean Environment Programme and is implemented locally throughout the Caribbean. The Lead Organization in St. Kitts is the St. Christopher Heritage Society, a non-profit voluntary organization concerned with the protection of the heritage of St. Kitts -- natural, man-made and cultural. The Nevis Historical and Conservation Society, based at the Museum of Nevis History, is the Lead Organization in Nevis. The completion of the Action Plan marks a significant step forward for conservation in our country. It provides background information on the status and distribution of sea turtles, evaluates historical and contemporary threats, and describes scientifically sound solutions to many threats facing turtles and their habitats. It also establishes priorities for conservation and legislative action and is an excellent tool for public education and fund-raising. The following is a brief abstract of the Action Plan.

Three species of sea turtle, all internationally classified as endangered species (Groombridge 1982), nest in St. Kitts and Nevis; namely, the hawksbill (*Eretmochelys imbricata*), green (*Chelonia mydas*), and leatherback or river turtle (*Dermochelys coriacea*). In addition to seasonal nesting, hawksbills and green turtles of varying sizes feed throughout the year in shallow waters. The leatherback is not resident; gravid females arrive each year for a summer nesting season. A fourth species, the loggerhead turtle (*Caretta caretta*), is occasionally observed offshore. The documented harvest of sea turtles in the federation dates back to 1603 when a work party dispatched to Nevis described a "Tortoyse so big that foure men could not get her into the Boate". The 18th century letters of William Smith declare green turtles to be "so common that they need no description." There can be little doubt that the once ubiquitous sea turtles were an important part of diet and commerce during the colonial era.

Today our sea turtle populations are depleted. Turtle hunters and observers familiar with the fishery disagree on the exact number of turtles still harvested each year, but it appears likely that 50-100+ turtles, mostly greens and hawksbills, are landed annually on each of the two islands. The number of nets set and the number of hunters who await gravid females on the nesting beaches is considerably lower than at any time in the past. The number of part-time turtle fishermen is estimated to be less than ten on each island. The number of spearfishermen targeting sea turtles is growing, however, and this is viewed as a serious threat. The collection of eggs is unquantified but approaches 100% in some areas. There is no legislation governing the harvest of turtles or their eggs at the present time, but the draft Fisheries Regulations of 1992 call for a moratorium on the capture of turtles and the collection of eggs. Such a moratorium is fully supported by the Action Plan.

The most significant stress on local turtle populations has been a virtually unregulated harvest. The consequences of over-harvest are nowhere more evident than on the nesting beaches. There is a consensus that the beaches once supported many more nests than are seen today. Too many of the federation's breeding females have been killed and their eggs taken. It is self-evident that if eggs are not allowed to produce hatchlings, there will not be a next generation of turtles. In addition to protecting the turtles and their eggs, we must preserve important feeding and nesting habitats. A few nesting beaches have been lost in recent decades, mostly to harbour development, but coming decades will see an unprecedented commercialization of the coastline. Several large hotels on the Southeast Peninsula of St. Kitts, for example, are in planning or construction stages. Offshore, an increase in yacht and cruise ship traffic will mean increased solid waste and pollution, anchoring, and recreational use of the often fragile seabed (e.g., coral reefs). Integrated coastal zone planning and improved law enforcement are needed. A variety of specific regulations to protect nesting and feeding habitat are presented in the Action Plan.

The Action Plan proposes a five-year national Sea Turtle Conservation Programme. The goals of the programme are (1) to obtain comprehensive and accurate data on the distribution of turtle nesting and foraging habitat and (2) to promote the conservation and recovery of remaining sea turtle stocks. Activities, including habitat and market surveys, management planning, training, and environmental education, are described. In addition to national efforts to conserve sea turtles, it is essential that St. Kitts and Nevis support international initiatives to conserve these highly migratory reptiles. In this regard, the Government is encouraged to ratify CITES, MARPOL, and the UNEP Cartagena Convention (with SPAW Protocol). In summary, an integrated approach to the continuing decline of sea turtles is needed, including strong domestic and regional legislation, habitat protection, population monitoring, and enhanced public awareness. To ensure that regulations to safeguard turtles and their habitats have grassroots community support, user groups (e.g., fishermen), conservationists, government personnel, restaurant owners, and concerned citizens actively participated in the development of the Action Plan.

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OSTIONAL: A COMMUNITY WHICH LIVES TOGETHER WITH THE OLIVE RIDLEY MARINE TURTLE, *Lepidochelys olivacea*

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INTRODUCTION

Ostional is a village, a beach and a National Wildlife Refuge. It is a tranquil place where three components blend together: the social aspect, the management of the turtle egg as a resource and the study of the phenomenon of the arribada of the olive ridley marine turtle. This community conserves the customs of rural costal populations of the Costa Rican Pacific. Subsistence agriculture is secondary to the turtle egg harvest in maintaining this community. Since the destruction of our natural resources is occurring on an accelerated level, management is the alternative which remains for these resources and in the future, management projects will be the only way to maintain an equilibrium between our society and the environment.

THE LOCATION OF OSTIONAL BEACH

Ostional is located in Guanacaste Province about 360 kilometers (213 miles) to the southwest of the capitol, San Jose. The vegetation of the area is characterized by dry tropical forest covering about 280 hectares within which are situated the Ostional community, large cattle ranches, agricultural areas of basic grains, mangos and reforestation farms and also Ostional beach which has the largest congregation of nesting marine turtles in Latin America.

WHAT IS THE ASSOCIATION OF INTEGRAL DEVELOPMENT OF OSTIONAL (A.D.I.O.)?

Since 1987 the Ostional Community has been organized by means of a communal development association with the objectives of integral development of the community and conservation of the marine turtles.

Activities of A.D.I.O. members - First among community activities are the harvesting and marketing of turtle eggs. This provides economic support to the members of the association. The harvesting of the eggs occurs during the first 36 hours of the arribada, after approval by the Ministry of Agriculture and Livestock. The people of Ostional, organized into various work groups, harvest, pack and market these eggs. There are 10 work groups, each directed by a coordinator. The men in the group locate nests laid the previous night using their feet, the women remove the eggs, placing them in large rice sacks and another group transports the eggs to the packing center.

The sacks of eggs are washed in the ocean and the eggs are then packed into smaller plastic bags. These bags hold two hundred eggs and are pre-stamped with the seal of A.D.I.O. At present, marketing is conducted by affiliates of the association. Egg distribution reaches commercial centers in various locations within Costa Rica. In 1992, A.D.I.O. financed a study of the egg turtle marketing with the goal of improving its marketing procedures.

Other activities - Some of the turtle conservation activities performed by members of A.D.I.O., are as follows: beach surveillance, removal of tree trunks during the dry season (December to April), and women and children release the turtle hatchlings.
Committees of health, sports and road improvement have been formed, each with its own objectives and goals that promote the integral development of the community.

UTILIZATION OF THE PROFITS PRODUCED

Of the profits generated from egg sales, 70% is distributed among association members as payment for their labors and 30% among the conservation project, administrative expenses and communal projects. By means of the profits, the following constructions have been achieved: the health center, a house for school teachers, the A.D.I.O. office, the rural guard office, an egg packing center, remodelling the school and a research laboratory. At the moment the research lab has served as lodging for university students from the United States as well as housing for the biologist contracted by ADIO and as a classroom for training the beach guards. Also contributions have been made to the respective institutions for road maintenance and a deposit for the installation of electrical service for the town.

THE NEED FOR ECONOMIC AID

Aside from all the achievements of this rural community, certain necessities have been identified, these include: the purchase of farm land, infrastructures, training, environmental education and the creation of the management plan for integral development.

Purchase of farmland - Costa Rica is suffering from large scale expansion of tourism along the Pacific coast and Ostional is not an exception. Large hotel chains are buying land adjacent to the beaches. Thus there exists the need for the purchase of the farmland where A.D. 1.0 . could establish buffering areas around the refuge to ensure the protection of egg-laying beaches. It is also necessary to relocate families residing on the vegetated upper areas of the main nesting beach since they are occupying a part of the turtles' nesting area and also because of the intrinsic danger characteristic of intertidal zones.

Infrastructures - The installation of the refuge information center, the construction of a crafts center, an extension of the laboratory building and remodelling of the packing center are all infrastructures needed by the town.

Training - Training is needed specifically in organization and administration for the ADIO board of directors and other community members with the goal of forming community leaders. Training is also needed to teach community members to be nature guides responsible for giving tourists information concerning marine turtle biology, the importance of conservation, the utilization of the turtle eggs and other aspects of the refuge.

Training the women of the town is needed to promote diverse activities such as: sewing, cooking typical Costa Rican food, crafts and others. At the same time it is necessary to locate financial support to promote the creation of small industries for the production of the above activities .

Environmental Education Program - Presently Ostional needs a formal school environmental education program as well as an informal - intensive program for non-student residents. We seek international support to hire a permanent environmental educator since we cannot count on national funds for this purpose.

Management plan for the integral development of Ostional - It is necessary to modify the present management plan into a management plan for integral development. The present management plan does not totally adapt to the current reality and therefore an integral management plan would give ADIO the opportunity to administrate the refuge and the surrounding areas. This would include regulations on land ownership, on the construction of buildings within the refuge, the enforcement of wildlife laws as well as offer other development alternatives so that the community does not depend exclusively on turtle eggs.

SEA TURTLES IN THE NATURAL RESERVE MONA ISLAND, PUERTO RICO, 1992

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INTRODUCTION

Mona Island is an undeveloped island located midway between the Dominican Republic and Puerto Rico and consists of an elevated limestone plateau which rises some 40 to 70 meters above sea level. Night patrols were made in order to tag and measure as many turtles as possible. Daytime surveys were made on the remaining beaches to record nesting activity. Hatching activity was documented. For nine consecutive years the island has been a natural laboratory for sea turtle research.

RESULTS

Between June 7 to December 9, 316 emergences were recorded, including 142 nests and 174 false crawls. The crawl effort was estimated to be 2.25 crawls/nest. In 1992 Uvero beach was the most favored beach with 73.8% of nests among the beaches. Three nests were depredated by feral pigs on two beaches (Figure 1).

Our 12-week study showed that the peak of the season was between August 17 and September 21 with 58 nests (Figure 2).

Six nests were lost due to heavy offshore swells. Mujeres, Coco, Caigo and Brava beaches suffered extensive damage from erosion.

Sixteen turtles were tagged, of which three were tagged remigrants. One nesting leatherback was tagged by Miguel A. Nieves in 1987 and was tagged again. This turtle showed mutilations on front and back flippers. Two turtles were observed with half of their back flippers missing and another turtle, shown by tracks on the sand, had both back flippers missing.

The average incubation period was 59.2 days with range of 54-63 days. The average number of eggs was 140 and ranged from 85 to 298. Hatching success was estimated to be 82%.

DISCUSSION

The population of hawksbills has declined drastically in Puerto Rico and the whole world, and Mona Island is not an exception. This year the presence of new nesters on the beach were minimal. Fishermen are aware of the occurrence of the species and travel long distances to the island, staying anchored offshore for the illegal catch. This activity occurs during holiday weekends. One carcass of a juvenile turtle was found at a depth of 30 m in front of Cueva El Gato.

This year, some fences are down due to corrosion and in this way access to the beach by pigs is easier.

CONCLUSIONS AND RECOMMENDATIONS

Turtle poaching still continues at Mona Island. Our constant educational program for visitors and fishermen has made good relationships.

Much needs to be done with this species. The involvement of private and governmental agencies for funding educational programs throughout its range are very important to create awareness for how important these little known sea creatures.

Installment and maintenance of fences to avoid the access of pigs to the beaches is needed.

We emphasize the need for a good boat with which maritime patrols by the DNR Rangers could increase in the surrounding waters to minimize poaching by fishermen.

The law enforcement must be aggressive and inflexible, this will control if not stop the illegal catch.

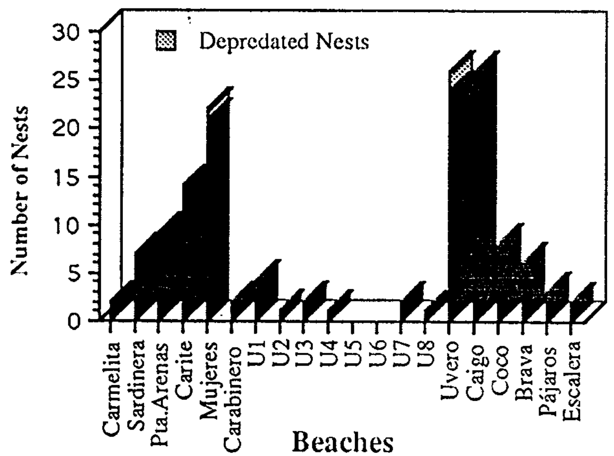

Figure 1: Nests per beaches.

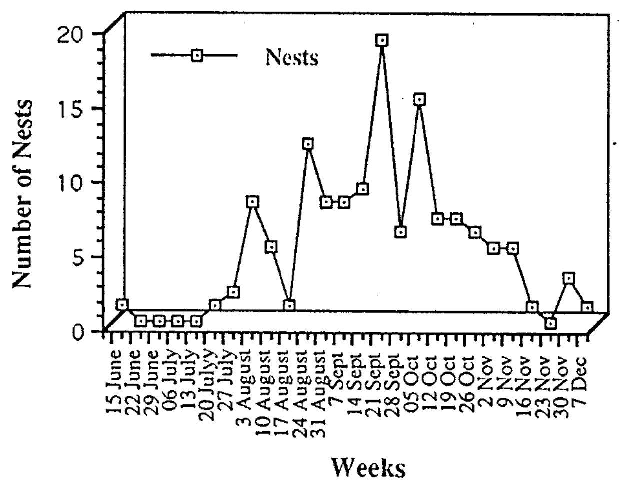

Figure 2: Nests per week.

GENETIC EVIDENCE FOR PRECISE WITHIN-BEACH HOMING OF NESTING GREEN TURTLES (*Chelonia mydas*) AT TORTUGUERO, COSTA RICA

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Meylan et al. (1990), using maternally transmitted mitochondrial DNA, have found significant genetic divergence among different nesting populations of female green turtles (*Chelonia mydas*) in the western Atlantic. They conclude from these results that females exhibit strong natal homing behavior. I extracted DNA from blood samples representing 20 females nesting along Tortuguero beach, Costa Rica and estimated the genetic relatedness of 10 randomly drawn pairs using multi-locus minisatellite DNA fingerprinting. The preliminary results revealed that individuals nesting closer to one another were more closely related than were individuals which nested farther apart. These results suggest that females are extremely site-specific in their homing behavior.

METHODS

DNA fingerprinting is a direct and relatively simple way of visualizing hypervariable minisatellite regions of genomes of individual animals. This technique uses standard DNA technology to reveal a class of hypervariable loci that occur by the hundreds in each individual, and that are common to all vertebrates that have been examined. Allelic variation among these loci is determined mainly by the number of tandem repetitive units of a core sequence found at each site (Jeffreys et al., 1985). The methods involve using a restriction endonuclease to cut DNA (which has been isolated from the nucleated cells of any tissue, such as blood) at specific base sequences along the DNA molecule. The DNA fragments produced by this enzymatic digestion are then separated by size along an electrical gradient in an agarose gel. The resulting smear of fragments is transferred out of the gel and permanently bound onto a stable nylon membrane. Those fragments among the total that carry a particular nucleotide sequence are identified via hybridization with a radioactively labeled "probe" molecule carrying the complementary nucleotide sequence (in the case of fingerprinting, the core sequence of the tandem repetitive units). The positions at which the probe attaches are recorded by exposing x-ray film to the hybridized membrane. The resulting autoradiograph shows dozens of bands that correspond to the many different fragment sizes bearing the core sequence. This is the "fingerprint". The size (length) of the labeled fragments can be estimated by comparing their positions within the smear to those of fragments of known size.

Genetic variation among individuals leads to enormous differences in banding patterns observed. The banding patterns become more and more dissimilar as individuals diverge genetically until few bands are shared--that is, few DNA fragments of a particular size that hybridize with the probe in one individual also hybridize in another individual. This technique is sufficiently sensitive to differentiate among all individuals within a population except for those that are genetically identical. Because the loci assort in Mendelian fashion, siblings, as well as parents and offspring share at least 50% of their bands. After calibration against the proportion of bands shared by individuals of known relatedness (see Jeffreys et al., 1985, Georges et al., 1988), the relatedness of individuals drawn at random from a population can be estimated by the similarity of their banding patterns (Piper and Parker, 1992).

The nesting population of green turtles at Tortuguero can best be described as having a geographically linear distribution, with females depositing clutches along the entire 22 miles of beach. This potentially allows for the development of a pattern to the distribution of genetic variability found within this population.

Within-population genetic structure was examined through the use of band-sharing estimates from multilocus DNA fingerprinting. Genetic similarity indices were calculated for pairs of nesting females, and the relationship between genetic similarity and nesting distances for each pair was examined through regression analysis.

RESULTS AND DISCUSSION

Results from analysis of these data revealed a negative correlation between the proportion of bands shared in pairs of nesting females, and the distance apart that members of the pairs nested (Fig. 1; $R^2=0.725$, $p<0.002$). Individuals nesting closer to one another had more similar banding patterns and were thus more closely related than were individuals which nested farther apart. These results suggest that females may be extremely site-specific in their homing behavior. If females that nest nearer to each other share a higher proportion of bands, and if these bands represent loci that are common by descent, then it is likely that the daughters of females nesting in particular areas of the beach tend to return to these specific areas to nest, and their offspring, in turn, home within a relatively narrow range of where their mothers nested. If this result is confirmed by the work that will be done in upcoming field seasons, it could provide useful information for managers of nest relocation programs, and for scientists studying green turtle homing behavior and its mechanisms.

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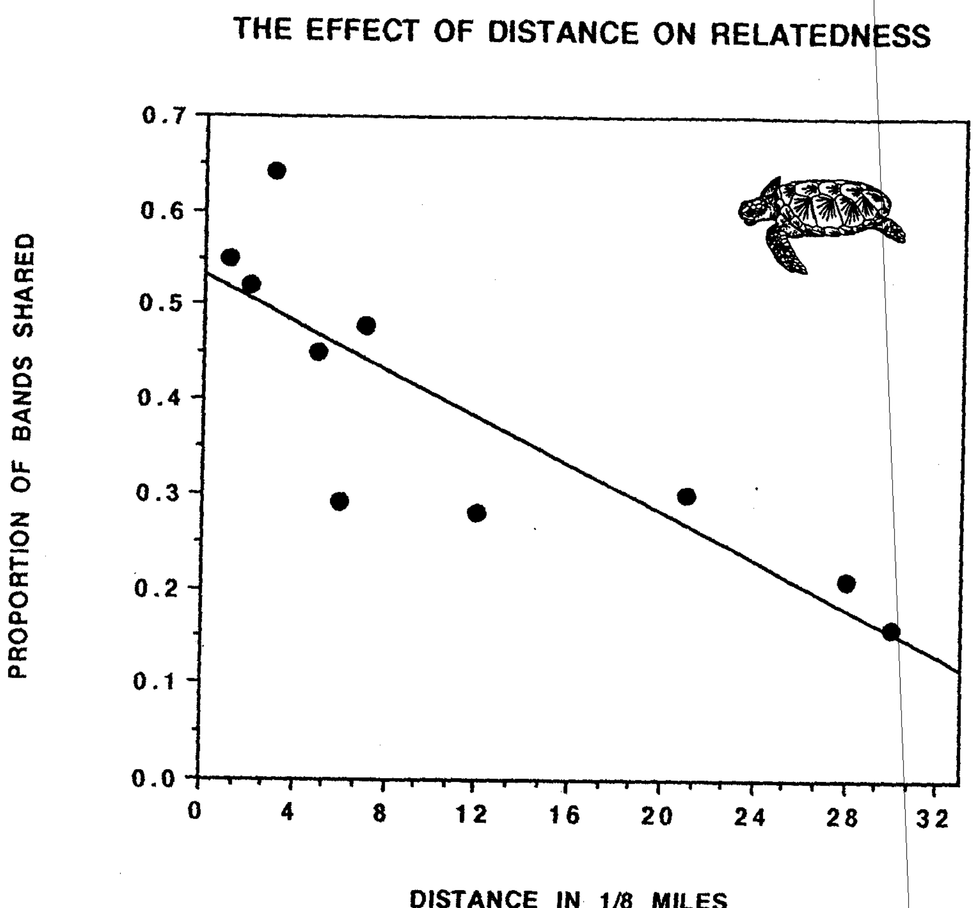

Fig. 1 Graph showing the relationship between the proportion of bands shared for dyads of nesting females and the distance apart that members of the dyads nested ($R2=.725$, $p<.002$).

MIGRATORY AND REPRODUCTIVE BEHAVIOR OF *Lepidochelys olivacea* IN THE EASTERN PACIFIC OCEAN

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Since 1990 we have used satellites to monitor the migrations of radio-tagged *L. olivacea* from their breeding/nesting area near Nancite Beach, Costa Rica to (1) document migration routes (2) identify foraging areas and (3) determine if the turtles migrate in socially structured groups. During the reproductive season (June through December), *L. olivacea* copulate at sea en route to or in the shallow waters (< 200 m deep) offshore Nancite Beach. The turtles aggregate nearshore and once a month the females synchronously emerge on the beach *en masse* to lay their eggs (*arribada*). Most females lay two egg clutches during a nesting season and remain nearshore for the internesting period (1 - 2 months). The females are relatively inactive during this time and do not feed in the nearshore habitat. After the last clutch of the season has been deposited, female *L. olivacea* leave the nesting beach individually. Their post-nesting migration routes traverse thousands of km of deep oceanic waters (> 1,000 m deep) and are geographically distributed over a very broad range (from Mexico to Peru and 3,000+ km west of Costa Rica). *L. olivacea* do not migrate to one specific foraging area. Rather, they exhibit a nomadic movement pattern and occupy a series of feeding areas within their oceanic habitat. Data collected from a few individuals demonstrated that some female *L. olivacea* return to Nancite Beach annually to nest. Annual variability in the movement patterns of female *L. olivacea* were observed and may be attributed to temporal and spatial variability of food resources

THE WESTERN AUSTRALIAN MARINE TURTLE CONSERVATION PROJECT - AN UPDATE

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The Western Australian Marine Turtle Conservation Project was most recently reviewed in Prince (1993). Other information concerning western Australian region marine turtle populations, and progress reports on work of the project prior to this review, have been included in annual project newsletters 1 through 4 (Prince [ed.] 1989, 1990, 1991, 1992), and in papers presented to the Australian Marine Turtle Conservation Workshop 1990 (Coates et al., in press; Prince, in press a & b).

In this paper I present a preliminary review of the project work done since preparation and submission of Prince (1993). Beach work for the 1992/93 nesting season has recently been completed.

SEASONAL OBJECTIVES

The major objective set for the 1992/93 beach work program pre-season was to increase the effort focussed on the loggerhead and hawksbill turtle populations nesting at South Muiron and Rosemary islands respectively, in an attempt to achieve a substantial increase in the number of tagged animals of these relatively scarce species. Maintenance of coverage of the turtle populations using other established study sites within resource limits was the secondary target. Tagging targets were to attempt to mark a minimum of ca.10% of the nesting populations of untagged green turtles at the major rookeries, with ca.30% of these to be double-tagged, and to aim at double-tagging all new loggerhead and hawksbill turtles. Additional tags were to be applied to all remigrant turtles. Restriction of funding support was also anticipated, and attempts to obtain supplementary support from external sources were planned.

RESULTS AND DISCUSSION

The South Muiron Island loggerhead turtle objective was substantially met, with the study site staffed from 27 November 1992 to 27 January 1993, when adverse weather and declining turtle abundance prompted termination. The Rosemary Island objective was less easy to fulfil, but a substantially increased effort was still achieved overall. Tagging work late October 1992 was spectacularly successful, but we were not able to build on this through November-December 1992, apart from a one day session early December. Renewed effort from 6-21 January 1993 produced a good supplementary result, although the numbers of nesting hawksbills available nightly had by then apparently declined from early season abundance.

Work at the established study sites produced variable results. On-site work at North West Cape was maintained from 28 November 1992 to 31 January 1993, but the volunteer effort available was reduced in comparison with the 1991/92 season. Barrow Island work could not be sustained at desirable levels through mid-summer, and plans to attempt partial retrieval late January- early February 1993 were thwarted firstly by unavailability of suitable staff, and then by severe adverse weather. In contrast, the Varanus Island work effort was maintained. A reduced work program was also the result for Cape Thouin in December 1992, due to other demands pre-season on services of the local site coordinator. The planned Lacepede Islands work in December 1992 was limited to 11 days only on-site by initial transport and then personnel problems. The planned full complement of 4 site workers was only available for the last seven days of this reduced time.

A small unexpected bonus was achieved with the volunteer tagging of a second small group of nesting green turtles at Scott Reef mid December 1992.

Where problems did occur, as noted, these were largely due to resource limitations. Our efforts to attract additional external funding support were reasonably successful, but were not quite sufficient to cover the reduction as anticipated in operating funds received from usual sources. Shortage of funds also precluded any follow-up feeding ground work at the Montgomery Islands, although the Exmouth Gulf volunteer effort in this respect continued to be productive.

Despite the problems touched on above, we were able to tag nearly 2200 new turtles this past nesting season, and to intercept and retag some 237 remigrant turtles. These data are summarized in Table 1.

Between 400 and 500 nesting green turtles were beaching nightly at our Lacepede Islands site, approximately 30-40% of the seasonal peak numbers recorded here in the 1991/92 season. Remigrant turtles were found each night, comprising about 2-5% of the turtles onshore. These included turtles from each of the 1986/87, 198?/88, 1988/89, and 1989/90 tagged cohorts. For the first time, several green turtles making their second remigration were found.

The small nesting hawksbill population at Varanus Island also produced further substantial remigrant data. This population is considered ideal for more intensive study.

Increased effort at the Cape Thouin flatback rookery over the past few years is also now producing some more substantial data on short term remigration by this species.

Unfortunately, our work programs at most study sites to date have not been suited to determination of clutch frequency and total egg production of individual nesting female turtles within a nesting season, but this deficiency is being partially redressed by the increased effort at North West Cape and Muiron Islands in particular. However, some nesting turtles seem to be attending nesting beaches for periods up to three months on recent observation.

Much detailed work remains to be done at nesting beaches regarding production of young turtles. Project duration is also too short yet to provide good remigrant and survival data for most adult female groups.

We were partially successful in our efforts to obtain additional external funding support for the field work from a combination of direct donations and ecotourism, but this effort still did not cover the reduction in other funding. More reliable means of sustaining and expanding this work need to be secured.

ACKNOWLEDGEMENTS

Major support for this project is provided by the Western Australian Department of Conservation and Land Management and the Australian National Parks and Wildlife Service. Additional assistance is provided by West Australian Petroleum Pty. Ltd. for work at Barrow Island, and by Hadson Energy for work at Varanus Island. Volunteer conservation groups including CARE at Exmouth and the KRMB Naturalists group made donations to assist with work at North West Cape and the Muiron Islands during the 1992/93 season. Other assistance was also provided this season by ecotour groups lead by Coates Wildlife Tours; Rob and Jan Brandli are thanked for their cooperation. The beach work program would not be possible without the contributions made by the many volunteers involved each season. Help from my colleagues Andy Williams and Greg Oliver is gratefully acknowledged.

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Table 1. Summary of New Turtles Tagged (a), and Remigrants Observed (b), by Species and Location, 1992/93 Nesting Season.

LOCATION		G	F	H	L	TOTAL
		SPECIES				
Lacepede Islands	(a)	555*	4	-	-	559*
	(b)	149	5	-	-	154
Barrow Island	(a)	53	7	-	-	60
	(b)	2	-	-	-	2
Muiron Islands	(a)	126	1	2	246	375
	(b)	2	-	-	8	10
North West Cape	(a)	608	-	5	5	618
	(b)	4	-	-	2	6
Varanus Island (Lowendals)	(a)	-	6	38	-	44
	(b)	-	1	30	-	31
Rosemary Island (Dampier Archipelago)	(a)	30	54	223	2	309
	(b)	-	3	-	-	3
Cape Thouin (Mundabullangana)	(a)	-	111	-	-	111
	(b)	-	31	-	-	31
Scott Reef	(a)	30	-	-	-	30
	(b)	-	-	-	-	-
Exmouth Gulf@		70	-	3	12	85
TOTALS	(a)	1 472	183	271	265	2 191
	(b)	157	40	30	10	237

Species codes: G = Green, F = Flatback, H = Hawksbill, L = Loggerhead; * some data lost, @ Feeding ground captures only.

LES D'ENTRECASTEAUX ENFIN! REPORT OF AN EXPEDITION TO STUDY THE SEA TURTLES OF THE D'ENTRECASTEAUX REEFS, NORTH OF NEW CALEDONIA

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The name La Perouse crops up in odd places -- a suburb south of Sydney; the main graveyard in Port-of-Spain; a village in central Manitoba; the scientific name of a Micronesian megapode. But outside these eclectic memorials, the name of Jean-Francois de Galaup, comte de La Perouse, is little remembered today. But this was far from the situation two centuries ago, when the search for the vanished La Perouse caught the public imagination in a way comparable only to that for Dr. Livingstone eighty years later.

La Perouse, the living embodiment of French exploratory zeal, style, and aristocratic elan, had set out for the western Pacific on a voyage of exploration and empire-building, as France's response to Captain Cook's triumphant discovery of New Holland (now known as Australia) a few years earlier. His fleet included two ships, the Astrolabe and the Boussole, and he was known to have reached Botany Bay (where Sydney now stands), from which he departed on March 10 1788. These were the days before FAX, and no further word was anticipated until La Perouse's expected arrival in late 1788 on the far side of the Indian Ocean, in Mauritius. He did not arrive. Nor did he show up back home in France in 1789, as his planned itinerary had projected.

By 1791, the challenge to find La Perouse was taken up by another French aristocrat, Antoine-Raymond-Joseph de Bruni, Chevalier d'Entrecasteaux, who re-conditioned two ancient, creaky cargo ships, the *Truite* and the *Durance*, renaming them both generically (and euphemistically) as "Frigates," and specifically as *La Recherche* and *L'Esperance* -- i.e. "Search" and "Hope," names richly symbolic of the task in hand. On September 30, 1791, the little fleet set out with great hopes. As an indication of the public obsession in France with the mission to find La Perouse, it is recorded that, even on the very morning of his execution, Louis XVI had asked about the status of the search.

They reached the western Pacific early in 1792, and discovered much. Sailing northeast from Van Diemen's Land, they reached the island rich in *Araucaria* trees, south of New Caledonia, that had been named Isle of Pines by Captain Cook when he passed close by in 1774, but whose name was rendered in d'Entrecasteaux' log with the more Freudian spelling "Isle of Penes," perhaps in augury of the *Club Naturiste* that exists there today.

The fleet sailed up the west coast of New Caledonia, up to the islands of New Guinea, back through the Solomons, down to New Caledonia again, and then east to Tonga and New Zealand, discovering and naming islands after themselves all the way. In eastern New Guinea, the large islands now called Normanby, Ferguson, and Goodenough were named the Iles d'Entrecasteaux; the enormous reef system north of New Caledonia was named Recifs d'Entrecasteaux, and the four small islands in this reef (except for the first, called Isle Surprise because it was unexpected) were named Iles Huon, after Jean-Michel Huon de Kermadec, Captain of the "La Recherche." (Today, only the northernmost island bears the name Huon, the others having been re-named Fabre and LeLeixour). Rossel Island, the terminal member of the chain east of New Guinea, was named after Lieutenant Elizabeth de Rossel, and the nearby Trobriands were named after Lieutenant Jean Francois de Trobriand.

The northernmost and smallest of the Loyalty Islands was named after Beautemps-Beaupre, and only the expedition's abrupt change of course to a due easterly one prevented the expedition discovering the main Loyalty islands of Mare, Lifou, and Ouvea.

Shortly thereafter, the expedition sailed into chaos and disaster. Huon de Kermadec died at Balade, New Caledonia, in May 1793, and d'Entrecasteaux himself died at sea on July 20 of the same year. The expedition then fell into the hands of the fanatical young Royalist d'Hesmivy d'Auribeau, who, noting that the French Revolution had thrust the fatherland into what he considered alien hands, turned the expedition over to the protection of the Dutch in Java. The upshot was that France lost both ships and, in the course of a long and unhealthy stay in the Dutch East Indies, half the expedition's men, neither able-bodied seamen, nor officers, nor artists, nor scientists being spared the onslaught of fatal diseases.

And La Perouse was not found. It was not until 1826 that the Irish Captain Dillon noticed a scabbard bearing La Perouse's crest in the hands of a native in the Solomon Islands, and two years more were to pass before Dumont d'Urville found submerged remains of the *Boussole* and the *Astrolabe* near the island of Vanikoro.

The next event of note was the accidental 1854 visit of the American William Billings, master of the junk *Ningpo*, to the d'Entrecasteaux Reef. Billings, on a cargo journey from Hong Kong to Australia, found himself, victim of storms and erratic winds, shipwrecked on a reef about six miles east of Iles Leleixour and Fabre. Plans were proposed to raft to the Isle of Pines, but the crew refused, terrified by tales of cannibalism amongst the natives of both the mainland of New Caledonia and the Isle of Pines itself. Billings was forced to hunker down until rescue came. And it was sea turtles that saved him during those arduous months.

Billings wrote: "Every preparation was now made for a long sojourn on the island by keeping a vigilant look-out for turtle, which now began to come on shore in great numbers. Two large pens were built, and upwards of eighty, weighing on an average 5 cwt, were put into them."

"The pens being full they commenced drying the flesh of others to provide against the time they would desert these shores; which they do during the months of November and December, after depositing their eggs, and return as early as July, increasing daily from this period. They were so numerous in September that the Master turned twenty-seven one morning without wetting his feet, and he counted eighteen more asleep in about six inches water, which could have been captured without difficulty."

That Billings survived to publish his observations, which appeared in the Nautical Magazine and Naval Chronicle in March 1856, was the result of a courageous expedition by his Chief mate and a passenger, the pair incongruously named Mr. Tough and Mr. Dainty respectively, who improvised a sailing raft and managed to reach the coast of Australia. There they were severely beaten and stripped naked by aboriginals, but after several weeks they managed to crawl into Moreton Bay and ultimately reached Sydney, where the Colonial Government immediately dispatched a rescue ship, HMS *Torch*. The *Torch* reached Billings on October 26, 1854.

The intriguing allusion to great numbers of turtles was not followed up. Early in the 20th century there was extensive guano mining in the islands of the d'Entrecasteaux Reef by an Australian company named Austral Guano, but the written record of these operations is scant, although the profile of Ile Surprise shows major scars of guano mining to this day. In researching his 1962 book "The Green Turtle and Man," James Parsons found the Billings account, in Lt. Chimmo's 1856 paper, but summarized it in only a few lines, with the closing comment: "One wonders if they still haul up there today, and in what numbers."

Half-remembering this comment, and noticing the name "d'Entre- casteaux Islands" on a map while I was undertaking a sea turtle survey in Papua New Guinea in 1976, I committed significant resources both to aerial survey of the coasts of all three of these islands, and to extensive interviews with local inhabitants, but found little evidence of turtles in any numbers. It was only upon my return to Florida that I became aware of my having confused the d'Entrecasteaux Islands (part of Papua New Guinea) with the reefs of the same name that are part of New Caledonia.

In 1979, while attending a sea turtle conference at the South Pacific Commission in New Caledonia, George Balazs invited me to participate in an aerial survey of the entire New Caledonia coast, including the d'Entrecasteaux Islands, that was jointly funded by NMFS and the South Pacific Commission. We found only occasional tracks on the mainland beaches, but the islands, 125 years after Billings made his observations, showed evidence of major nesting -- abundant on the southern island of Surprise, and reaching saturation level on the other three. It was most exciting. We also saw numerous tracks on the beach on Beautemps-Beaupre, although this island was not in the same category as the d'Entrecasteaux reef islands, either geographically or turtle-wise.

Follow-up proved difficult. But after years of trying to mount an expedition, I undertook another aerial survey in February 1987. We failed to find any of the islands, and my fear of emulating Earhart (Amelia, not Lew) increased as the pilot, clearly not having a clue where he was, flew up, down, and around over the trackless Pacific for several hours without finding anything -- not even an atoll reefline, that could have guided us to an island.

Finally, however, we made it. In late 1991, with sponsorship from the Chelonia Institute and the PROE program and in partnership with the New Caledonia Nature Protection Society, I celebrated the 200th anniversary of the d'Entrecasteaux expedition by chartering a ship out of Noumea and visiting each of the four islands, in company with a team of young and enthusiastic French volunteers, a Melanesian chief, my wife Sibille, and a captain who knew how to navigate. On the way north, we visited the island of Belep, the last inhabited island and one where the French are still reluctant to go, the natives never having forgiven the colonizers for having forcibly evacuated their forebears for six years in 1892 in order to establish a leper colony. However, we were able to visit the island for a few hours, making it clear that I, for one, was not French; that we were celebrating d'Entrecasteaux' bicentenary rather than the leprosarium's centenary; and that we wanted to inter-view them about their annual turtle-hunting trips to Ile Surprise. Even so, events became threatening after a few hours, and we were forced to take refuge in a hidden bay on Ile Pott, to the north.

The reef islands turned out not only to have spectacular concentrations of sea birds, including frigates, red-tailed tropic birds, mutton birds, and boobies of three species, but also spectacular numbers of turtles -- all greens, *Chelonia mydas*. We counted 310 tracks on Ile Surprise, but only tagged 14 turtles there. On Huon, however, on December 11, we counted 1800 tracks, and tagged 149 turtles that night before the tags ran out, and found one turtle that had been tagged on Wistari Reef, Queensland, in 1985. We saw 572 tracks on Ile Fabre, 130 tracks and 80 nests on one small unnamed sandy cay nearby, and 150 tracks on another cay. A single night on Fabre and another night on Leleixour resulted in the tagging of 54 turtles in each case. The modal OC carapace length of all turtles was 105 cm, and the largest 122 cm.

Conditions were so dry that the turtles had difficulty nesting. The sand tended to flow back into the incomplete nest cavity, and we saw a great many aborted nesting attempts, with the turtle returning later that night (or the following night) for another attempt. On Isle Leleixour, many turtles were temporarily trapped by low tide after nesting, walking or resting in a long channel in the reef rock that paralleled the beach. But this groove contained enough water to prevent the turtles' overheating in the sun, and they were able to escape as the tide rose. On the other hand, several dead turtles were found on Isle Huon, some with no evidence of having been caught in obstructions. Perhaps not all died while nesting, in that one of the dead turtles was smaller than any nesting female we measured, and these islands were documented by Billings as having significant numbers of turtles basking near the water's edge in the daytime. Rene Grandperrin of ORSTOM de Noumea advises me that this still occurs on the long south beach of Huon.

HATCHLING MISORIENTATION ON AN URBAN BEACH (BOCA RATON, FLORIDA)

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Hatchlings on urban beaches are sometimes unable to locate the sea because they are attracted in other directions by anthropogenic light sources. Experiments carried out at a Boca Raton beach showed that such cases of misorientation were common. They occurred under two sets of conditions: when lights were turned on at various times of the night (temporal changes in lighting), and when other light sources, left on all night, illuminated some parts of the beach but left adjacent areas dark (spatial changes in lighting). Experiments carried out in the laboratory examined the response of hatchlings to "urban silhouettes". These mimicked the outline of high buildings, spaced apart, and set against an illuminated (city) background. These stimulus configurations were selected because such sites were usually preferred by females nesting at Boca Raton. Hatchlings, however, were unable to orient away from these silhouettes. Hatchling performance improved when a lower, solid silhouette (simulating a dune or low bushes) masked the spaces between buildings.

Our data suggest that both the presence of anthropogenic light sources, and of background silhouettes with many light gaps, contribute to the high incidence of hatchling misorientation at Boca Raton. To correct the problem, spaces between buildings must be masked by barriers (bushes, dunes, tall trees) which prevent light from reaching the beach. Our behavioral data, if widely applicable to other urban areas, suggest ways in which existing seaside communities can be modified so that they remain attractive, and productive, nesting sites for sea turtles.

SATELLITE TRACKING OF JUVENILE KEMP'S RIDLEY SEA TURTLES NEAR SABINE PASS, TEXAS

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Five juvenile Kemp's ridleys, ranging from 32 to 36 cm in straight carapace length and from 5 to 7 kg in weight, were fitted with satellite transmitters and released at Sabine Pass, TX. They were tracked in the Gulf of Mexico for periods up to 72 days in water depths ranging from 1 to 13 m. Preliminary data on their movements indicate that these turtles spent time in association with the Sabine jetties, nearshore coastal areas and Sabine Banks, 13 km offshore from the turtles' release site. Four of the five turtles remained in the Sabine area where they were captured. The fifth turtle, captured in Galveston, approximately 110 km to the south, returned to Galveston Bay in 10 days.

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RADIO AND SONIC TELEMETRIC MONITORING OF IMMATURE GREEN SEA TURTLES IN THE BRAZOS-SANTIAGO PASS AREA, SOUTH PADRE ISLAND, TEXAS

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A cooperative study between the National Marine Fisheries Service, Galveston and Texas A&M University, Galveston was conducted on movements (NMFS) and habitat characterization (TAMU) of green sea turtles at the Brazos-Santiago Pass jetties, South Padre Island, Texas, from 31 July to 26 September 1992. The NMFS portion of the study is discussed here. Nine turtles were fitted with sonic and backpack radio transmitters. Two of these were given trailing floats containing a time-depth recorder. A tenth turtle was given only a sonic transmitter. Releases were at point of capture. Monitoring from boat and land averaged 9-10 hours per day. Observation data were grouped into the categories dawn (05:00-09:00), day (09:00-17:00), dusk (17:00-21:00), and night (21:00-05:00) for analysis. Eight turtles remained near the jetty area throughout the study period. These turtles generally stayed within 10 m of the rocks. Total study period movements along jetties ranged from less than 370 m to over 1200 m. Core areas (areas containing $\geq$ 50% of observation time) ranged from 46 to 275 m and often varied by time of day. The channel was seldom used, with most use by the two largest turtles. Analysis of surface/submerged times indicate that dive intervals shorten during early morning and evening, and are longest at night. Results appear to demonstrate that these turtles have at least short-term range fidelity, have very little use of the channel, and are most active at dawn/dusk and least active at night.

COORDINATION OF THE LATIN AMERICAN TAG SYSTEM PROJECT (LTSP)

Carmen Roldán-Chacón
Nuria Bolaños-Vives
Any Chaves

Programa Tortugas Marinas, Universidád de Costa Rica, San José, Costa Rica

We wish to let everyone know of the activities that are carried out in our program, as well as our objectives. Moreover we would like anyone having an interest in tagging research in the Eastern Pacific to join us.

The Latin American Tag System Project is a result of the first Symposium on Eastern Pacific Sea Turtles held in Costa Rica in 1986. The main objective of this meeting was to coordinate sea turtle tagging activity in the Eastern Pacific. Due to non-permanent projects and various political reasons there has been a major loss of tagging information.

An example of this situation is the case of Honduras, where tags had the Honduras Wildlife Department return address. Nonetheless, whenever there was a change of personnel in that office, there was also a loss of interest to collect tag information, even though it was the same University researches that carried out the tagging project. The Wildlife Department received the information but did not send it to the University.

Thus by coordination and handling all the information in a single data base, we assure that data is always accessible to the researchers. We also provide economic support because tags are expensive. Many researchers have wanted to initiate tagging programs but have not been able to obtain funds to have their own tags made. Guatemala is an example of this last case. A Guatemala project had been unable to establish a tagging program, but when they learned in 1992 through a workshop that Costa Rica distributed tags, they joined the program immediately.

Our project is funded with World Wildlife Funds and tags are provided by the US Fish and Wildlife Service.

The basic objectives of the Program are:

1. Maintenance and updating of a tagging data base, containing information on tag returns and observations.

2. Inform researchers and pay rewards (T-Shirts).

3. Support the edition of the Marine Turtle Newsletter, spanish version.

4. Support and evaluate the Conservation and Sustainable Development Ostional Project.

5. Coordinate the University Community Work Project on Sea Turtles.

6. Advise conservation groups, students and national and foreign researchers.

7. Train young researchers through specialized courses. For example, during July 1991 and 1992, Tag System Project Personnel participated in a Latin American course.

8. Education to different population sectors related to sea turtle conservation and management. Coordinated visits with the Natural History Department of the Museum of Costa Rica, have been carried out to important nesting beaches. Brochures and articles have been written for radio and TV.

9. Small Document Center with relevant and current publications which is accessible to researches and the public.

Activities 8 and 9 have made many folks fond of sea turtles. Each year more and more people come for consultants or to serve as volunteers.

Since 1987, about 40,000 tags have been given. The tag return address is BIOL-UCR (Biology School-University of Costa Rica). Ten countries are integrated into our program. The current Data Base has about 25,000 tags included.

Table 1 displays the number of records or turtles by country and the number of beaches. The low reports for some projects may be due to the following factors:

1. The tags have not yet been used.

2. Researchers are late with their reports.

The data base includes all tags applied since 1985, with information such as:

a. Tag number(s)
b. Sex
c. Species
d. Date
e. Responsible person
f. Country and beach

Since March 1992, the data base have been corrected, updated and completed. The future plans of the LTSP are:

1. Continue the tag return database
2. Increase the number of projects.
3. Support, advise and assess turtle research
4. Obtain a PC computer with a 120 mb hard disk, 386 AT and a RAM memory of 4 mb

TABLE 1.

COUNTRY	# PROJECTS	RECORDS
Colombia	2	93
Costa Rica	19	8738
Ecuador	1	48
El Salvador	1	44
Guatemala	1	173
Honduras	1	-
México	14	13039
Nicaragua	1	1871
Panamá	10	520
TOTAL	50	24526

COMPARISON OF ORGANOCHLORINE CONTENTS IN ATLANTIC LOGGERHEADS (*Caretta caretta*) AND HAWAIIAN GREEN TURTLES (*Chelonia mydas*)

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Organochlorines are of concern because of evidence linking them to adverse biological effects, such as decreased reproduction and immunosuppression. Recently, researchers have become interested in a possible relationship between exposure to toxics and incidence of fibropapilloma tumors in green turtles. The pilot study described here was done in order to examine this possibility.

Samples of liver and subcutaneous fat were obtained from five Hawaiian green turtles, which had stranded at the locations shown (Fig.1). Three of these turtles had tumors which rated a score of 2 (scale 0 - 4), with the tumor scoring system used by NOAA in Hawaii. These turtles are denoted by triangles on the map. The remaining turtles, marked by circles, were free of tumors by external and internal exam. The tissues were frozen and shipped to VIMS in insulated boxes with blue ice. Upon thawing, each sample was chemically desiccated and extracted in a soxhlet apparatus for 48 hrs. using dichloromethane (DCM) as the solvent. The extracts were purified using gel permeation chromatography which removes large biological molecules and open column chromatography with Florisil to remove polar interferents. The final extracts were injected on a capillary gas chromatograph (GC) equipped with an electrolytic conductivity detector. Identifications were obtained by comparison of retention indexes to known standards and were confirmed by mass spectrometry using negative chemical ionization. The results were compared to those from a similar analysis of five loggerheads from the locations shown (Fig.2).

Regardless of tumor status, the levels of organochlorines detected in the tissues of the green turtles were low. Total PCBs ranged from below the quantitation limit (BQL) to 58.2 ppb in subcutaneous fat (BQL to 17.1 ppb in liver). DDE, the primary metabolite of the pesticide DDT, was found at concentrations from BQL to 22.5 ppb in the subcutaneous fat (BQL to 6.31 ppb in the liver). DDD, another degradation product of DDT, was found ranging from BQL to 9.62 ppb in subcutaneous fat (BQL to 0.94 ppb in liver). No parent DDT was detected in either tissue of any of these turtles. It should be noted the upper limit of these ranges are attributed to a turtle taken from Diamondhead. The values stated for this turtle may be overestimated, due to interference of biologic material which was not removed by the clean-up process. In contrast, total PCBs in the loggerheads ranged from 184 ppb to 1030 ppb in the subcutaneous fat (Fig.3) (29.3 ppb to 345 ppb in the liver). DDE was found in concentrations from 96.2 ppb to 408 ppb in subcutaneous fat (9.35 ppb to 34.6 ppb in the liver). DDD ranged from 2.39 to 18.3 ppb in subcutaneous fat (BQL to 0.92 ppb in liver). Parent DDT was found in the subcutaneous fat of one of the loggerheads at 4.31 ppb. The mean recoveries of spiked standards were 92.9% for the green turtles and 96.2% for the loggerheads.

Factors such as condition of the animal and exposure may affect the organochlorine content of an animal's tissues. Organochlorines are hydrophobic compounds which tend to partition into tissues with high percentages of lipid. The lipid contents of the tissues taken from the tumor afflicted green turtles were low, as determined gravimetrically from the DCM extracts and the more conventional method of Bligh and Dyer.

This is not believed to have greatly affected the analysis, however, as the tissues taken from non-afflicted green turtles had lipid levels comparable to the lipid levels found in the corresponding loggerhead turtle tissues (Table 1).

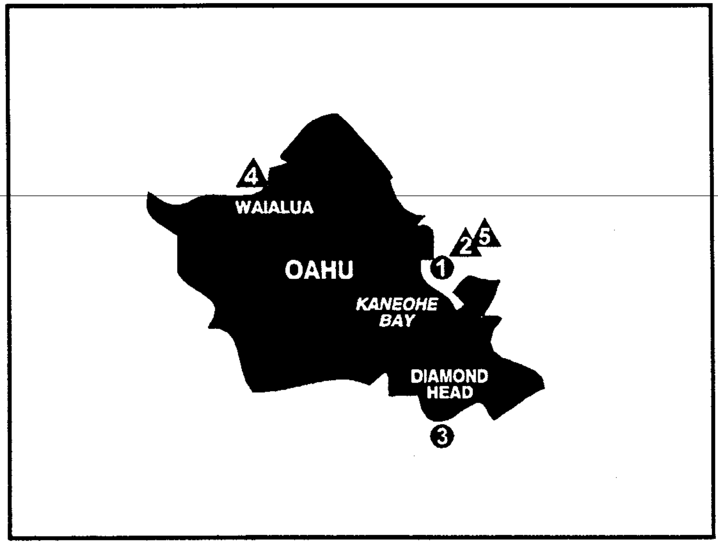
Table 1. Lipid Analysis

	Mean % Lipid (SD = standard deviation)	
	Liver	Subcutaneous Fat
Tumor (+) green turtles	3.57 (1.61)	9.70 (13.2)
Tumor (-) green turtles	9.95 (4.65)	64.6 (2.30)
Loggerhead turtles	6.76 (1.19)	40.6 (13.4)

Although the lipid contents of the tissues from the non-afflicted green turtles were similar to those of the loggerhead tissues, the organochlorine levels from the non-afflicted green turtles were still considerably lower.

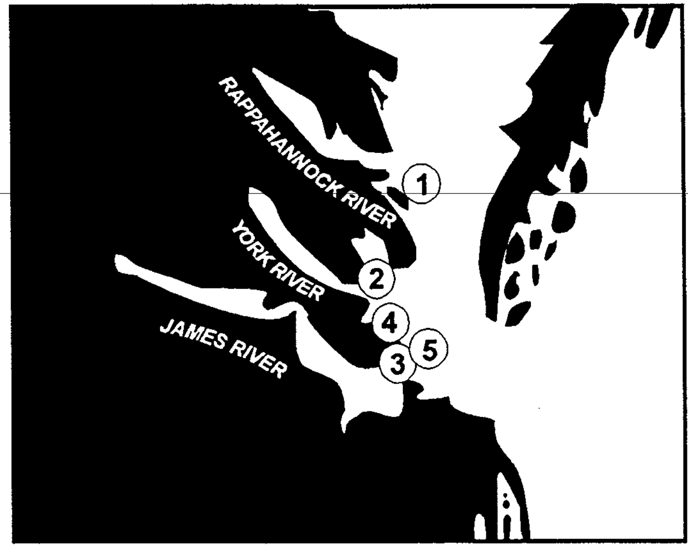
Because organochlorine pollutants have been shown to bioaccumulate via the food chain, the differing diets of the two species may be a major contributor to the different organochlorine levels observed in their tissues. The primarily herbivorous green turtles may have a lower incidence of exposure to organochlorine chemicals than the largely carnivorous loggerheads. Although the levels of organochlorine pollutants were slightly higher in the green turtles which were free of tumors, the overall organochlorine levels in the Hawaiian green turtles were low. The FDA limit for edible tissue burdens of PCBs is 2000 ppb and the highest concentrations seen in these turtles was two orders of magnitude lower. The small difference between tissue pollutant levels of tumor vs non-tumor afflicted turtles does not mean that organochlorines are not involved. Biological effects of organochlorines have been shown to be species dependent and controlled studies must be done to determine the effects of these and other toxicants on specific biologic systems before they are ruled out as contributing factors to fibropapilloma occurrence.

FIGURE 1
HAWAIIAN TURTLES



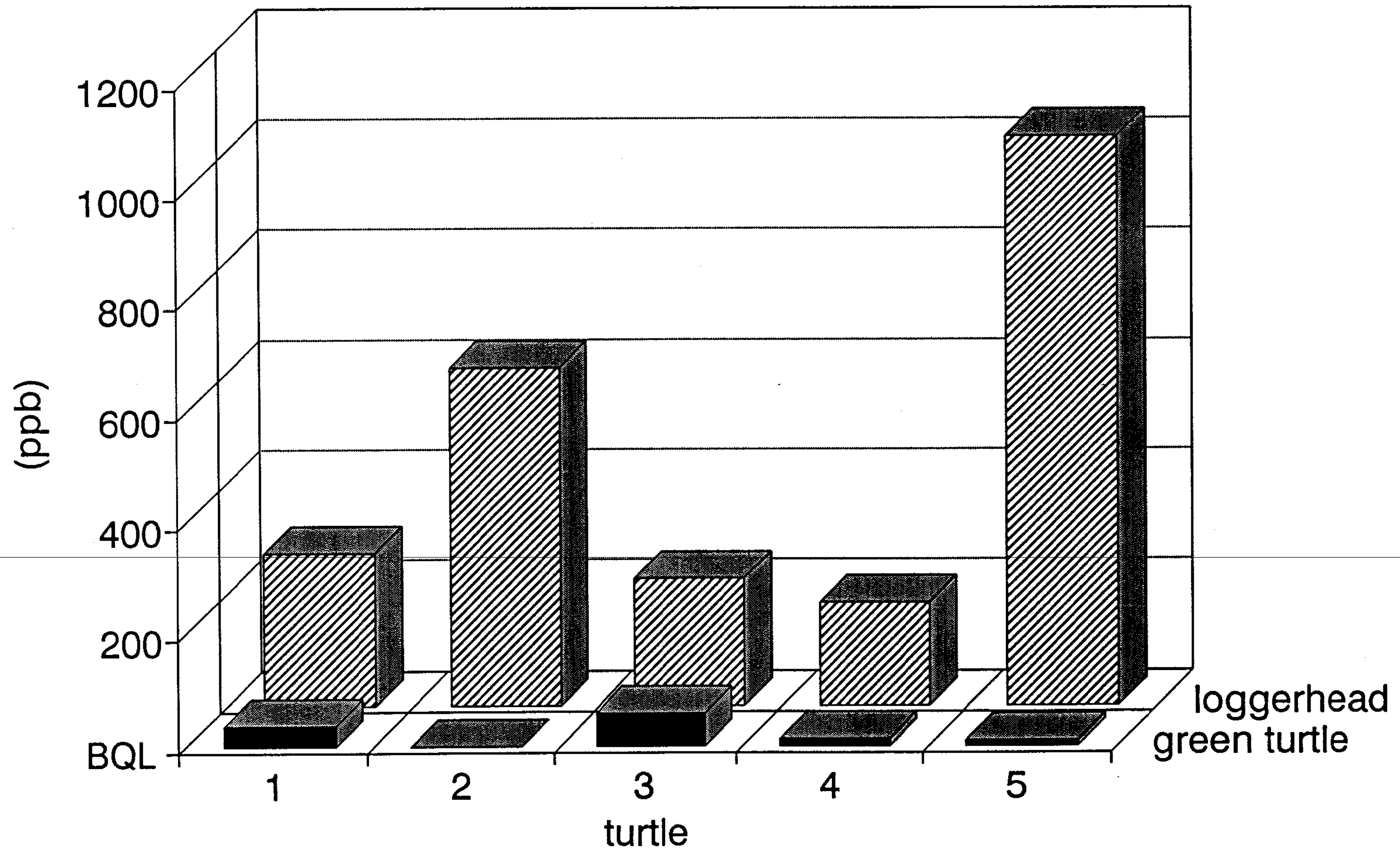
TURTLE	STRANDING DATE	LOCATION	STRAIGHT CARAPACE LENGTH NOTCH TO NOTCH (cm)	TUMOR SCORE (0-4)
1	9 APR 92	KANEOHE BAY	43.2	0
2	29 APR 92	KANEOHE BAY	50.7	2
3	6 MAY 92	DIAMOND HEAD	39.0	0
4	13 MAY 92	WAIALUA	85.6	2
5	18 MAY 92	KANEOHE BAY	63.8	2

FIGURE 2
ATLANTIC TURTLES



TURTLE	STRANDING DATE	LOCATION	STRAIGHT CARAPACE WIDTH NOTCH TO NOTCH (cm)
1	21 MAY 91	GWYNN'S ISLAND	57.8
2	21 MAY 91	BENA	57.7
3	22 MAY 91	FORT MONROE	56.8
4	19 MAY 91	SEAFORD	61.3
5	21 MAY 91	FORT MONROE	65.2

FIGURE 3
HAWAIIAN GREEN vs LOGGERHEAD TURTLES
Total PCBs (ppb) in Subcutaneous Fat



NESTING PATTERNS OF LOGGERHEAD SEA TURTLES ON AN URBAN BEACH (BOCA RATON, FLORIDA)

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We analyzed the distribution of nests on a 7.32 km section of Boca Raton's beach. Our goals were to determine: (1) if females nested more often in some areas than in others; (2) if patterns were consistent among nesting seasons (1989 - 1992); and (3) which environmental variables were most strongly correlated with regions of high nesting density. Females deposited most nests in the southern portion of the study site, an area dominated by high trees and condominiums. These density patterns were consistent among years. Nesting density was unrelated to beach depth; light levels toward land, out to sea, or measured from the beach sand; depth vs. distance bottom profiles; or the horizontal extent of objects (houses, condominiums, tree clusters) on land. Nest density was, however, strongly correlated with the elevation of objects behind the beach. Our data suggest that urban beaches can be attractive to nesting sea turtles if they contain tall buildings, high dunes or large trees located behind the beach.

SEX RATIO OF IMMATURE GREEN TURTLES IN AN EAST CENTRAL FLORIDA DEVELOPMENTAL HABITAT

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In December, 1989, a major hypothermic, or cold-stunning, event took place in east central Florida, primarily affecting the southern portion of Mosquito Lagoon and the northern reach of the Indian River Lagoon, a well known developmental habitat for the green turtle, *Chelonia mydas*. During a six day period encompassing the cold-stunning event, 246 green turtles were recovered from the region. Twenty-seven percent of the turtles were either dead or died shortly after recovery, those surviving the event were transferred to holding facilities, where they were maintained prior to release for six weeks until the risk of a second severe cold spell had passed. Based upon comparisons with previously documented cold-stunning events in this system and considering the severity of the 1989 freeze, we believe that virtually all of the green turtles inhabiting this portion of the system were affected. We use the term "population" herein as a reference to this group of individuals. Mean straight carapace length of the group was 52.3 cm with a range of 26.6 to 77.0 cm, fitting the characterization of this region as a developmental habitat. A detailed discussion of the cold-stunning event can be found in Schroeder *et al* (1990). The present paper reports on the results of a subsequent investigation into the sex ratio of this population of immature green turtles, recovered as a result of the cold-stunning event.

A number of researchers working with populations of immature marine turtles have been steadily adding information to our body of knowledge about sex ratios in the wild. Geographic areas where green turtle sex ratios are under intensive study include Hawaii, Australia, the Bahamas, Panama, Bermuda, and Florida. The elucidation of sex ratios has important theoretical and conservation implications. Wibbels *et al* (1991) present a thorough review of the importance of understanding sex ratios for populations of immature marine turtles. These include the evaluation of sex-specific behavior patterns, evaluation of manipulative management practices with egg clutches, investigation of sex-specific growth rates, and total adult population estimates based on counts of nesting females. As a result of our "windfall" of turtles resulting from the cold-stunning event, we felt we had an excellent opportunity, with a large sample size, to examine the sex ratio of a population of immature green turtles inhabiting an important developmental habitat. In this paper, we describe the two ways in which we attempted to sex individual turtles and the results of those techniques, and we compare our data to those reported in the literature for other populations of wild green turtles.

RESULTS AND DISCUSSION

We utilized two techniques to discern the sex of individuals. On one group, the 66 individuals that died during the cold-stun event we conducted necropsies. Carcasses were fresh at the time of necropsy and sex was assigned through direct gonadal examination using, as a general rule of thumb, the descriptions given in Rainey (1981). In addition to the gross examination, a sub-sample of gonads was removed and examined microscopically to validate the gross technique. In all cases, the microscopic examination agreed with the sex assigned during gross examination.

The second sexing technique we used, pioneered by Owens *et al* (1978), measured the level of circulating serum testosterone to predict the sex of turtles that survived the cold-stun event. Just prior to release, approximately six weeks into their captivity, blood samples were drawn from the dorsal cervical sinus, utilizing the widely practiced technique described by Owens and Ruiz (1980). Samples were centrifuged and serum was pipetted off and frozen until analysis. The radioimmunoassay technique used to determine testosterone titer in each serum sample followed the methodology developed and described in detail by Wibbels (1990).

Necropsy Results

Sixty-six of the 67 turtles that died during the cold-stun event were necropsied. Of these, 42 of the turtles were female and 24 were male, yielding a sex ratio of 1.75:1.0 (female:male). This ratio was significantly female biased ($P<.05$, chi-square=4.91). Techniques utilized in other studies investigating sex ratios of populations of immature green turtles in the wild include laparoscopy (direct examination of gonads using micro-surgical techniques) and/or evaluation of serum testosterone levels through radioimmunoassay. Among these studies, our results for the Northern Indian River Lagoon and those reported in 1989 for Heron Atoll, Australia (Wibbels pers. comm.) are significantly female biased. Sex ratios reported from an earlier Heron Atoll study (Limpus and Reed, 1985), the Southern Bahamas (Bolten *et al*, 1992), and Hawaii (Wibbels *et al*, 1993) were not significantly different from a 1:1 ratio. Studies of the immature loggerhead population along the Southeast U.S. coast have consistently yielded female biased sex ratios (Wibbels *et al*, 1987; Wibbels *et al*, 1991). To date, no consistent sex ratios have emerged for immature green turtle populations over a wide geographic area.

We further examined sex ratios within size classes of turtles to determine if the overall female bias was consistent throughout size classes (defined in 10 cm SCL intervals). Only the four size classes between 30 and 70cm yielded a sample size large enough to test for significant difference from an unbiased sex ratio. Of these four classes, only one, the 50-59.9 cm group was significantly different from 1:1 and was strongly female biased, ($P<.025$, chi-square=6.125). In comparison to other studies with immature wild green turtles, Limpus and Reed (1985) found no significant difference from a 1:1 sex ratio within size classes, while Bolten et al (1992) found a significantly female biased sex ratio within the same size class we identified as female biased, 50-59.9 cm. Other researchers have suggested that sex bias within size classes may reflect the effects of environmental sex determination on hatchling cohorts many years previous.

Radioimmunoassay Results

Blood samples were analyzed to derive testosterone titers for 130 of the 179 turtles that survived the cold-stun event. Serum testosterone titers ranged from 4.06 to 562.0 pg/ml and exhibited a high degree of variability. Previous studies that have verified the radioimmunoassay technique by examining gonads through laparoscopy, have consistently shown that females produce low levels of testosterone, males produce significantly higher levels, and that there is a zone of overlap where a small percentage of turtles of both sexes occur (a bi-modal distribution).

Figure 1 illustrates the distribution of testosterone titers resulting from this study, grouped into 10 pg/ml "classes". For immature green turtles at Heron Atoll, Australia, that were sexed by laparoscopy and for which testosterone titers were determined, there were few females above 10.0 pg/ml and few males below 20.0 pg/ml, only 4% of the sample fell into an undetermined sex zone (Wibbels pers. comm.). Two previously referenced studies, Bolten *et al* (1992) and Wibbels *et al* (1993), used radioimmunoassay only, without verification by laparoscopy, to predict sex by identifying the points on their distribution curve above which males are predicted and below which females are predicted. The undetermined range or overlap zone was different: 10-20 pg/ml for the Southern Bahamas and 30-40 pg/ml for Hawaii. Our results showed no obvious trend toward bi-modal distribution. It was impossible for us, using radioimmunoassay alone, to determine if, and where, a zone of overlap existed because of the absence of a bi-modal distribution. Without such a determination, reliable predictions of sex ratios cannot result. We were therefore unable to predict sex ratio from our radioimmunoassay results.

Based on the general range of reported values for known-sex individuals from other sampling localities, we believe that a large percentage of the turtles in the 20-40 pg/ml range are females and suggest, as one possibility, that normal serum testosterone production may have been altered as a result of thermal stress followed by a six week period of acclimation to much higher water temperatures. Average water temperatures in the month preceding the cold-stun event were in the 19-20°C range, the cold-stun event dropped water temperatures to a low of 4.4°C, and the holding facilities in which the animals resided were consistently at 25-26°C. Studies by Morris (pers. comm.) showed increased production of serum testosterone by immature male and female captive Kemp's ridleys held in warm water conditions and other researchers have noted that thermal factors in captivity may influence testosterone production. It is also possible that unknown effects of captivity, other than temperature, may have altered the normal production of testosterone for one or both sexes resulting in no clear separation of testosterone concentration values.

In light of the radioimmunoassay results derived from this study, we offer the following recommendations for future cold-stun events:

1. Efforts should be made to collect blood samples as close to "rescue" as possible from both live and comatose/dead individuals. (This would guarantee a sample of known sex animals, the necropsied group, for which serum testosterone titers could be calculated thereby helping to establish the male/female cutoff point.)

2. Blood sampling should be repeated during captivity to aid in our understanding of the effects of hypothermia and captive holding on serum androgen concentrations.

3. Verification of sex should be accomplished by laparoscopy for at least a sample of the live turtles across all size classes. This technique must be conducted by highly trained individuals under carefully controlled conditions.

We believe that radioimmunoassay is an important, virtually no-risk technique that can yield highly reliable results. However, we offer some cautions regarding radioimmunoassay as a result of what we learned from this study:

1. In at least some cases, such as that described herein, radioimmunoassay techniques must be validated to accurately assign the cutoff point(s) for prediction of sex ratios.

2. Validation is essential where no clear bi-modal distribution of testosterone titers results.

3. Validation may be especially important where thermal stress has occurred.

4. Validation may be important in the sampling of previously unstudied populations to determine if the application of cutoff points predicted for other populations is appropriate.

ACKNOWLEDGEMENTS

Many people contributed to this study. Janice Grumbles processed the blood samples and ran the assays. Funding to analyze the blood samples was provided by the National Marine Fisheries Service - Miami Laboratory. The UCF turtle group and the Archie Carr Center for Sea Turtle Research assisted with blood sampling and provided blood sampling equipment. Erik Martin, Jeannette Wyneken, and George Zug assisted with necropsies. The Merritt Island National Wildlife Refuge, Epcot's Living Seas, and Sea World of Florida were instrumental in the rescue, interim holding, and release of this large group of turtles.

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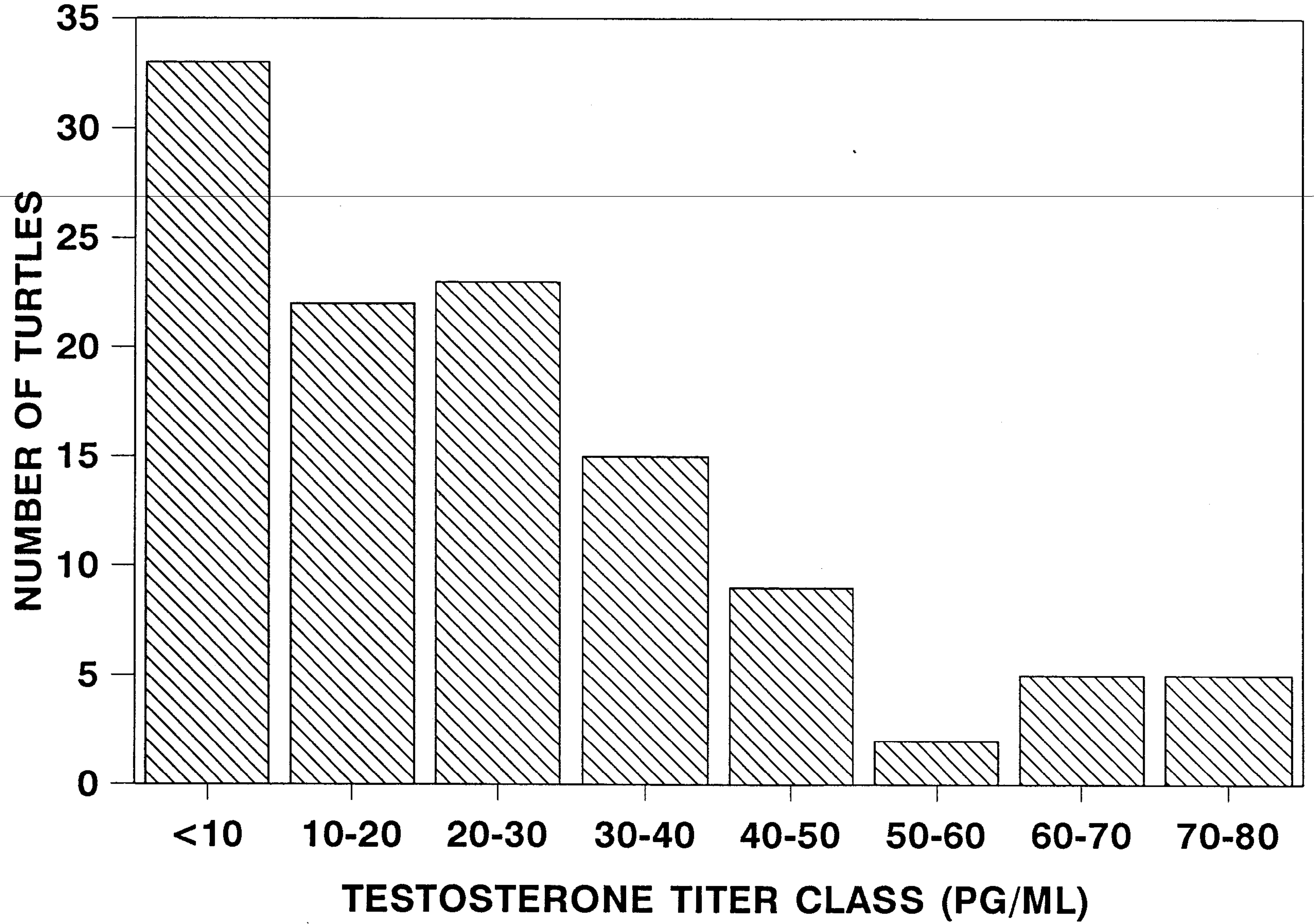

Figure 1. Testosterone titers of cold-stunned *Chelonia mydas* (N = 130) grouped into 10pg/ml classes. Fifteen individuals had titers above 80pg/ml and are not included in this histogram.

UNSCRAMBLING EGGS: A BIOCHEMICAL METHOD OF SPECIES IDENTIFICATION TO AID IN THE PROSECUTION OF MARINE TURTLE EGG POACHERS

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Egg lipids from loggerhead, green, leatherback and hawksbill turtles were examined to determine if fatty acid composition could be used as a means of species identification, primarily as a forensic tool to support enforcement of endangered species regulations. Distinct profiles were found for each of the species examined. Species identification, based on fatty acid composition, have been instrumental in successful prosecution of several egg poaching cased in South Carolina, Florida, and the US Virgin Islands. A computer database of fatty acid profiles has been established and currently contains compositions for 205 eggs, oils, depot fats, and muscle. These profiles include fatty acids biosynthesized by the animal as well as those from direct incorporation of dietary fatty acids. In addition to characterizing the animal, the profiles provide information on dietary components of the various species and feeding habits prior to nesting. Information is continually added as samples become available. Several cooperative projects have also been initiated with other marine turtle researchers to explore the potential of fatty acid compositions to indicate turtles' diets and the possibility that the females may be deficient of essential fatty acids at nesting time.

THE GENETIC STRUCTURE OF A LOCAL LOGGERHEAD SEA TURTLE POPULATION BASED ON mtDNA ANALYSES

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Management of sea turtle populations requires the determination of the geographic source of turtles. In instances involving illegal possessions, in cases of single or mass strandings, or in the collection of life history data, one of the most important components is the determination of the natal origin of juvenile and adult turtles. An analysis of the genetic information of loggerhead turtles suggests they follow natal homing behavior similar to green turtles. Therefore, nesting populations of loggerheads should be managed as "demographically independent units". If nesting females are depleted or reduced at a particular locale, the dispersal rate from other regions may not be sufficiently rapid to restock the original population over a timescale that can be meaningful and adequately controlled by wildlife management agencies. By analyzing mitochondrial DNA (mtdna) it is possible to look at migratory behavior and determine population structures of female loggerheads (Bowen et al. 1992).

In the southeastern United States, nesting areas for loggerhead turtles range from North Carolina southward into Florida. Breaks in nesting basically coincide with locations of major beach development and occur between New Smyrna Beach and Jacksonville Beach, Florida, the Grand Strand area on the north coast of South Carolina and along the Outer Banks of North Carolina. These interruptions in nesting sites create three distinct rookery areas that are hundreds of miles long.

It is critical for the management of the species to understand the structure of local sea turtle populations at any given feeding area and to identify any segregation between these areas. Do turtles from Eastern seaboard rookeries return to these locations once they leave their pelagic habitats? Do they migrate into the Caribbean to feed there? Do turtles from Floridian rookeries stay in the more tropical regions or do they travel northward to feed along the Georgia, South Carolina, North Carolina and Virginia coasts? Through tagging studies, Meylan (1982) and Meylan et al. (1983), showed that Florida-nesting loggerheads have a tendency to migrate to the Caribbean and the Bahamas. In contrast, Georgia-nesting loggerheads are only found along the eastern coast of the United States (Bell and Richardson 1978 and unpublished data). Even though it has been suggested through genetic information that loggerhead females engage in natal homing tendencies, environmental markers such as heavy metal concentrations in egg shells and epibiota on carapaces indicate that Florida and Georgia-South Carolina nesting populations tend to segregate on various feeding grounds (Bowen et al. 1992, Caine 1986 and Stoneburner et al. 1980). These three independent data sets (tagging returns, epibiota and heavy metal studies) serve to support feeding area segregation. Mitochondrial DNA provides a natural tag to address the issue of migrations without relying on metal or plastic tags or the duration of these artificially applied markings.

Genotypes of hatchlings from the Florida and Georgia/South Carolina rookeries were defined by Bowen et al. (1992) based on mtDNA restriction fragment length polymorphism (RFLP) profiles. A study was initiated on the local juvenile loggerhead sea turtle population in the Charleston Harbor Entrance Channel (CHEC). Blood samples were drawn and immediately processed on board a trawler; the serum was separated by centrifugation from the red blood cells, and the samples were frozen. Restriction endonucleases, found to be informative in distinguishing genotypes, were used to analyze the population of juvenile loggerheads in the CHEC.

Preliminary results indicate that fifteen of the thirty-three loggerheads (45.5%) tested from the CHEC exhibited the strictly Floridian haplotype. The remaining eighteen individuals (54.5%) showed a haplotype that is shared between the Georgia/South Carolina and Florida rookeries. Using the Roff-Bentzen test for heterogeneity, it was determined that the juvenile population in the CHEC was not identical to either rookery complex. The population must therefore be an assembly of juveniles recruited from natal beaches throughout the southeast. There appear to be substantial numbers of juveniles from Florida beaches migrating north into the waters off South Carolina.

Although there is evidence of mixing of both Georgia/South Carolina and Florida turtles in the CHEC, it appears that the mix is disproportionately composed of Georgia/South Carolina individuals. It is estimated that approximately 46% of the CHEC individuals originated in Florida. Since 90% of the nests on the East Coast are found in Florida and only 6.5% are found in South Carolina (NMFS 1991), it is clear that the CHEC population is not a uniform mix of individuals from all nesting grounds. This implies that Georgia/South Carolina turtles are more heavily represented in the CHEC population than might be expected from the relative abundance of nests in the respective regions.

It can be concluded from this study that there is a feeding ground integration in the Charleston Harbor Entrance Channel. Genetic studies using techniques such as mtDNA analysis provide a means to obtain a more complete view of the life history of sea turtles around the world.

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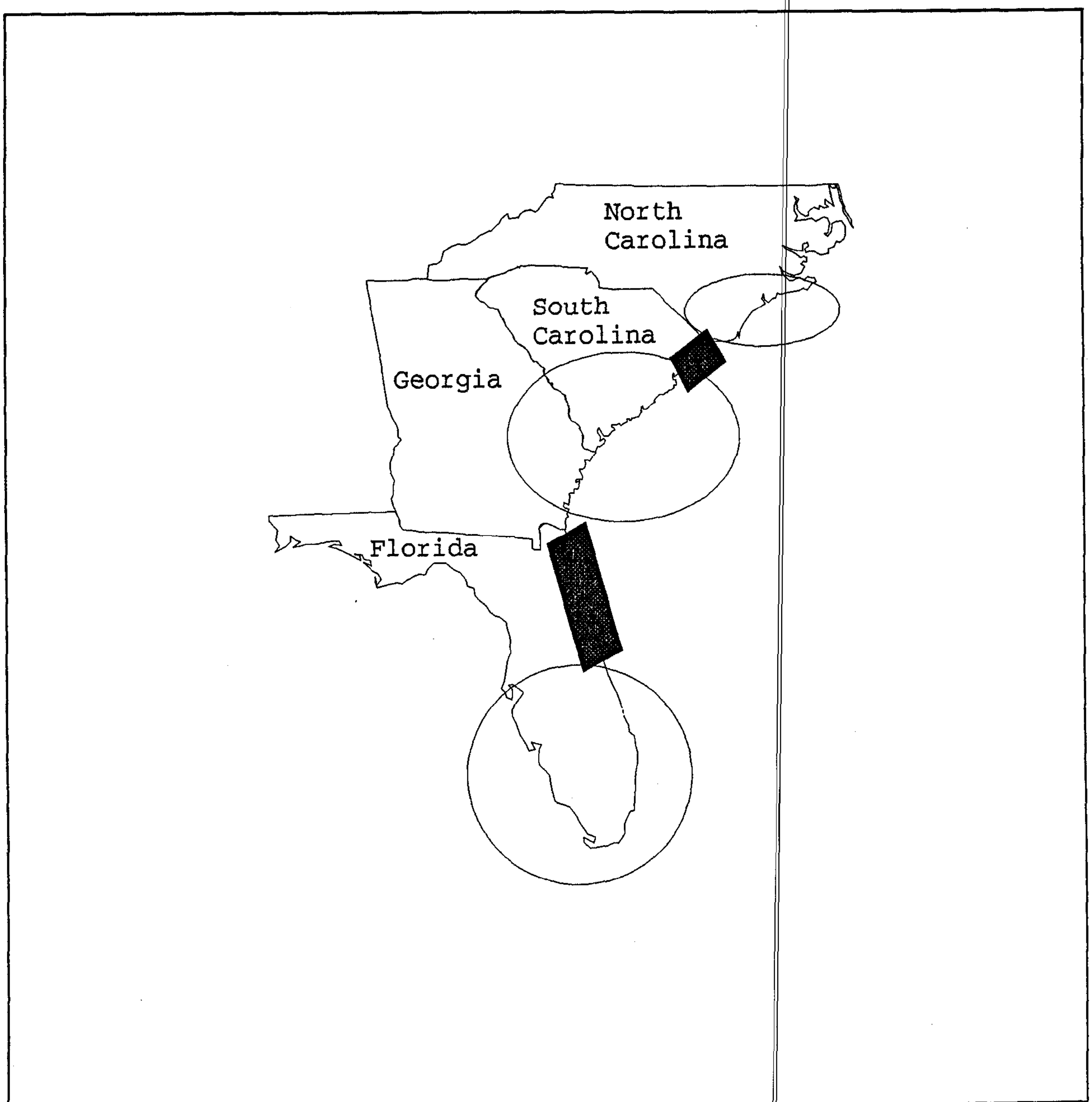

Figure 1. The three proposed loggerhead sea turtle genetic rookeries of the southeastern United States with the two areas of little or no nesting included in the shaded regions.

SEA TURTLE ABUNDANCE, SEASONALITY, AND GROWTH AT THE MANSFIELD CHANNEL, TEXAS

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Numerous historic accounts substantiate that large numbers of green sea turtles (*Chelonia mydas*) once occupied Texas bays. However, little is known about the numbers, species composition, seasonality, residency, size classes, and growth of sea turtles currently occupying Texas inshore waters. The present study was undertaken to gain information on sea turtles within waters surrounding the Mansfield Channel jetties and the Laguna Madre.

METHODS

The Mansfield Channel is one of only three water exchange passages to the hypersaline Laguna Madre estuary, located along the southern Texas coast. Shaver (1990) presented descriptions of the Mansfield Channel and Laguna Madre.

Sea turtles were captured using a tangle net (91.4 m long, 2.4 m deep, 25 cm stretch mesh) that was set at dawn and retrieved one hour prior to dusk or earlier if adverse conditions developed. The net was deployed at the Mansfield Channel jetties on one day per month, from June 1989 to December 1992, for a total of 435 hours. Additionally, nets were deployed at 20 locations within the Laguna Madre, north of the Mansfield Channel (Shaver, 1990), for a total of 289 hours from June 1989 through May 1990.

All turtles captured were identified to species, measured, weighed, tagged, and photographed (Shaver, 1990). Various environmental parameters were measured and recorded at 0900, 1200, and 1500 hours and at additional times when turtles were captured. Catch-per-unit-effort (CPUE) indices, expressed as the number of turtles caught per km-hour (Guseman and Ehrhart, 1990), were derived for each sample date.

The Sea Turtle Stranding and Salvage Network database was searched for records of turtles found stranded within Texas inshore waters from 1980-1992. Size and species composition comparisons were made between turtles netted and turtles found stranded within the Laguna Madre and connecting passes to the Gulf of Mexico.

RESULTS AND DISCUSSION

All turtles netted were juveniles. Only one green sea turtle was captured in the Laguna Madre during 289 hours of netting effort (0.0 turtles/km-hour) (Shaver, 1990). Due to the disparity of capture success within the Laguna Madre and Mansfield Channel, this individual was restricted from further analyses reported below. Shaver (1990) presented possible reasons for the low number of sea turtles captured within the Laguna Madre.

One hawksbill (*Eretmochelys imbricata*) and 72 green turtles were captured during 435 hours of netting (1.8 turtles/km-hour). The hawksbill was caught on 16 May 1991. It was smaller than all green turtles netted and measured 24.7 cm straight-line carapace length (SLCL).

Cumulatively, green turtles were caught at the Mansfield Channel during all months of the year except January (Fig. 1). However, more were captured when water temperatures, air temperatures, and water salinities were higher, typically during the summer. No turtles were caught when mean water temperatures were below 15.5 C. It is likely that they left the jetty area during that time and entered deeper and warmer waters.

Most green turtles were captured from 0600 to 1000 hours and 1400 to 1600 hours (Fig. 2). The bi-hourly distribution of capture data may be reflective of diel differences in activities and habits of turtles at the Mansfield Channel. The pattern of high catch in the early morning and mid-afternoon is consistent with periods of feeding documented for green turtles in the Bahamas by Bjorndal (1980) and in the Virgin Islands by Ogden et al. (1983). Both investigations noted that green turtles occupied resting places during mid-day breaks.

Forty-three of the 72 green turtles captured were different individuals. Twenty-five of the 43 were caught only once. However, 18 of the 43 *C. mydas* (42%) netted were subsequently recaptured from one to five times. The mean interval between the first and last capture of these 18 individuals was 4.0 months (range 1-17 months).

Initial capture SLCL of the green turtles ranged from 26.6 to 52.0 (mean = 34.2) cm. This mean is nearly identical to that found by Guseman and Ehrhart (1990) for green turtles caught along the Florida Atlantic coast. The mean SLCL growth rate calculated for the 13 recaptured turtles measuring 30-40 cm SLCL was 8.9 cm/year. This mean is nearly identical to that recorded by Bjorndal and Bolten (1988) for green turtles in the Bahamas.

Seventy-two turtles, including 66 green, five loggerhead (*Caretta caretta*), and one hawksbill were found stranded within the Laguna Madre and connecting passes to the Gulf of Mexico. The species composition of turtles netted was significantly different from the species composition of turtles stranded. The mean SLCL of netted *C. mydas*, 34.2 cm, was significantly smaller than the mean SLCL of stranded individuals, 45.7 cm. Also, the SLCL of the netted hawksbill, 24.7 cm, was slightly smaller than that of the stranded hawksbill, 28.0 cm. Thus, based upon species and size composition comparisons, turtles netted at the Mansfield Channel should not be used as a strict index to those occurring within the entire Laguna Madre area.

Differences in species and size compositions of the two groups may reflect differences in habitat utilization of the Mansfield Channel and the Laguna Madre. It is likely that transient and seasonally resident turtles utilize the Mansfield Channel for foraging and resting habitat. Green sea turtles may stop at the Mansfield Channel to access feeding pastures within the Laguna Madre, after they exit inshore feeding pastures, or prior to continuing travels within offshore waters. Based on relatively high recapture rates, it appears that many of the turtles that arrive at the Mansfield Channel in the spring and summer become seasonally resident and remain there for a few months. These individuals may use the area as an intermediate developmental habitat between the pelagic and lagoonal stages. However, turtles that enter the Laguna Madre may establish residency for longer periods of time and grow to a size larger than most found at the Mansfield Channel.

ACKNOWLEDGEMENTS

Gratitude must be extended to the National Park Service (NPS) for continued support of this project. Numerous NPS employees and volunteers assisted with activities. Appreciation must also be expressed to the U.S. Fish and Wildlife Service, including Richard Byles and Jack Woody, for partial support of the first two study years and to the Southwestern Parks and Monuments Association for partial support of the third study year.

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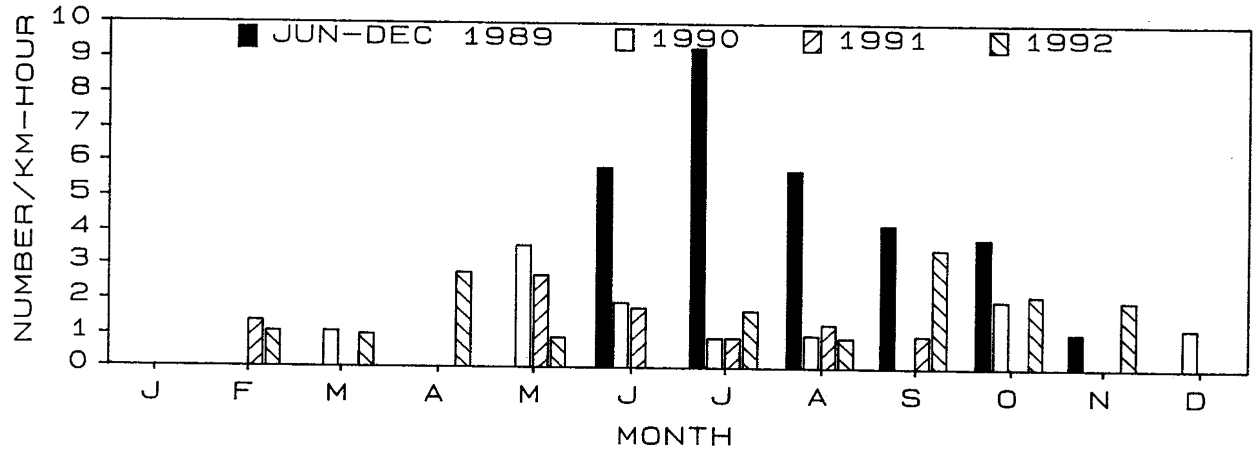

Fig. 1. Number of C. mydas caught per km-hour at the Mansfield Channel jetties from June 1989 through December 1992.

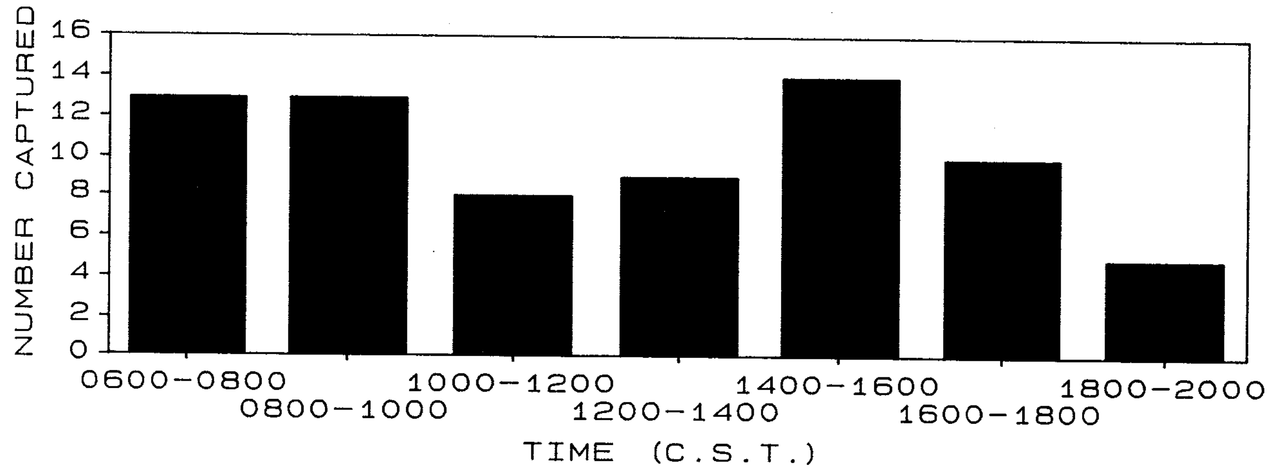

Fig. 2. Capture times of C. mydas netted at the Mansfield Channel jetties from June 1989 through December 1992.

THE EFFECT OF HURRICANE ANDREW ON A MONITORED *Caretta caretta* NESTING BEACH

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While the effects of hurricanes are generally spoken of in terms of lives lost and dollars of property damage, their effects on wildlife are less well quantified. However, these storms have the potential to alter whole communities, affecting everything from forest canopy structure to soil chemistry. Almost no information has been gathered on the effects of hurricanes on sea turtles and their habitats (Cely, 1991), despite the fact that hurricane season in the Caribbean and Northwest Atlantic (May 1 - November 1) overlaps almost exactly with sea turtle nesting seasons in the region. Hurricane Andrew, a force 4 hurricane which struck South Florida on August 24, 1993, provided an opportunity to examine such an impact on a monitored loggerhead (*Caretta caretta*) sea turtle nesting beach.

METHODS

Eight nests were relocated from Jupiter, Florida to Fisher Island, Miami, Florida, between Aug. 8 and Aug. 12, 1993 as part of an ongoing study on the renourished beach. Data on temperature, gas exchange, hatching success and hatchling fitness had been obtained in previous runs (1991 and 1992) and was used as baseline data for comparison of post-hurricane values. The 8 nests were dug up after 70 days to determine hatching success, and unhatched eggs opened to determine their stage at death.

RESULTS

Not surprisingly, Hurricane Andrew greatly increased mortality in the loggerhead nests. Hatching success in the nests averaged only 36.0% (silicate sand) and 23.5% (aragonite) after the storm, vs. 92% and 89.2% respectively, before the hurricane. Emergence success was only 14% (silica) and 18.7% (aragonite) vs. pre-hurricane emergence successes of 90.7% and 88.3% respectively.

Total mortality (unhatched eggs + dead hatchlings) was 86% and 81.3% in silica and aragonite sands, respectively, vs. 9.3% and 11.7% mortality in 1991. Of those eggs which didn't hatch after Hurricane Andrew (68.6% and 77.8%, silica vs. aragonite) the greatest number died early in incubation, (about 2 weeks), and thus appeared to be victims of the hurricane storm surge which covered the beach for 5-6 hrs. A much smaller number survived this initial flooding but died several weeks later, probably as a result of further flooding from torrential rains.

Hatchling mortality was greatest in nests at the rear of the hatchery, which were buried under an additional 1.5 ft of sand (2.3 ft total) after the storm, and thus most likely suffocated or died of exhaustion trying to escape the nest. Nests near the front of the hatchery, on the other hand, were eroded such that only 2-3" of the original 9" of sand covered the eggs after the storm.

CONCLUSIONS

Hurricanes clearly can cause massive and widespread mortality of sea turtle nests, both from drowning and from radically altered beach topography. Since hurricanes may strike wide areas of beach in the Caribbean and SE United States an average of once every 5 yrs, they are likely to play a major role in shaping sea turtle populations and ecology, and should be taken into account in any modelling of sea turtle populations.

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DAILY MONITORING OF SEA TURTLE NESTING AND NEST SUCCESS: AN EVALUATION OF SOME METHODS

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One of the problems associated with monitoring sea turtle nesting activity and nest success when surveys are made the morning following oviposition is the reliance on trained but inexperienced observers who must make decisions on whether a crawl has resulted in a nest. The ultimate goal of the monitoring is to approach reality in assessments.

As part of a larger monitoring program on Cumberland Island, Georgia, we utilized two methods of surveys, one nested within the other, to assess the quality of each method. At the onset, we recognized that each method had certain advantages for answering different questions, but this report deals primarily with the problem of differentiating false crawls from crawls resulting in oviposition. This study also has application to aerial nesting surveys where ground truth teams assess crawls without having seen the turtles on the beach the previous night.

METHODS

Since most investigators cannot visually assess crawls with 100% accuracy, some errors are expected. The two methods used herein were designed to assure that errors were one-sided, that is, only over-estimates or under-estimates. In Method A, any disturbance, thrown sand, interruption, or irregularity in a track was designated a nesting crawl. Therefore, all estimates of the number of actual nests would always be greater than reality. In Method B, suspected nest sites were hand-excavated to confirm the presence of eggs. To avoid damaging shallowly covered eggs in a nest, probing for soft sand was not used. If no eggs were found within five minutes, the crawl was called a false crawl; consequently, all estimates based on these data would be less than reality. Method A was used every day of the 87 day nesting season. Method B was utilized on three randomly chosen days during each week of the season, a total of 29 days, and was thereby nested within Method A. Only data from the 29 days were used for this report.

All putative nest sites of Method A were marked and monitored as were actual nests of Method B. Method B guaranteed that we were monitoring a set of actual nests which could be used for predation studies. All putative and actual nest sites were excavated after hatchling emergence or, if no emergence, at the end of the hatching season.

RESULTS AND DISCUSSION

The results of this study were expected to be clear-cut; they were not. September storms caused severe erosion of the beach and some putative nest sites were lost. Consequently, analyses of Method A took two forms in an effort to correct for the lost data.
We compared the two methods for data collected on the 29 randomly chosen days throughout the season. While 34 nests were found by Method B, 86 putative nests were recorded by Method A for the same 29 days. Of the 86, 13 were lost to storm erosion, 4 were deemed false crawls after excavation of the site at

the end of the season, and 69 were confirmed nests. Excluding the lost putative nests, the correct percentage for Method A was 94.5%: for Method B, 49.2%.

Exclusion of all data after 13 July, which would allow enough time for incubation and hatching prior to the September storm erosion, allows a comparison of methods with the storm bias removed. Unfortunately, we were unable to determine the fate of 8 putative nests because they were not excavated in time. Four of these 8 putative nests were regularly inundated by normal high tides and probably drowned if actual nests, and the four others were likely false crawls as they were recorded as questionable by the observer. If they were all actually false crawls, the percentage of correct designation was 82.9% (58/70) while at the same time for Method B the correct designation percentage was 46.6% (27/58).

Another bias was introduced when nests were depredated on the night of oviposition, because no decision was involved in determining whether the crawl had resulted in a nest. Excluding first-night depredation provides, perhaps, the best measure for comparing the accuracy of each method. Using this comparison, the differences are most divergent: 93.1 % accuracy for method A, 31.4 % for Method B. Excluding all data prior to 13 July changed the figures only slightly: 92.3 % for Method A, 35.4 % for Method B.

While both methods of "day after" surveys have bias, Method A, when using relatively inexperienced field personnel, more closely approaches reality and removes much of the subjective aspects of identifying nesting crawls. For Method B we have no measure of inter-observer variability in finding eggs, but we suspect such variability is great. If a uniform index method for assessing nesting activity is desired, Method A is superior to Method B, and greatly reduces the time required for the daily survey. The time aspect could be especially important for long stretches of nesting beach or zones of heavy nesting activity. Method B proved to be no better than flipping a coin to determine if a crawl had resulted in a nest.

ACKNOWLEDGMENTS

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DIVING BEHAVIOR AND VERTICAL DISTRIBUTION OF LOGGERHEADS, AND A PRELIMINARY ASSESSMENT OF TRAWLING EFFICIENCY FOR CENSUSING

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INTRODUCTION

Cape Canaveral is adjacent to one of the largest nesting grounds for loggerhead turtles in the U.S. Because of frequent dredging in the Cape Canaveral shipping channel to accommodate military and cruise ships harbored there, many loggerheads are killed. This research project entailed monitoring sea turtles' behavior in and around the channel during July and August 1992 to determine the best time in which to dredge to minimize impact on the sea turtle population. Additionally, we conducted preliminary tests on the effectiveness of trawling.

MATERIALS AND METHODS

Thirty-one turtles were captured by trawling, outfitted with both radio and sonic transmitters, and released back into the channel near the site of capture. Turtles were not monitored for the first 24 h after release to allow the animals to acclimate to capture and handling. Tracking was coordinated by radio among three research vessels (the trawler Mickey Anne, an inflatable boat, and a tracking boat) and a base station. The turtle tracking boat and base station both were equipped with a rotatable directional Yagi antenna. The base station also had a programmable scanner which constantly scanned for all turtle transmitter frequencies, allowing base personnel to direct the tracking boat to the closest available transmitter equipped turtle. Turtles were monitored individually for two hours within each of five time periods: Early A.M. (00:00-04:00), Late A.M. (08:00-12:00), Early P.M. (12:00-16:00), Mid P.M. (16:00-20:00) and Late P.M. (20:00-24:00). Temperature profiles, environmental data, and location of the turtle were also recorded during each monitoring period.

To determine the effectiveness of trawling as a method of capturing turtles off of the bottom, artificial targets (1 gal. milk jugs with 2 kg of sand and a sonic transmitter inside) were dropped to the bottom in 10 to 15 m of water. Personnel in the inflatable boat, using a directional hydrophone, positioned themselves directly above the target as the trawler aligned the nets and trawled over the target. Twenty-one such trials were performed, ten to test the effect of net configuration and eleven to test the influence of substrate on trawling. Three trials had the standard configuration used for turtle censusing, and seven trials used nets which had weights added to the lead line to assure that the net was dragging the bottom. Eight trials were conducted on hard substrate, and three trials were done on soft substrate to determine the effect of bottom type on trawling effectiveness.

At the conclusion of monitoring, each turtle was used to test the efficiency of pinpoint trawling on live animals. Instead of pin-point targets, the inflatable boat located the turtle and maintained a position directly above the animal as the trawler passed over the designated location. The monitoring boat also was stationed nearby to record the animal's behavior and its position in the water column as the trawler attempted its capture.

RESULTS AND DISCUSSION

There appeared to be two size classes occupying the channel during July and August 1992. The smaller group, comprised primarily of subadults had a mean SCL of 60.4 cm, and the larger group consisted of females, with a mean SCL of 90.4 cm. Of the 31 animals that were outfitted with telemetry units, 23 were still in the area after the 24 h waiting period. Of these, 21 were monitored for a 2 h time period; two were monitored twice. Forty-eight percent of these animals were found within 3 km of their release site, 20% were found between 3 and 10 km away from their release site, 13% were found greater than 10 km away, and 19% were never recontacted. Turtles appeared to spend very little time in the channel itself. During the subsequent sampling, none of the turtles were recaptured, which may indicate avoidance behavior.

In 22 of the 25 two-hour profiles, turtles dove to the bottom at least once. In over half of the profiles, turtles spent greater than 10 consecutive minutes at the bottom. Most turtles surfaced for greater than three minutes, and the longest surface duration was approximately nine minutes. These minimal surface times have important implications on estimating population sizes from aerial surveys.

Turtles spent 25.0 to 57.6% of their time in the bottom third of the water column, with the highest values observed during Late P.M. Four out of five turtles apparently remained stationary on the bottom during this time period for a minimum of 25 min. A noteworthy finding was that the turtles spent considerable time at mid-depths (Fig. 1). This value is increased, however, because turtles must move through this section as they surface and dive, thus adding to the total time spent at mid-depths. Turtles spent the least amount of time in the upper third of the water column. Hence, when dredging during the summer, it would be prudent to avoid dredging during the Late P.M. time period at Cape Canaveral.

Water temperatures ranged from 19.1°C to 30.7°C, with thermoclines occurring primarily between 6 m and 12 m depending on location. These observed thermal gradients may have influenced the turtles' movements within the water column. At least three turtles spent major portions of their time in mid-water just above the thermocline, where a slight dive would place them in water several degrees cooler. Other factors such as food availability and light intensity also may have influenced their position and behavior.

Trawling without extra weight on the lead lines of the nets resulted in missing the artificial targets two out of three times. The net with the extra weight retrieved the target in six out of the seven trials. When these trials were performed on soft substrates, the target was missed two out of three times. On hard bottom type, the target was missed only once out of eight trials.

When trawling live turtles, the heavier net vastly improved the effectiveness of trawling, capturing three times more turtles than the lighter net. In 13 separate trawls, the heavier net caught two or more turtles simultaneously, while the lighter net resulted in only one multiple capture.

During our pinpoint trawling study we were able to monitor the behavior of the turtle as it was passed over. Only one turtle was successfully caught using this method. The other three turtles used to evaluate pinpoint trawling exhibited what could only be described as avoidance behavior as the trawl net approached (Fig. 2). Trawling efficiency can be strongly influenced by turtle behavior. It remains to be seen whether such behavior is common among all turtles, or only those with recent interactions with trawlers. A long term study is needed to evaluate turtle/trawler interactions and its possible role as a means to mitigate or eliminate impacts of dredging on sea turtles.

ACKNOWLEDGEMENTS

We would like to thank the U.S. Army Corp of Engineers, especially Dave Nelson, for their support in every aspect of this project, and Chuck Dickerson and Dena Dickerson for their commitment to the study. The

State University Research Foundation especially Director Ken Cross supported our efforts and provided equipment vital to conducting this research. Jeffrey R. Schmid generously provided invaluable assistance in the field. Eddie Chadwick, Captain of the Mickey Anne, exhibited patience and enthusiasm throughout the project, sometimes under difficult environmental conditions.

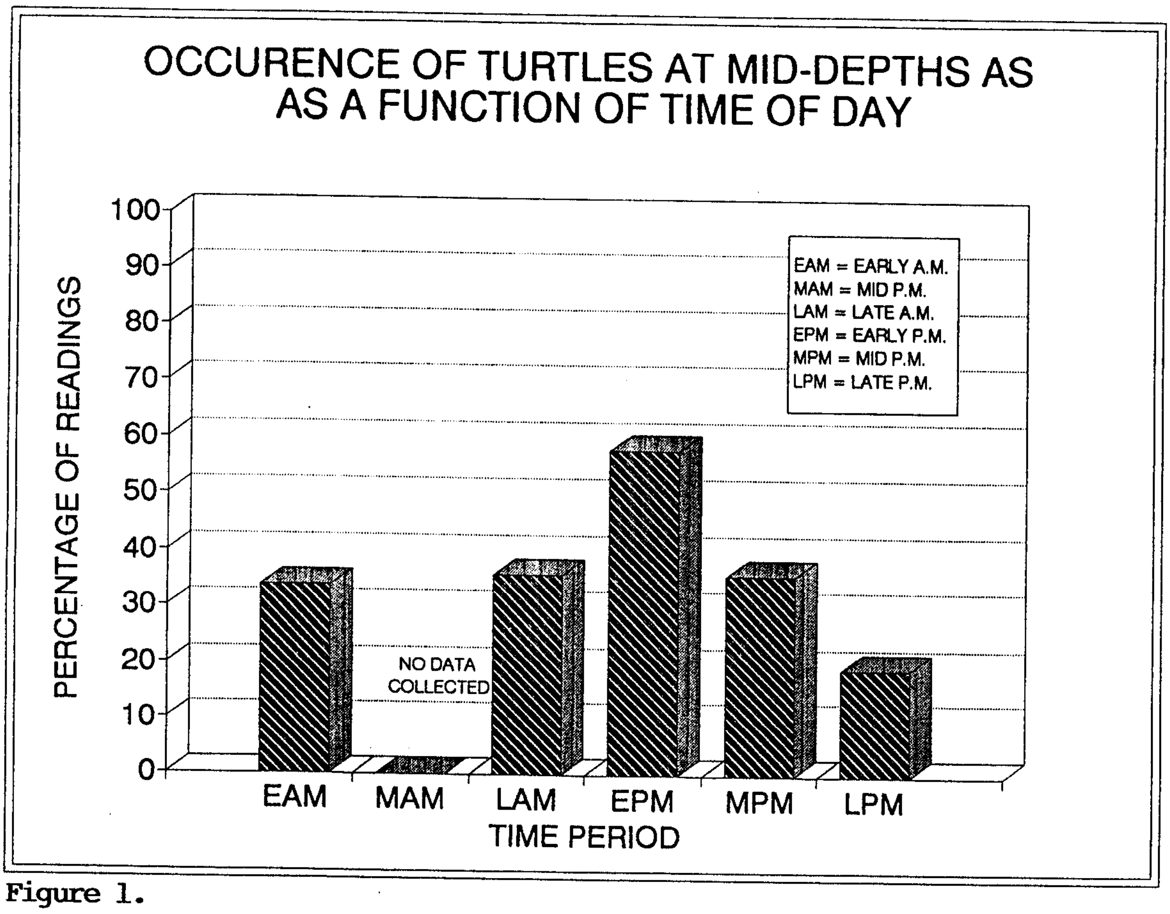

Figure 1.

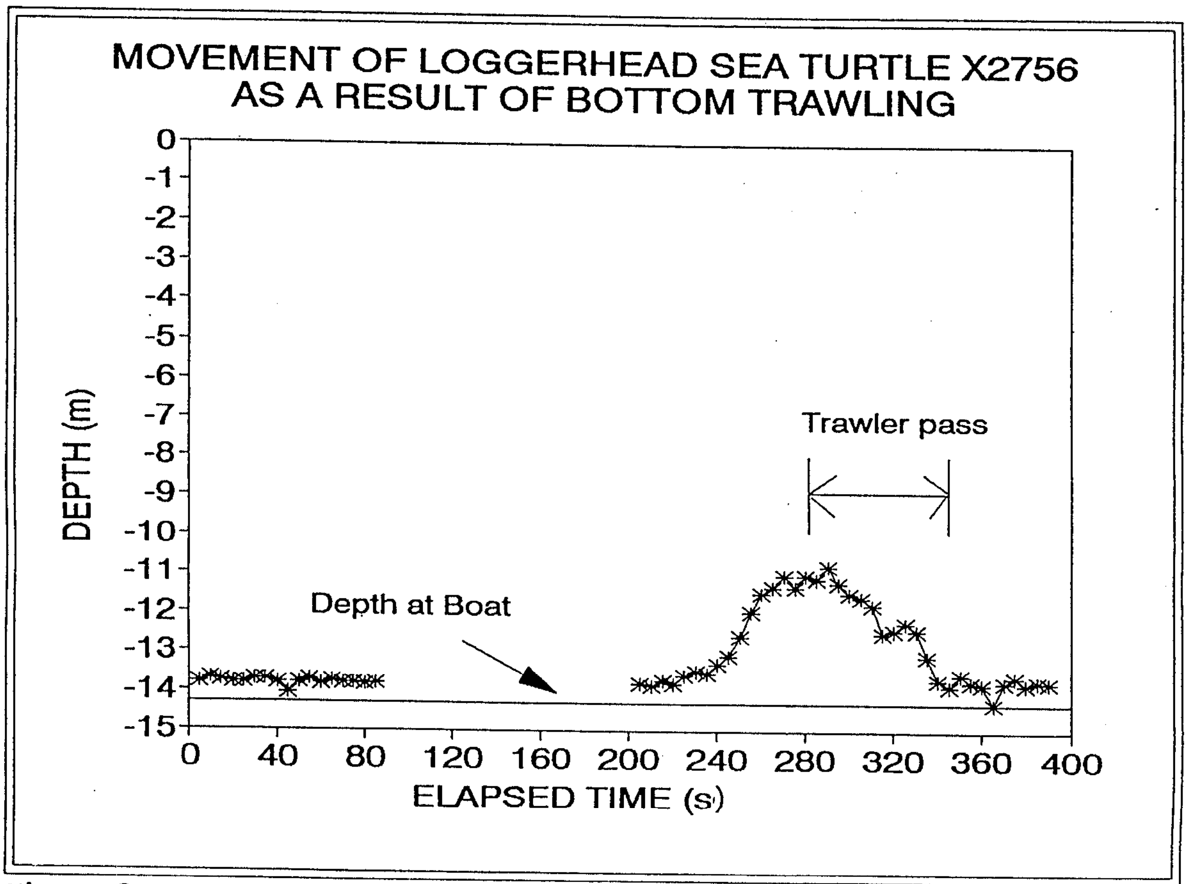

Figure 2.

INTERNATIONAL IMPLEMENTATION OF TEDS LAW PL 101-162 BY THE U.S. GOVERNMENT: FACT OR SCIENCE FICTION

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This paper is given in rebuttal to an earlier paper by Gibbons-Fly et al representing the U.S. Department of State and Commerce. You were just told by Gibbons-Fly what a great job the U.S. government is doing in transferring TED technology. Since the passage of PL 101-162 in 1989, seven countries have received training. At this rate it will take 40 years to reach the 80 plus countries who have commercial shrimp trawling vessels in waters shared with endangered sea turtles. Can the sea turtles survive forty more years of drownings in shrimp nets?

In 1989 Congress passed a law aimed at international conservation of sea turtles: PL 101-162. It is a one page, very short, simple law that has three basic provisions:

1. provide Congress with a list all nations that conduct commercial shrimp fishing operations which may adversely affect sea turtles;

2. initiate negotiations as soon as possible for the development of bilateral and multilateral agreements with other nations for the protection and conservation of sea turtles; and

3. prohibit by no later than May 1, 1991 the importation of shrimp from nations that do not adopt a comparable program for the protection of sea turtles from shrimp trawling.

A copy of this short law is provided so you can read it for yourself (Figure 1). It may be one of the few laws where one does not need to be a lawyer to understand it.

How many turtles are impacted by the international shrimp fleet? There is no data and no one knows for sure. If one assumes that the rate of capture of turtles per ton of shrimp for the combined international fleet is equal to the rate of capture for the U.S. fleet (before the use of TEDs), more than 155,000 turtles are caught each year.

In its limited wisdom, Congress gave all nations approximately 18 months from its passage in November 1989 to its implementation date of May 1991. In its extremely limited wisdom, Congress allowed the President to determine what agency would be responsible for implementation of this simple law. Our then "environmental President" George Bush chose that well known environmental agency the Department of State.

So what happened next? In consultation with the U.S. National Marine Fisheries Service the Department of State developed a list which identified more than 80 nations as having commercial shrimp fishing operations which would directly affect sea turtles. Unfortunately, the State Department was not interested in letting laws passed by Congress get in the way of its perceived more important diplomatic missions. It decided to enforce the law only selectively and issued regulations greatly reducing its effectiveness by:

1. Limiting its application to part of the fleet of the 14 nations of the Caribbean/Atlantic region by excluding the requirement for TEDs use from these countries Pacific shrimp fishery. It completely eliminated application of the law to 56 nations or 82 percent of all wild-caught shrimp which is imported into the United States.

2. extending the 18 month grace period Congress granted nations to come into compliance by moving the deadline for compliance three additional years in the future -- until May 1, 1994.

The result of these regulations was to send mixed and very confusing signals to those countries which import shrimp into the U.S. Caribbean nations wanted to know why they had to implement TEDs use if Asian nations were let "off the hook." Countries began to question how serious the U.S. Government was about enforcing this law. First they believed they had to come into compliance by May 1, 1991. Now it was May 1, 1994. Some countries must now believe if they wait until 1994, the law will again be changed to some unspecified date in the future.

Is Earth Island Institute's interpretation of this law that **it should apply** to all nations identified as having shrimp fishing operations that impact sea turtles "radical" or just plain wrong? Internal documents between the Department of State and Commerce demonstrate that U.S. National Oceanic Atmospheric Administration's general Counsel lawyers believe otherwise: "The Department of State has raised the question of whether the law could be applied only to a restricted population of sea turtles. The initial review by NOAA General Counsel, however, has not determined whether such a limited interpretation of the law's reference to "such species of sea turtles" could be justified legally. In addition there may be policy reasons to avoid such a narrow interpretation." (Emphasis added by author, Memorandum for John A. Knauss, Under Secretary for Oceans and Atmosphere; FROM James E. Douglas, Jr. Acting Assistant Administrator for Fisheries; January 25, 1990).

The Department of State itself admits in a required progress report to Congress (1990) that "Because four of the five species protected under this law are known to occur worldwide, this law, if given its broadest possible interpretation, could affect imports from more than 80 countries..."

I rhetorically ask: Are we talking about "interpretation" or are we talking about enforcing a law as it was clearly written?

Following meetings and discussions in which Earth Island Institute failed to convince the Department of State to issue regulations that would actually implement the law as it was clearly written, Earth Island Institute filed a lawsuit against the Department of State and Commerce in federal district court in San Francisco in February 1992.

Our positions are the following:

I. The law should be applied to all countries equally, not selectively enforced;

2. The three year extension beyond the 18 month grace period Congress granted nations to come into compliance is illegal. Although extensions may be needed for some countries that show a good faith effort to meet the deadlines, we believe many nations could easily meet this deadline because of the very small size of their fleet or because some countries had begun research into turtle excluder device (TED) technology many years before the legislation was passed; and

3. The U.S. should provide technical and economic assistance in the transfer of TED technology to other nations.

Mexico is an example. Documents from the Mexican Government's Fisheries Ministry state: "In 1983, in an effort to promote greater protection and conservation of sea turtles, Mexico began research to evaluate the incidental catch of these chelonians in commercial shrimp fishing operation in Mexican waters. Starting that year, research was launched on the use of devices that at the time were called 'bycatch excluders'. In 1984, under the supervision of the Instituto Nacional de la Pesca, the first experimental fishing tests began." (Comprehensive Program for Protection of Marine Turtles. Progress Report, Mexico's Department of Fisheries National Fisheries Institute, April, 1992; official translation U.S. Department of State).

If Mexico began research on TEDs 10 years ago, should they need an additional three year extension which will allow tens of thousands of more turtles to drown?

There have been criticisms of this law - among them the comment that the U.S. government should not dictate to other nations how they should protect their environment. I agree. I also know that the U.S. is the world's **largest consumer of** shrimp. We created the huge market that sustains the massive shrimp fleet that exists today. I believe we have an **ethical and moral** responsibility to ensure that the shrimp that enters the U.S. market is harvested with techniques that do not destroy the marine environment and threaten the survival of sea turtle populations.

Pl 101-162 does not dictate to other nations that they must use TEDs; it does require nations to adopt measures to protect sea turtles if they want to enjoy the privilege of selling their shrimp in the U.S. market.

Another criticism that has been leveled at this law concerns the fact that implementation of TEDs in the U.S. took ten years. How can we expect other nations to do it more quickly?

My answer is two-fold: (1) a large part of this time was research and development of TEDs. It is not necessary for every nation to spend the millions of dollars and waste another ten years to reinvent the wheel. It only takes a fishermen a couple of weeks to learn to use a TED and the cost ($50-$350/net) is inconsequential compared to the expenses of operating a $100,000+ vessel; and (2) the past decade of Reagan-Bush policies allowed U.S. shrimpers to postpone the inevitable, probably in violation of the Endangered Species Act. This is not something we should be proud of nor should we allow this failure to be used as an excuse to let another decade and another million turtles drown in the nets of the international shrimp fleet.

After speaking with ecologists and environmentalists from a number of countries regarding PL 101-162, some are concerned that the law puts too much emphasis on TEDs, which may not be the major problem facing sea turtles in their respective country. Again, I agree. TEDs are not an ultimate solution, they should only be seen as part of an integrated approach to sea turtle conservation and restoration. One does have to recognize the cumulative impact from the fleets of eighty nations though, even if any one country's contribution to the overall mortality is small. U.S. shrimp fishermen have often complained that their individual capture of turtles is only one or two per year. This may be true, but when you multiply this by the 16,000+ vessels in the U.S. fleet, you end up with significant mortality. The same can be said for the collective action of the fleets of many nations.

WHAT'S TO BE DONE?

Cooperation is better than coercion. The U.S. government was supposed to "initiate discussions as soon as possible" with other nations to implement treaties for the protection of sea turtles. The United Nations is the obvious forum for such agreements. Since the Department of State still has not developed a U.N. resolution encouraging TED use, Earth Island Institute has drafted such a resolution. If you can help encourage the appropriate officials in your respective country to introduce this resolution, please ask me for a copy.

If you live in the U.S., contact your Senator and Congressperson and ask for oversight hearings on the Department of State's implementation of PL 101-162 and ask for additional funds to assist in the transfer of TED technology to other nations. If you belong to an environmental organization, encourage them to join the fight to get TEDs implemented worldwide.
[For a complete copy of documents excerpted in this paper, contact the author.]

ACKNOWLEDGEMENTS

I would like to thank Deborah Sivas, Elisabeth Gunther and the firm of Heller, Ehrman, White and McAuliffe for their pro bono assistance with our law suit to ensure implementation of PL 101-162 and Kathy Nielsen, Christine Niven and Troy Peters for their assistance.

Figure 1: Copy of PL 101-162, Section 609

Sea turtles. Conservation. International agreements. Fish and fishir Maritime affairs. 16 USC 1537 note.

SEC. 609. (a) The Secretary of State, in consultation with the Secretary of Commerce, shall, with respect to those species of sea turtles the conservation of which is the subject of regulations promulgated by the Secretary of Commerce on June 29, 1987—

(1) initiate negotiations as soon as possible for the development of bilateral or multilateral agreements with other nations for the protection and conservation of such species of sea turtles;

(2) initiate negotiations as soon as possible with all foreign governments which are engaged in, or which have persons or companies engaged in, commercial fishing operations which, as determined by the Secretary of Commerce, may affect adversely such species of sea turtles, for the purpose of entering into bilateral and multilateral treaties with such countries to protect such species of sea turtles;

(3) encourage such other agreements to promote the purposes of this section with other nations for the protection of specific ocean and land regions which are of special significance to the health and stability of such species of sea turtles;

(4) initiate the amendment of any existing international treaty for the protection and conservation of such species of sea turtles to which the United States is a party in order to make such treaty consistent with the purposes and policies of this section; and

(5) provide to the Congress by not later than one year after the date of enactment of this section—

(A) a list of each nation which conducts commercial shrimp fishing operations within the geographic range of distribution of such sea turtles;

(B) a list of each nation which conducts commercial shrimp fishing operations which may affect adversely such species of sea turtles; and

Reports.

(C) a full report on—

(i) the results of his efforts under this section; and

(ii) the status of measures taken by each nation listed pursuant to paragraph (A) or (B) to protect and conserve such sea turtles.

Imports.

(b)(1) IN GENERAL.—The importation of shrimp or products from shrimp which have been harvested with commercial fishing technology which may affect adversely such species of sea turtles shall be prohibited not later than May 1, 1991, except as provided in paragraph (2).

President of U.S.

(2) CERTIFICATION PROCEDURE.—The ban on importation of shrimp or products from shrimp pursuant to paragraph (1) shall not apply if the President shall determine and certify to the Congress not later than May 1, 1991, and annually thereafter that—

(A) the government of the harvesting nation has provided documentary evidence of the adoption of a regulatory program governing the incidental taking of such sea turtles in the course of such harvesting that is comparable to that of the United States; and

(B) the average rate of that incidental taking by the vessels of the harvesting nation is comparable to the average rate of incidental taking of sea turtles by United States vessels in the course of such harvesting; or

(C) the particular fishing environment of the harvesting nation does not pose a threat of the incidental taking of such sea turtles in the course of such harvesting.

COMPARISONS OF IN SITU AND RELOCATED LOGGERHEAD SEA TURTLE (*Caretta caretta*) NESTS AT PROJETO TAMAR, BAHIA, BRAZIL

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I conducted a comparative study of nine *in situ* and 16 hatchery-incubated nests of the loggerhead sea turtle (*Caretta caretta*) in Praia do Forte, Bahia, Brazil. Daily nest temperatures, incubation duration, hatching success, development stage attained by unsuccessfully hatched eggs, and hatchling mass were analyzed for possible differences between natural and hatchery-incubated nests. Sand samples were analyzed to determine possible differences in water potential and moisture capacity. Results indicate significantly warmer nest and sand temperatures in the hatchery than in the *in situ* site throughout the majority of incubation. Analyses of sand texture from samples of *in situ* and hatchery nest environments show no differences between sites, indicating similar water potential and moisture capacities for both incubation environments. Effects of increased temperatures, such as offspring sex ratio, are discussed.

No statistically significant differences were found for incubation duration, hatching success, and hatchling mass between nest sites. Among those eggs that failed to emerge, however, significantly more pipped hatchlings were found in relocated nests than in *in situ* nests. There was a marginally significantly higher percentage of embryos that died in the early stage of development from *in situ* nests than in the hatchery. No other comparative tests of hatching results for the two nests sites were statistically significant.

The present study is the first documentation of incubation conditions and hatching results for any sea turtle population nesting in Brazil, one of the world's most active loggerhead rookeries. Relocation of threatened sea turtle eggs to protected open-air hatcheries has been a common conservation technique employed by Projeto Tamar for the past decade. Results from this study indicate that hatching results in an artificial incubation environment can be highly similar to natural nest sites when effort is taken to best approximate natural nesting conditions.

CORTICOSTEROIDS DURING NESTING IN THE OLIVE RIDLEY (*Lepidochelys olivacea*) SEA TURTLE AT PLAYA NANCITE, COSTA RICA

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The olive ridley sea turtle (*L. olivacea*) is known to nest not only in a solitary fashion but also in large, synchronous aggregations. This phenomenon has been termed *arribada* (the word in Spanish for arrival). For the last three years our laboratory has been involved in the study of several aspects of this phenomenon at Playa Nancite, Costa Rica. The aim of the project is to identify the most relevant factors that could be responsible for the control of the occurrence of the phenomenon. The endocrine mechanisms underlying such behavior are of particular interest. During an *arribada* at La Escobilla, Mexico, Schwantes (1986) determined that corticosterone (B) levels in nesting females were significantly lower than those of stressed females at the time of slaughter. B is a steroid hormone which has been used as an indicator of the physiological stress that an animal may experience. This hormone is the end product of the hypothalamo-pituitary-adrenal (HPA) axis. From the work of Schwantes it was concluded that the HPA axis in *arribada* nesting females may be inhibited. This conclusion assumed that the nesting process is actually stressful to the animals. Parallel to that study, Figler et al. (1989) measured the circulating levels of arginine vasotocin (AVT) on the same turtles and determined that this hormone undergoes an increase at the time of egg laying. This increase has been related to the stimulation of contractile movements of the oviduct which are responsible for the expulsion of the eggs from the animal into the nest. Because AVT is known to activate the HPA axis in many vertebrate species, this finding, along with Schwantes' results, supports the idea of a neural/endocrine inhibition of the axis. Accordingly, we carried out a series of experiments to determine whether B levels were reduced in *arribada* nesting females. In addition, we wanted to determine if there was an inhibition of the HPA axis in these animals.

METHODS

For these studies, we captured olive ridley females while basking in the water at different times of the day (0600, 1200, 1600, 2400 hrs.; n=10 for each time). Also, 10 females were captured on the beach immediately after nesting during an *arribada* event. All the animals were bled upon capture. Additionally, to determine whether the HPA axis could be stimulated in *arribada* nesters, 10 *arribada* and 10 solitary nesters, along with 10 females and 10 males captured in the water, were each turned over onto their carapaces and maintained in this position for 6 hrs. Serial blood samples were taken at the following times 0, 20, 40 and 60 min., and 2, 4, and 6 hrs. Plasma separated from samples was stored in liquid nitrogen for radioimmunoassay for B.

RESULTS AND DISCUSSION

The first part of the study demonstrated that basal B levels in nesting *arribada* females were significantly elevated as compared with those of females captured in the water at the same time, or captured in the water at any other time of the day. Therefore, we conclude that the HPA axis is functional and activated at the time of nesting. In the second part of the study we found that, for all groups of animals tested, mean B levels were increased significantly as animals remained on their carapaces. In spite of this trend for increase in mean B levels, this hormone did not increase significantly in every female turtle, i.e some of the turtles in each group showed no increase in B levels during the experiment. This was true for all groups tested, except for the males, in which all animals showed increased B levels during the 6 hrs period. This suggests that the non-responsiveness observed in some of the females is not restricted to the nesting process and that it is gender specific. From these results, we propose that a physiological inhibition of the HPA axis takes place in some of the olive ridley females found at Nancite. This inhibition may be particularly important in determining whether some females will successfully participate in an *arribada*, a phenomenon where a high degree of physical contact is a normal feature of the high density, synchronous nesting phenomenon.

ACKNOWLEDGMENTS

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SPONGIVORY IN CARIBBEAN HAWKSBILL TURTLES, *Eretmochelys imbricata*: DATA FROM STRANDED SPECIMENS

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INTRODUCTION

On a global basis, the hawksbill turtle *Eretmochelys imbricata* appears to feed on a wide variety of benthic and floating taxa including ascidians, terrestrial and marine plant matter, marine algae, sponges and coelenterates among others (Witzell, 1983). On the other hand, the diet of hawksbill turtles within the shallow coastal waters of Panama, Lesser Antilles and Hispaniola appears to feed quite specifically on marine sponges (Meylan, 1984, 1988). There is very little information on the feeding habits of hawksbill turtles on the Puerto Rican shelf (Vicente and Carballeira, 1992). This study provides information on the gut contents of 11 stranded specimens of *E. imbricata* found within the coastal waters of Puerto Rico and of the U.S. Virgin Islands.

METHODS

The gut contents of 11 hawksbill turtles were retrieved. The ingesta was then sieved through a 3mm mesh and rinsed with fresh water. The contents were then preserved, sorted and then identified to the lowest taxonomic level possible. Histological sections and spicule preparations were done when necessary. The similarity matrix shown in Table 2 was constructed using the following formula:

$$SI = \frac{C}{\sqrt{A \times B}}$$

where SI = Similarity Index; C = the number of sponge species (within the gut) found in common; A = the number of species in specimen A; and, B = the number of species in specimen B.

RESULTS AND DISCUSSION

Plant fragments and invertebrates other than sponges were infrequently found in the guts of the specimens analyzed. On the other hand, demosponges constituted the bulk of the ingesta (see Table 1). The chicken liver sponge *Chondrilla nucula* was found in considerable amounts in eight of the eleven specimens. *Chondrosia collectrix* and *Geodia* spp. were also found to be important components in the diet of the hawksbill turtle.

A preliminary analysis of the similarity matrix shown in Table 2 suggests that there is very little if any relationship between body size, locality and food preferences of hawksbill turtles. For example, specimen 3 and 4 (SI = 1) were obtained from the same locality (SE coast of P.R.) but were different in size (one was an adult (73.5 x 56.5 cm) and the other was a juvenile (20.3 x 14.0 cm). Specimens 3 and 6 consist of one adult and one juvenile obtained from two different localities. Both were feeding on the same prey (*Chondrilla nucula*). Specimens 4 and 6 were both juveniles of equal carapace dimensions (20 x 14 cm) but from two different localities (one from the SE and the other from the NE coast of Puerto Rico). Both were exclusively grazing on *C. nucula*.

This study suggests that hawksbill populations within the U.S. Caribbean have similar feeding habits as those populations found elsewhere within the West Indian Region (Meylan, 1988). The Caribbean populations of *E. imbricata* are almost exclusively spongivores showing a strong preference for the choristid demosponge *Chondrilla nucula*. There appears to be very little if any relationship between body size, location and feeding habits in this species.

C. nucula is a coral reef associated sponge. Coral reef monitoring studies in the Caribbean have demonstrated an increase in algal biomass. This increase in algal cover has caused a significant decline in the populations of *C. nucula* (Vicente, 1987). A decline in this important prey item could represent another obstacle in the recovery of hawksbill populations within the Caribbean region.

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Table 1. Percent composition of demosponges within the digestive tracts of *E. imbricata* (n = 11).

Specimens

Species	1	2	3	4	5	6	7	8	9	10	11
Agelas sp.		+									
Aplysina fistularis					+						
Chondrilla nucula			95	100	10	100		1	69	45	52
Chondrosia collectrix					+		94	98	30		44
Cynachira alloclada					22						
Darwinell-idae					+						
Geodia spp		90						2	+	22	2
Hadromeri-dae		+									
Myriastra					66						
Tethya crypta					2						+
Tethya actinia							6			27	
Niphates									+		
Haploscler idae									+		

Table 2. Similarity among 11 stranded hawksbill turtles (*Eretmochelys imbricata*) based on their food habits.

Sp.	1	2	3	4	5	6	7	8	9	10	11
1	1.0	0	0	0	0	0	0	0	0	0	0
2		1.0	0	0	0	0	0	.33	.26	.33	.29
3			1.0	1.0	.38	1.0	0	.58	.45	.58	.50
4				1.0	.38	1.0	0	.58	.45	.58	.50
5					1.0	.38	.27	.22	.17	.22	.38
6						1.0	0	.58	.45	.58	.50
7							1.0	.41	.32	.42	.71
8								1.0	.78	.67	.87
9									1.0	.52	.67
10										1.0	.87
11											1.0

MEDICAL CARE OF STRANDED SEA TURTLES AT SEA WORLD OF FLORIDA

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Oceanaria and private sea turtle rescue groups in Florida are organized into a sea turtle rescue network which recovers and cares for stranded turtles. Over a 7 year period Sea World of Florida has cared for over 265 sea turtles. While exact causes of strandings were not always determined, they included seasonal hypothermia, water craft trauma, entanglement, chronic debilitation (hypoglycemia, anemia); foreign body ingestion, abnormal buoyancy, predators, papilloma's, parasites, encephalitis, impaction, hatchlings, and other natural diseases. The most difficult thing facing the veterinary clinician caring for these animals is the time between injury or disease onset, and presentation to the facility. Diagnostic techniques utilized may include complete blood counts, serum chemistries, fecal parasite checks, radiology, fluoroscopy, endoscopy, and occasionally ultrasound and thermography. Treatment techniques include, rehydration, nutritional support, antibiotics, wound management, and occasional blood transfusion and surgery. Individuals which recover sufficiently are tagged and released.

MITIGATION OF NEGATIVE IMPACT OF TOURISM ON NESTING BEACHES AND TURTLES IN TURKEY

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Since 1989 a joint WWF-DHKD (World Wide Fund for Nature - Society for Protection of Nature, Istanbul) project in Turkey has been seeking to secure the protection of the 17 important nesting beaches identified by WWF in 1988 along the Turkish Mediterranean coast. The remit of the project is to work as closely and co-operatively as possible with the Government authorities to achieve the project objective.

Surveys of the beaches found that all were under threat either from direct or indirect impacts of the rapidly expanding tourism industry or from industrial pollution (Table 1). The most urgent of these threats related to tourism were of erosion of beaches as a result of construction on the beach or sand dunes, irrevocable destruction of beaches by large scale sand mining and accidental damage to turtles and nests by beach visitors.

Appropriate strategies for mitigation of the impacts of tourism were seen as:

1)National Laws to stop sand mining and construction within designated set back limits on all beaches.

2)Development of a system of zonation for nesting sanctuaries within the Ministry of Tourism development areas (Dalaman, Tekirova, Belek, Kizilot and Gasipasa) where feasible and in association with the Ministry of Tourism staff.

3)Development of public awareness programs for beach visitors.

4)Designation of the most valuable nesting areas as Special Protected Areas under the Barcelona Convention.

5)Elaboration of management plans for those nesting beaches (currently Ekincik, Dalyan, Patara, Fethiye and Goksu Delta) under the jurisdiction of the Authority for Protection of Special Areas (APSA).

CASE STUDY: ZONATION OF NESTING SANCTUARIES ON A MINISTRY OF TOURISM DEVELOPMENT AREA, BELEK

Construction of hotel complexes providing a total of 20,000 beds started in Belek in 1990. Working with the Ministry of Tourism staff the project identified 3 zones of 3-5 km beach length where nesting sanctuaries might be established between the areas of high density tourism development, (Figure 1). The designation of three turtle nesting zones was adopted by the Ministry of Environment in 1990 and 500m wide set back regulations for all construction inserted into the Government land use plans for the three nesting zones. This compared to a set back of 50 m from the sea line under the Ministry of Tourism plans for Belek. In 1991 the Ministry of Tourism changed their policy and successfully lobbied parliament to remove the 500 m set back limit. However the process delayed construction activities in the 3 zones and as a result all future construction will be subject to the 1992 Coastal Law revisions and better controls than in 1990. The project continues to campaign for protection of the nesting zones and as of February 1993 no construction had started in any of the three zones.

The zonation scheme demonstrated several vulnerable points of such schemes: 1) The viability of nesting sanctuaries of this size (under 5 km) relies on the commitment of the tourism managers on adjacent areas to screen and control lights from their establishments and restrict any activities that impact on the sanctuary zone. This commitment is variable and where no statutory body exists to monitor or enforce the mitigation measures the commitment of the mangers is directly related to the level of public concern among local people and tourists. Therefore extensive public awareness programs are required. 2) A sound legal basis is required for long term success. As tourism sites are developed the sanctuary areas become the last remaining prime sites for development and subsequently command greater premiums. 3) The scheme would greatly benefit from scientific monitoring of the effectiveness of the sanctuaries as the tourism development proceeds. No such studies are being undertaken in Turkey.

CASE STUDY: PUBLIC AWARENESS PROGRAMME AT DALYAN NESTING BEACH

Dalyan beach has been designated as a Special Protected Area since 1988. Access to the beach from Dalyan village is by 30-minute ride in a car or boat and this clearly facilitates control of visitor access. As yet no management plan has been elaborated for the area by the responsible authority (APSA). The main threats to the nesting beach and sand spit are accidental damage by the 2000-4000 daily visitors in the summer season, the construction of concrete based WC and cafe facilities on the sand spit by APSA and continuing erosion of the beach caused by abandoned hotel foundations.

Over the last four years the WWF-DHKD project has run a public awareness programme informing beach visitors of the need to protect the turtles. APSA has stationed wardens on the beach during the breeding season. The results have been very positive. In 1992 visitors complied with requests to keep all sun-beds and umbrellas outside of the nesting area, not to drive on or dig in the nesting area. They left the beach from 8 pm to 8 am to avoid disturbing the nesting turtles. In years prior to the public awareness programme beach parties at night were frequent.

The public information programme at Dalyan has demonstrated that tourists are willing to co-operate with efforts to protect the turtles and has provided a model for public information programs on other nesting beaches in Turkey.

Nesting Beaches	Visitor Pressure	Construction: Holiday houses	Construction: Int. tourism	Sand mining	Industrial pollution
Belek	■	■	■		
Dalaman	■	■	■		
Tekirova	■		■		
Gazipasa	■	■	■		
Kizilot	■	■	■	■	
Demirtas	■	■			
Kale	■	■			
Kumluca	■	■			
Anamur	■	■		■	
Ekincik	■				
Dalyan	■				
Patara	■	■			
Fethiye	■	■	■		
Goksu Delta	■	■			
Samandagi				■	
Kazanli					■
Akyatan	■				

Table 1
Sources of negative environmental impact on the 17 important sea turtle nesting beaches in Turkey 1993

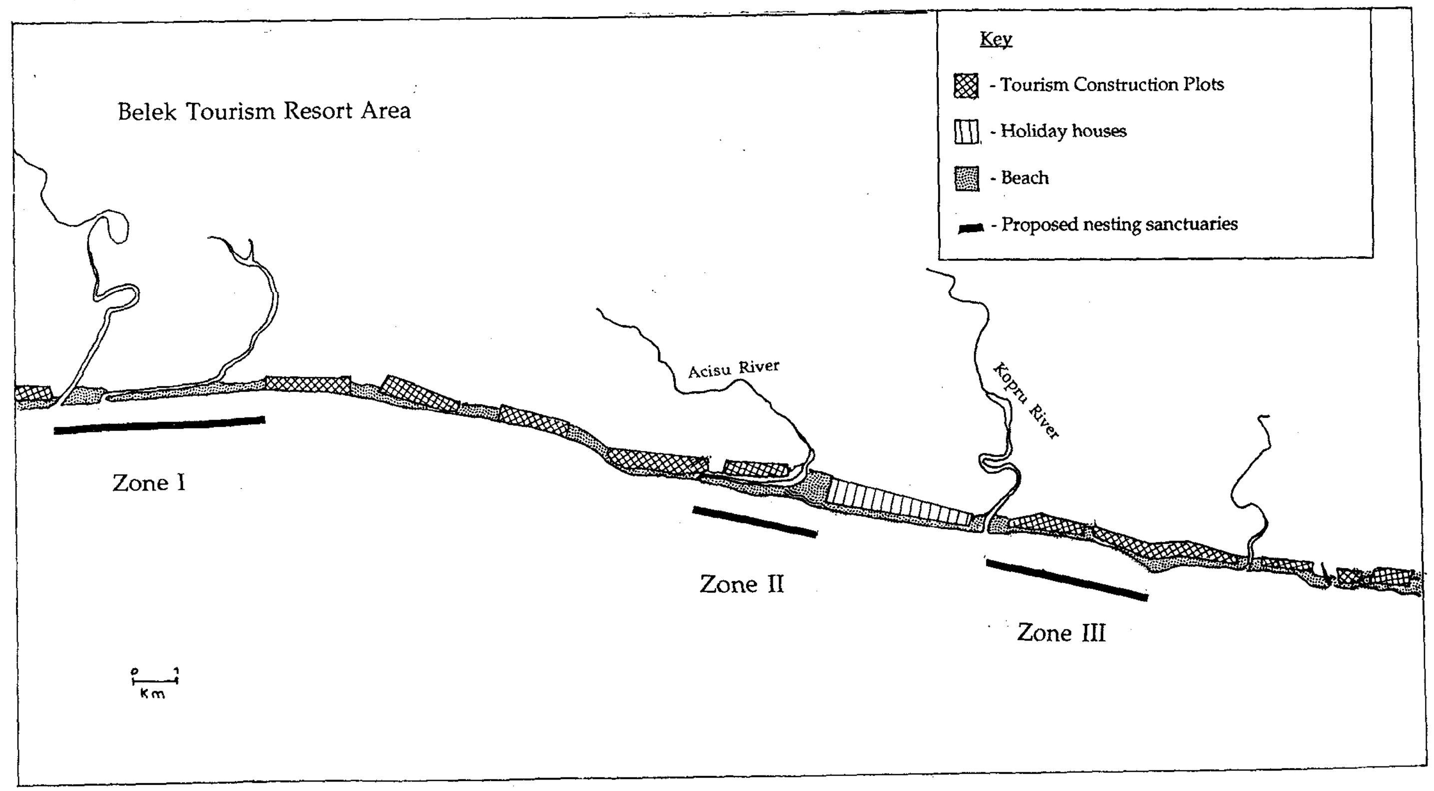

Figure 1 Proposed Zones for Protection of Sea Turtle Nesting, Turkey.

SOME "LOST-YEAR" TURTLES FOUND

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Sea turtle hatchlings emerge from their nests, crawl down beaches, and enter the ocean to begin their pelagic "lost years" at sea. Because open-ocean research is difficult and small turtles are inconspicuous, the pelagic phase remains the central enigma of sea turtle life history. The pelagic phase has been best studied in the Atlantic loggerhead (*Caretta caretta*). Numerous second-hand accounts (Carr, 1986b) and first-hand observations (Richardson and McGillivary, 1991; Witherington, in press) record the presence of neonate loggerheads within patches of *Sargassum* offshore. Although much attention has been focussed on the significance of convergence fronts and *Sargassum* to the ecology of young sea turtles (Caldwell, 1969; Carr and Meylan, 1980; Witham, 1980; Carr, 1986a), there have been no detailed studies describing how neonate turtles behave and what they encounter within these areas. The purpose of this study was to begin collecting baseline data on the behavioral ecology of pelagic neonate loggerhead turtles.

METHODS

Two regions in the Atlantic Ocean off Central Florida, USA, were searched for neonate loggerheads, approximately 2 NM east of Sebastian Inlet, Florida, and 6-20 NM east of Cape Canaveral, Florida. Searches were made aboard a 7-m outboard boat on three days: 2 August, 11 September, and 21 September 1992. The loggerhead hatching season in Florida occurs from July through October. Convergence fronts and areas of *Sargassum* were targeted as areas suspected to hold turtles. Turtles sighted were captured with a small dip net. Information gathered from each capture included time, location (determined with a Magellan NAV 5000 GPS), turtle behavior, straight-line plastron and carapace measurements, and notes on sea state and objects floating nearby. Stomach contents of two turtles were sampled by sea-water stomach lavage. Lavage was conducted with a 5-cm diameter rubber bulb (human ear wash bulb) attached to a 3-mm outside diameter flexible vinyl tube. Contents were separated with a fine-mesh cloth sieve, examined, sorted, fixed in 10% buffered formalin, and stored in 70% ethanol. All turtles were released where captured. Thirty loggerhead hatchlings from nests at Melbourne Beach, Florida, were measured on the night of their nest-emergence for comparison with turtles captured offshore.

RESULTS AND DISCUSSION

Fifty-six neonate loggerheads were captured and released during the three searches offshore. The catch-per-unit-effort (captures/search time) ranged from 1.7 to 7.7 turtles per hour. The highest capture rate occurred at a convergence front with *Sargassum* at the western edge of the Gulf Stream off Cape Canaveral. There were 44 turtles captured at this front, which extended approximately 1 NM on a N-S line.

The small sizes of the loggerheads captured (Fig. 1) suggest that they hatched during the most recent nesting season. However, many had grown substantially from hatchling size and carried with them additional evidence (healed wounds, algal growth, and *Lepas* barnacle attachment) that they had spent time at sea. As a group, loggerheads captured at sea (mean = 48.3 mm standard straight carapace length, SSCL) were significantly larger than hatchlings newly emerged from Florida nests (mean = 44.5 mm SSCL; df = 78, t = 5.24, $P < 0.0001$). The largest post-hatchling was 59.0 mm SSCL.

Of the 56 loggerheads captured, 41 were in a tuck when first observed. Turtles in a tuck float at the surface with their fore flippers flattened over the carapace and rear flippers folded overlapping the tail. All but two turtles in a tuck were near *Sargassum* patches. Ten turtles were found swimming with a rear-flipper kick pattern near *Sargassum* patches. With the rear-flipper kick stroke, fore flippers are held as in a tuck, and rear flippers are moved simultaneously to propel the turtle slowly forward. Three turtles were found in a rear-flipper kick pattern away from any flotsam, one turtle was found crawling on top of a *Sargassum* patch, and one turtle was found in a powerstroke pattern (fore-flipper stroke) away from any recognizable convergence or flotsam.

Items discharged from the two turtles during lavage included the following: a culicine mosquito (7.1 mm greatest diameter), unidentified animal tissue (1.5 mm), a blue plastic chip (4.5 mm), a partial *Sargassum* float (3.2 mm), a larval hippolytid shrimp (2.5 mm), a *Portunus sayi* crab meropodite (2.9 mm), a probable ctenophore (9.0 mm), and a sliver of woody plant tissue (3.2 mm).

The preceding evidence indicates that neonate loggerheads can live and grow in the Atlantic west of the Gulf Stream. The turtles found at sea most likely came from Florida's east coast, which is by far the closest major nesting area for loggerheads. This being the case, the loggerheads that were larger than hatchling size must have attained their growth between the Gulf Stream and the mainland. Turtles entering the Gulf Stream would exit the area quickly; the Gulf Stream flows north at approximately 100 NM per day. Waters west of the Gulf Stream may provide an important beginning to a loggerhead's pelagic existence.

Evidence on how neonate loggerheads behave and what they eat fits the profile of a low-energy-expenditure "float-and-wait" forager. It is not surprising that a buoyant animal living within a concentration of slow-moving floating food would allocate minimum resources for activity, thus, saving greater resources for growth.

How pelagic loggerheads disperse at sea is an important but poorly known part of their biology. To elucidate dispersal, one should understand both the behavior of surface currents and turtles. Surface currents are commonly modeled using information from the release and collection of drift bottles. But before surface-current models can be used to predict neonate turtle dispersal, one must understand when young turtles behave like drift bottles and when they do not. Hatchlings leaving the beach in bouts of frenzied swimming make considerable progress on their own (Wyneken and Salmon, 1992; Witherington, in press). Relatively inactive turtles within convergence fronts also may partially govern their own dispersal. Rather than simple drift bottles, young loggerheads may behave as "smart" drift bottles. Being at the convergence of currents as young turtles are, subtle movements from one side of a front to the other could considerably alter where they travel.

ACKNOWLEDGEMENTS

This study was funded by a grant from the U.S. Air Force to B. Witherington, K. Bjorndal, and A. Bolten, through the Archie Carr Center for Sea Turtle Research, University of Florida. D. Snodgrass assisted with the field work.

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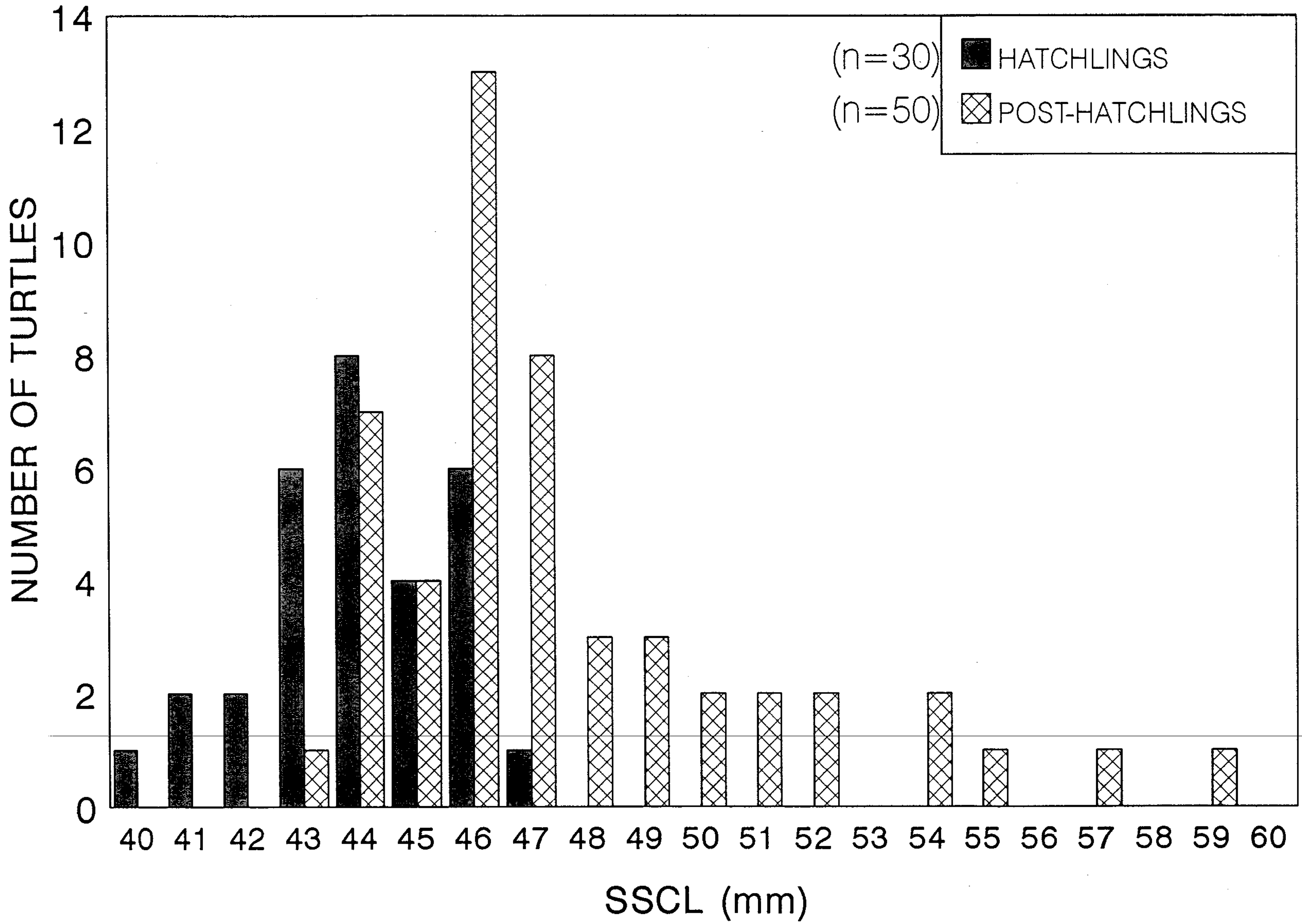

Figure 1. Standard straight carapace length (SSCL) of loggerhead turtles newly emerged from Florida nests (hatchlings) and captured at sea in the Atlantic Ocean off Florida (post-hatchlings) in August and September, 1992.

PART II: POSTER PRESENTATIONS

MARINE TURTLE NESTING ACTIVITY ON EGLIN AFB, FLORIDA, 1987-1992

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Eglin Air Force Base encompasses 463,448 acres of land in Santa Rosa, Okaloosa, and Walton counties in northwest Florida. The area surveyed for marine turtle nesting activity is confined to the 17 miles of federal beach on Santa Rosa Island which, due to property ownership, is divided into two sections (Figure 1).

Since 1987, a total of 131 loggerhead (*Caretta caretta*) and 22 green turtle (*Chelonia mydas*) nests have been documented on Eglin AFB (Figure 2). Although green turtle nests comprise only 14.4% of the total, this is felt to be significant as the species is not known to nest anywhere else along the northern Gulf coast of Florida.

Nesting by both species has occurred the last week of May through the third week in August. Mean incubation length for loggerhead nests is 66.5 days, with a range of 50 to 81 days; green turtle nests have a mean incubation length of 62.6 days and a range of 51 to 83 days. Clutch sizes for loggerhead turtles range from 53 to 170 eggs, with a mean of 116.5; mean clutch size for green turtles is 130.5, with a range of 76 to 172 eggs.

Reproductive success for each nest is determined by the percentage of yolked eggs per clutch that result in released or emergent hatchlings. Figures 3 and 4 represent the inventory results from 127 loggerhead and 22 green turtle nests. With the exception of 1988 and 1992, overall nesting success for loggerhead turtles has been relatively constant and ranges from 75.0% to 82.4%. One nest in 1990, and two nests in 1991, did not hatch due to low ambient temperatures; success rates without these impacted nests are 84.1% and 84.6%, respectively. A low nesting success of 56.3% for 1992 is primarily attributed to tidal inundations from three separate storm events, with secondary impacts from low ambient temperatures. Two nests were destroyed by storm tides and five did not hatch, apparently due to sand compaction around the eggs. Nesting success without the inundated nests is 79.5%. It is suspected a success rate of 52.6% for 1988 can be attributed to similar inundations caused by Hurricane Florence.

The reproductive success rate for green turtle nests has been significantly lower than that of loggerhead nests, with a much higher percentage of unhatched eggs having no apparent signs of development. Overall nesting success for green turtles ranges from 13.1% to 47.6%. In 1992, four nests did not hatch due to both tidal inundations and low ambient temperatures; the success rate without these nests is 57.2%. Although it is not known what specifically is causing decreased viability in green turtle nests, eggs from both the 1990 and 1992 nesting seasons have been collected for the US Fish and Wildlife Service to conduct possible contaminants analysis at a later date.

Mammalian predators are common along the western section of Santa Rosa Island and include domestic dog, coyote (*Canis latrans*), and raccoon (*Procyon lotor*). Depredation by mammalian predators accounts for less than 1% of mortality, as does depredation by ghost crabs (*Ocypode quadrata*). Root damage, both from penetration and matting, affected 1.7% of loggerhead and 3.0% of green turtle eggs. Impacts were primarily caused by sea oats (*Uniola paniculata*) and beach pennywort (*Hydrocotyle bonariensis*).

Continued daily monitoring of marine turtle nesting activity on Eglin AFB is necessary to provide accurate information regarding nesting densities and reproductive success rates. Daily monitoring enables success-limiting factors to be immediately recognized and corrected, and allows for accomplishment of Air Force mission requirements without impact to nesting marine turtles.

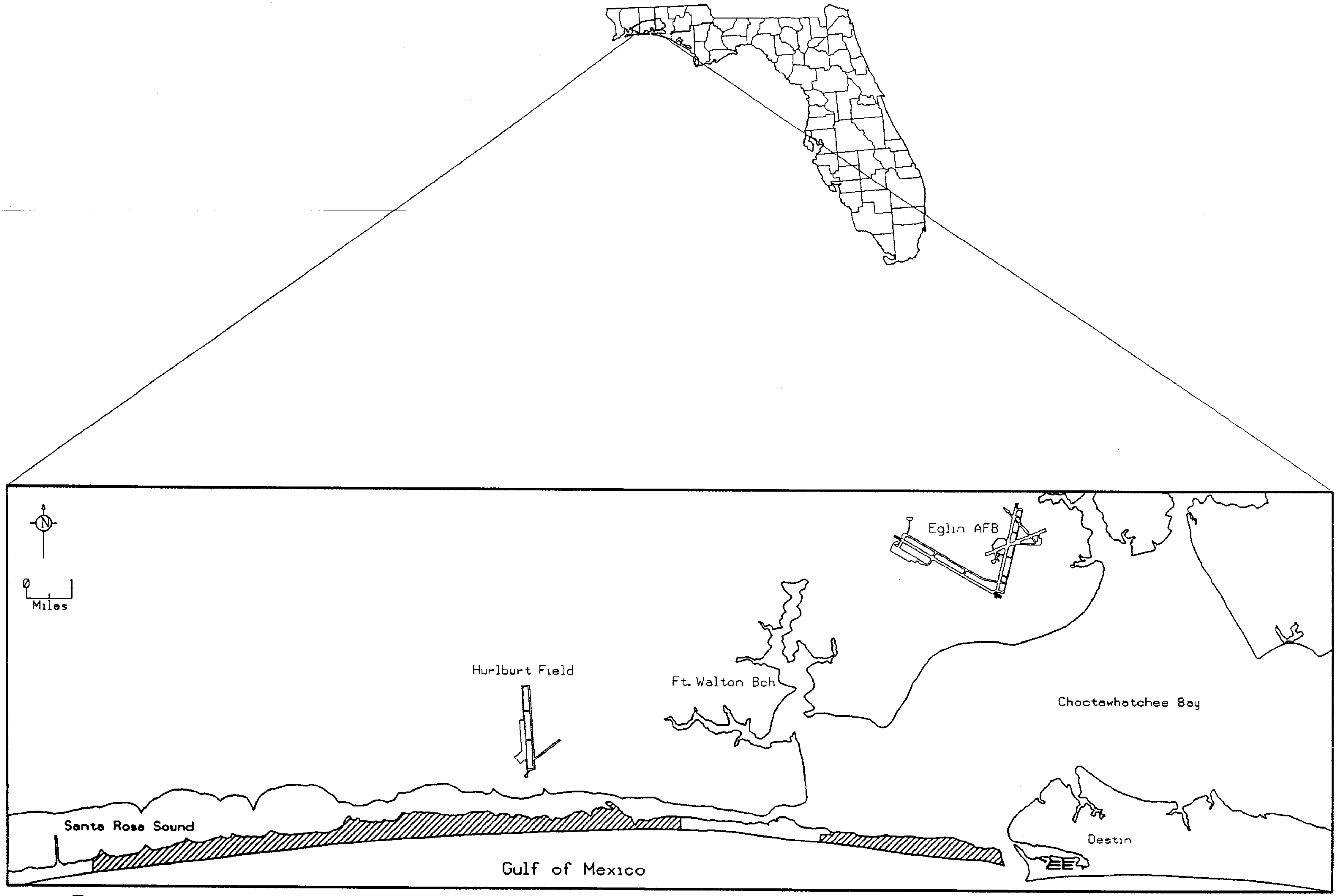

Figure 1. Survey area for marine turtle nesting activity on Eglin AFB, Florida.

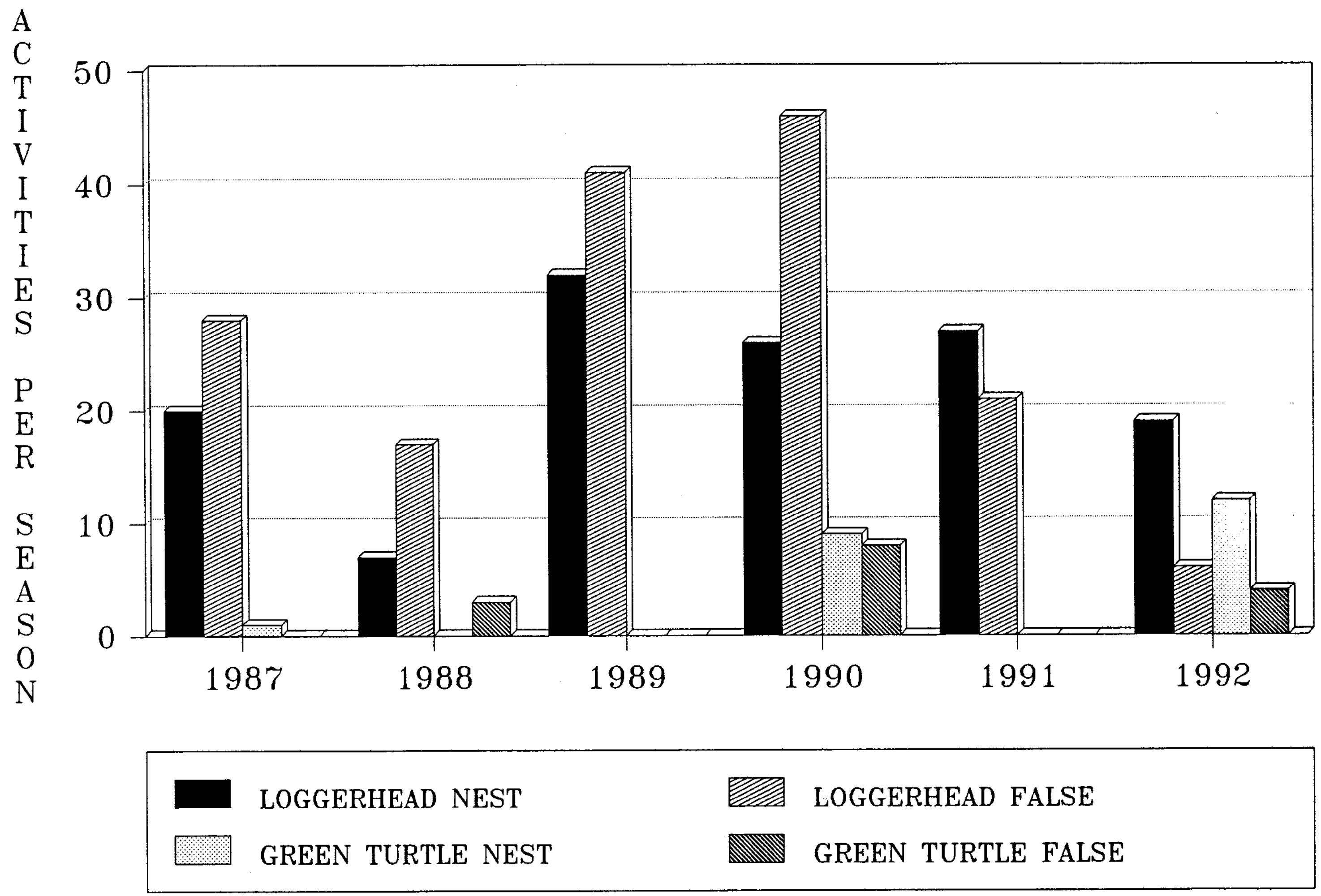

FIGURE 2. MARINE TURTLE NESTING ACTIVITY ON EGLIN AFB, FLORIDA, 1987 THROUGH 1992.

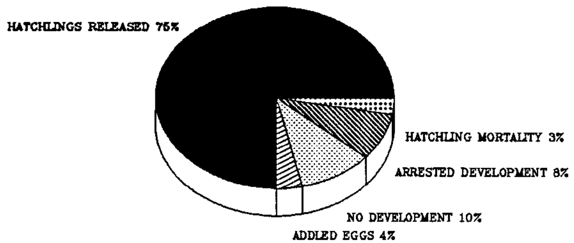

FIGURE 3. ASSESSMENT OF REPRODUCTIVE SUCCESS FOR LOGGERHEAD NESTS DEPOSITED ON EGLIN AFB, FLORIDA 1987 THROUGH 1992

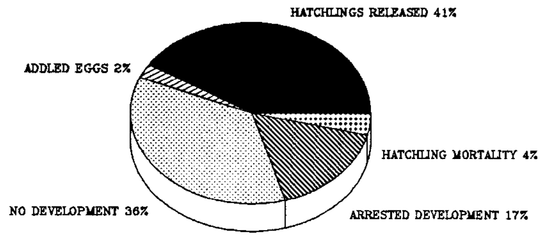

FIGURE 4. ASSESSMENT OF REPRODUCTIVE SUCCESS FOR GREEN TURTLE NESTS DEPOSITED ON EGLIN AFB, FLORIDA 1987 THROUGH 1992

HOMEWARD BOUND: SATELLITE TRACKING OF HAWAIIAN GREEN TURTLES FROM NESTING BEACHES TO FORAGING PASTURES

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Telonics ST-3 satellite transmitters linked to the Argos system were deployed on three green turtles, *Chelonia mydas,* nesting at East Island, French Frigate Shoals (FFS) during August 1992. The objectives of this study were to determine 1) migratory pathways to the foraging areas; 2) degree of fixation on a foraging area; 3) diving behaviors during the migrations; and 4) differences in migratory abilities between healthy turtles and ones moderately afflicted with fibropapillomas.

The intensive flipper tagging of nesting females and basking males has been underway in the Hawaiian Islands since 1973. Results show that reproductive migrations are carried out between FFS and numerous distant foraging areas throughout the 2400-km span of the archipelago (Balazs 1976, 1983). Isolated Johnston Atoll, situated 830 km to the south, also constitutes one of the foraging areas (Balazs 1985).

METHODS

A safe and secure method of attaching the transmitters was pretested on captive green turtles at Sea Life Park Hawaii. Silicone Elasatomer, a two-part compound, was first used to firmly position the transmitter against the contour of the carapace along the second central scute. This product cures within five minutes and produces no heat. Final attachment was then achieved by applying two layers of fiberglass cloth and resin, similar to what has been used by Beavers et al. (1992) and Renaud (1990). A sturdy plywood container was devised to place around the turtle to safely hold her in a prone position during the attachment process.

Two of the three turtles selected for satellite telemetry were already identified with flipper tags that had been applied at Johnston Atoll (U306) and Kaneohe Bay, Oahu (U260). The third turtle (U236) had not been tagged and was moderately afflicted with fibropapillomas. This tumorous disease is of major concern for green turtle populations in Hawaii, Florida, and elsewhere worldwide (Balazs and Pooley 1991). However, severe cases of the disease are seldom seen in the breeding assemblage at FFS. This is presumably due to the inability of heavily diseased individuals to achieve reproductive readiness and accomplish the required migration. The duty cycle of the transmitters used on U260 and U236 was 6 hours on, 6 hours off. The duty cycle of U306 was 10 hours on, 50 hours off.

The study was initiated during the latter part of the nesting season to increase the chances of the turtles leaving on their homeward voyage shortly after transmitter attachment. Short-range radio telemetry of green turtles within FFS had already been conducted in 1980 early in the nesting season to determine habitat utilization during internesting intervals (Dizon and Balazs 1982).

RESULTS AND DISCUSSION

All three turtles were successfully tracked by satellite during their homeward migrations. Two of the turtles, (U260 and U236) departed within four days of one another and swam in excess of 1100 km against prevailing winds and currents to Kaneohe Bay (Fig. 1). Instead of using the islands and shoals of the archipelago as navigational guideposts, as might be expected, both turtles followed similar paths to the south of the chain, beyond sight of land over water thousands of meters deep. The third turtle (U306) also traveled across open ocean, but directly south to Johnston Atoll (Fig. 2). The navigational system used on these voyages remains unknown. However, olfactory reception of chemical cues carried by currents from the islands is a plausible component to the piloting process (Carr 1972).

Both of the previously tagged turtles migrated to the same foraging area where they had been encountered earlier. The turtle with tumors took a less direct path, traveling 130 km farther than the healthy turtle, to arrive at the same foraging area of Kaneohe Bay. Short diving times for all three turtles indicated that they were mainly swimming close to the surface during their migration. However, mean submergence intervals regularly recorded by the transmitter over 12-hour periods revealed they were only at the surface 4-5% of the time.

This is the first reported study where green turtles have been successfully tracked on their high-seas migrations from a nesting beach to nearshore foraging areas (see Byles and Keinath 1990).

TURTLE U260 SUMMARY--This healthy 87 cm turtle covered a distance of 1130 km averaging 2.0 km/hr during her 23-day migration from FFS to Kaneohe Bay. During this transit the average dive times ranged from 2.3-5.1 min. Five individual dives were registered lasting 11-34 min. Ambient temperatures during the migration, as recorded by a sensor in the transmitter unit, ranged from 26-27° C. Transmissions from U260 continued for 3.5 months after the migration was completed, during which time the turtle remained within Kaneohe Bay.

The tagging history of U260 showed that she had been first encountered nesting on East Island during the 1989 season. In March 1992 she was hand-captured by the author in Kaneohe Bay while resting under a coral ledge at a depth of 5 m. In June 1992 she was seen back at East Island where four nestings occurred prior to transmitter attachment in August 1992. These data demonstrate two lengthy return trips to the same nearshore area of Kaneohe Bay, thereby suggesting a strong affinity for this particular foraging location.

TURTLE U236 SUMMARY--This 85 cm previously untagged turtle had 12 tumors ranging from 1-6 cm in diameter on her front flippers, neck, and eyes. Three nestings took place on East Island in 1992 prior to transmitter attachment. In addition, the turtle was seen ashore attempting to nest on 7 other nights. U236 traveled 1260 km averaging 2.0 km/hr during the 26 days it took to reach Kaneohe Bay. During this voyage average dive times ranged from 2.2-3.3 min. Four individual dives were registered lasting 26-29 min. Ambient temperatures ranged from 24-27° C.

Since her arrival, U236 has made at least one round trip excursion outside of Kaneohe Bay along Oahu's coastline to a reef area 11 km away. Transmissions were still being received from this turtle in April 1993, 8 months after deployment.

TURTLE U306 SUMMARY--This healthy 91 cm turtle had been originally captured by net and tagged nearly 9 years earlier at Johnston Atoll when she measured 87 cm (Balazs 1985). The principal foraging area for green turtles at Johnston Atoll is adjacent to a chemical munitions disposal facility operated by the U.S. Army.

Unlike the other two turtles tracked in this study, U306 nested at least once on East Island after the transmitter was attached. She was also seen nesting on three earlier occasions during the 1992 season. She departed FFS in mid-September 1992, about one month after transmitter attachment. The 830 km trip directly to Johnston Atoll took about 22 days at an average speed of 1.6 km/hr. However, during the last 70 km of the voyage the swimming speed was only 0.5 km/hr. The average dive times ranged from 2.3-3.3 min and were very similar to those exhibited by turtle U236. Two individual dives of 28 and 29 min were registered during the migration. Ambient temperatures ranged from 26-29° C. Transmissions from U306 at Johnston Atoll ceased during late February 1993, 6 months after deployment.

ACKNOWLEDGMENTS

This research and similar tracking planned for the future is dedicated to the memory of Dr. Archie Carr. Many years ago Dr. Carr was the first to recognize that satellites would eventually be used to unlock the mysteries of green turtle migrations. Much remains to be accomplished to fulfill this goal, but the technology is now at our disposal in a simplified form at relatively low cost.

The following individuals and organizations are acknowledged for their generous contributions to this study: R. Byles, T. Clark, W. Gilmartin, G. Gitschlag, S. Kaiser, S. Koga, K. McDermond, R. Miya, R. Morris, L. Ogren, J. Pappas, P. Plotkin, T. Ragen, M. Renaud, C. Rowland, A. Ward, M. Webber, B. Winton, D. Yamaguchi, the U.S. Fish and Wildlife Service, and Sea Life Park Hawaii. Special gratitude is expressed to Sally Beavers for traveling to Hawaii to share her considerable expertise in attaching satellite transmitters to sea turtles.

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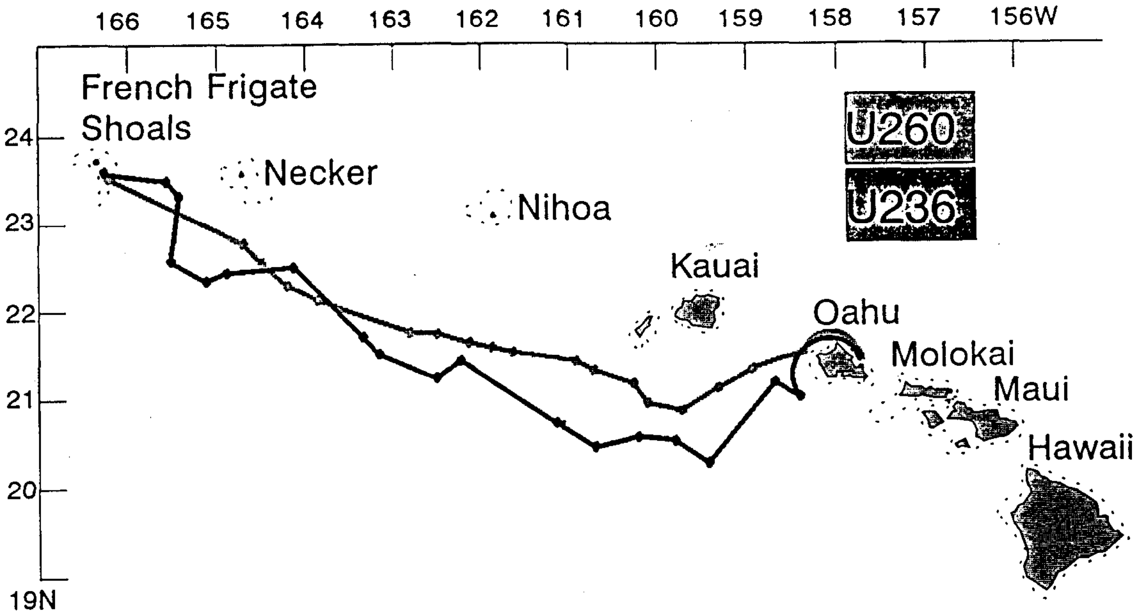

Figure 1. Migratory pathways taken by healthy turtle U260 and tumored turtle U236.

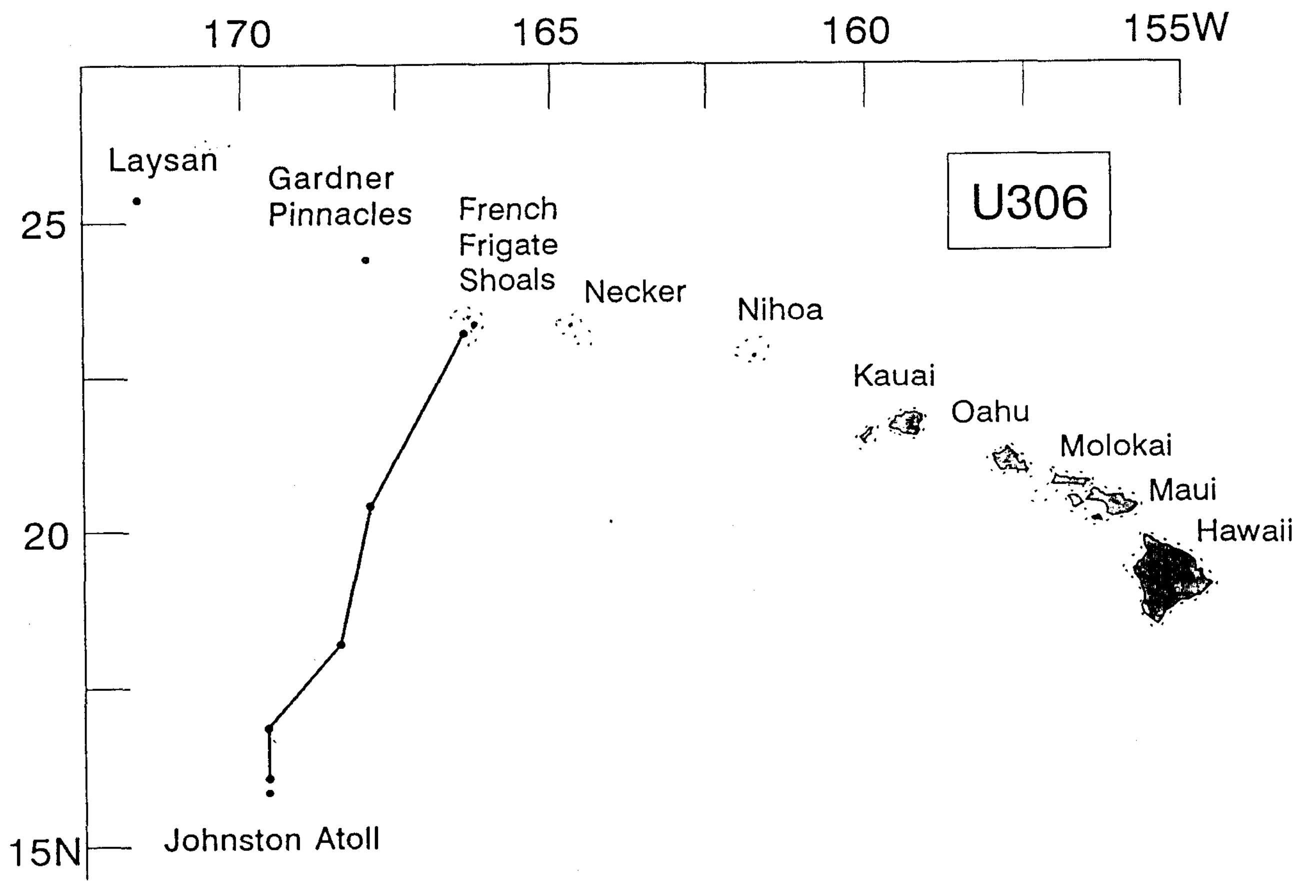

Figure 2. Migratory pathway taken by healthy turtle U306.

SEA TURTLE ONLINE BIBLIOGRAPHY

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The Archie Carr Center for Sea Turtle Research (ACCSTR) at the University of Florida has developed the "Sea Turtle Bibliographic Database." This bibliographic database can be accessed worldwide free of charge via a computer network called Internet. This on-line bibliography includes all aspects of sea turtle biology, conservation and management. Citations are from recognized bibliographic sources as well as "grey literature." Any changes to the on-line bibliography will be announced in CTURTLE and the Marine Turtle Newsletter. Unfortunately, at present, we cannot conduct searches for those investigators who cannot access the system.

Curating a database of this magnitude is a dynamic process. The database is continually being edited and updated. If you find an error in a citation or know of a citation that has been omitted, please send us the correct information. To help us maintain a comprehensive library, we would appreciate receiving a reprint of any of your sea turtle publications. Our address is:

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Archie Carr Center for Sea Turtle Research
Bartram Hall
University of Florida
Gainesville, FL 32611

FAX: (904)392-9166
E-mail (Internet): ACCSTR@zoo.ufl.edu

1) How to Access Via Internet

These procedures assume you know how to access the Internet. It is important for you to know what action to take in response to local system messages. Contact your local data center for additional information.

Signing on using the telnet command (or your host's equivalent)

enter:telnet nervm.nerdc.ufl.edu
or
enter:tn3270 nervm.nerdc.ufl.edu

2) How to Access Via Modem

To connect via dial-up terminals using ASCII terminal emulation, the telephone numbers are (Florida Suncom prefix for all 392 numbers is 622):

1200 baud: (904)392-7450

2400 baud: (904)392-9177

9600 baud: (904)392-2749 or 392-9942

3) After Connection to the University of Florida System

system display:NERVM logo
move cursor to command line
enter:dial vtam

system display:NERDC VTAM is active
enter:nerluis

system display:sign-on complete
(briefly displayed)

system display:LUIS user menu

4) Bibliography Main Menu

Once you have accessed the LUIS user main menu, select no. 15 (Additional Information Resources); then select no. 14 (Sea Turtle Bibliography). Follow the menu choices. You may search on the author or title fields as well as using keywords. Help is available for author (A), title (T), and keyword (K) searches by typing EXP followed by A, T, or K. For example, help information for keyword searches is accessed by typing EXP K. The truncation character is "?" without the quotation marks.

5) To Sign-Off

When you have completed the search process, type stop; select 30; then select 30 again; at NERDC VTAM is active screen, type: undial. You will now be back in your host system.

ACKNOWLEDGMENTS

Development of the Sea Turtle Bibliographic Database has been made possible by the generous support of the U.S. Fish and Wildlife Service (Earl Possardt and Jack Woody), U.S. National Marine Fisheries Service (Charles Oravetz and Terry Henwood), and the Japanese Sea Turtle Association (Naoki Kamezaki). Marjorie Carr, C. Kenneth Dodd, Greg Forbes, John R. Hendrickson, David Owens, and Anders Rhodin (The Chelonian Research Foundation) have provided valuable reference collections for our use. Staff at the University of Florida Libraries and the Florida Center for Library Automation have provided inspiration, knowledge and technical assistance with the LUIS system. Graduate students of the ACCSTR have assisted with the compilation of the database; Peter Eliazar is currently curating the database.

CTURTLE: AN EMAIL INFORMATION NETWORK FOR SEA TURTLE BIOLOGY AND CONSERVATION

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Karen A. Bjorndal

Archie Carr Center for Sea Turtle Research, Bartram Hall, University of Florida, Gainesville, Florida 32611 USA

To improve communication among individuals around the world who are interested in sea turtle biology and conservation, the Archie Carr Center for Sea Turtle Research at the University of Florida has established CTURTLE -- an email conference and bulletin board. CTURTLE is a LISTSERV managed email list on BITNET, an academic and research computer network, which is connected to many other computer networks worldwide.

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INTRASEASONAL NESTING ACTIVITY OF LOGGERHEAD SEA TURTLES ON BALD HEAD ISLAND, NORTH CAROLINA

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Activities of loggerhead sea turtles (*Caretta caretta*) nesting on Bald Head Island, North Carolina were monitored using tagging methods to determine intraseasonal nesting patterns. Research conducted in recent years on nesting sites for loggerhead sea turtles indicates Bald Head Island represents the northernmost nesting concentration along the east coast of the United States and where the largest number of nests are reported annually (Crouse, 1984; Hopkins and Richardson, 1984; Schwartz, 1989). Numbers of nests per year have ranged from 72 to 196 (Crouse, 1984; Brooks, 1989). Although nest records have been kept since 1980, data on nesting patterns by individual turtles was relatively unknown. Preliminary efforts to identify individual nesting females began in 1983 with phototagging, a method which involves taking a photograph of the turtle's carapace from a standard point posterior to the nesting turtle and using barnacle patterns and prominent scars on the carapace to match in the photographs of individuals. This form of tagging often proved to be unreliable during the span of the nesting season due to changes in barnacle patterns. Only turtles with distinct scars were identified by photographs for interseasonal records. Dependable tagging methods were not fully incorporated into the turtle monitoring program on Bald Head Island until 1991. During the nesting seasons of 1991 and 1992, nesting females were photographed and tagged with monel flipper tags in both foreflippers after completion of their nesting activities. Phototagging was useful in allowing us to identify turtles that had lost their flipper tags during the nesting season. Using both tagging methods provided data necessary to determine intraseasonal nesting patterns by individual turtles.

METHODS

Beaches of Bald Head Island were patrolled nightly during the nesting season, May through August, from dusk until dawn using two ATVs to cover approximately 18 km of beach. A dual patrol method was used to ensure all possible nesting sites were monitored approximately once each hour. All female turtles encountered while nesting were photographed and were tagged with at least two tags in the distal edge of the foreflipper (one tag in each foreflipper) upon completion of nesting, as recommended in the "Manual of Sea Turtle Research and Conservation Techniques" (Pritchard et al., 1983). Turtles were generally tagged during the last stage of nesting, while the turtle was covering her nest with sand. For turtles returning to nest, badly corroded or damaged tags were replaced with new tags, and turtles returning with only one tag were given an additional tag so that all turtles had at least two durable tags upon leaving the beach. Data collected on each turtle including tag numbers, number of nests, and date and time of nesting were used to determine intraseasonal nesting patterns.

RESULTS

A total of 123 females were tagged and photographed, which accounted for 83% of the 319 nests laid during the 1991 and 1992 nesting seasons. Intraseasonal nesting patterns were consistent for both years; most females (53%) nested once, 13% nested twice, 15% nested three times, 7% nested four times, 10% nested five times, and 2% nested six times (Figure 1). The internesting interval averaged 13.9 days (range 10-20 days) for both years (Figure 2). Incorporating all possible nesting individuals into annual nesting population estimates, 1991 had a population range of 69 to 108 nesting females that produced 182 nests. The range for 1992 was 54 to 73 nesting females that produced 137 nests. Monel flipper tags provided means for volunteer turtle watchers on Oak Island (2 miles distant) to report a nesting by one turtle that had nested previously and was tagged on Bald Head Island in the summer of 1992.

DISCUSSION

Loggerheads in the northernmost part of their range in the western North Atlantic exhibit intraseasonal nesting patterns that are similar to those exhibited by populations elsewhere in the range of the species. Future goals of the sea turtle monitoring program on Bald Head Island will be to increase the saturation efficiency (intercept more nesting turtles) to ensure thorough data for determining intra- and interseasonal nesting patterns and to better estimate population size of turtles nesting on Bald Head Island. An efficient tagging and monitoring program must be continued for at least six years in order to develop population estimates and other models, as outlined in "A Recovery Plan for Marine Turtles" (Hopkins and Richardson, 1984). The efficiency of the tagging program on Bald Head Island may not be known until the nesting seasons of 1993 or later to verify that any turtles tagged in 1991 or 1992 return to nest with monel flipper tags. The highly efficient tagging and monitoring methods used in Richardson's study (1982) involved the use of several types of tags with application of six tags per turtle, compared to only two tags given to turtles on Bald Head Island. Observed nestings over the next few years may determine the need for alternative tagging methods for turtles nesting on Bald Head Island.

ACKNOWLEDGEMENTS

The author would like to acknowledge the North Carolina Wildlife Resources Commission, the National Marine Fisheries Service, the Bald Head Island Conservancy, and the University of North Carolina at Wilmington for materials and financial support. I especially want to thank all the university students who assisted in this project over the last three years. This project would not have been possible without their dedication and hard work.

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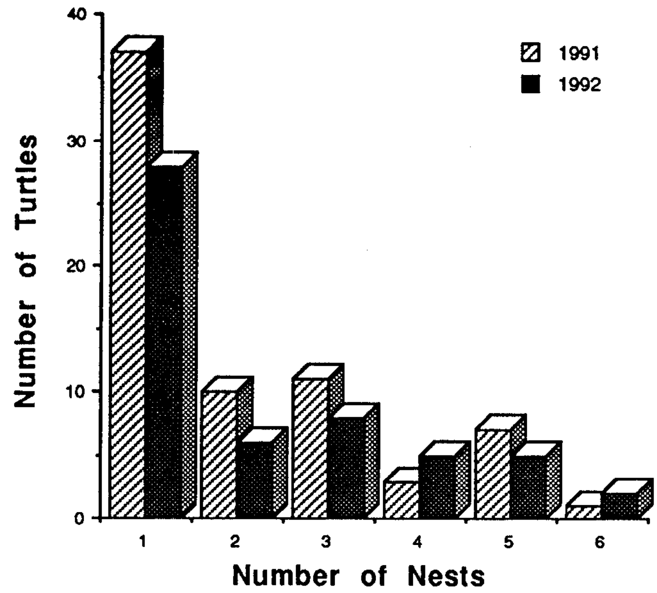

Figure 1. Intraseasonal nesting frequencies of turtles in 1991 and 1992. 83 % of nesters are reoresented.

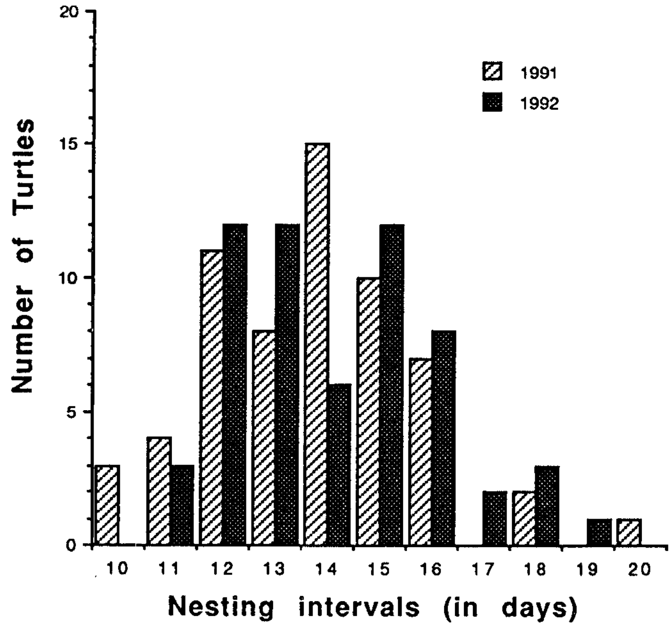

Figure 2. Intraseasonal nesting intervals by multiple nesters in 1991 and in 1992. Interval for both years averaged 13.9 days. (x=13.9)

DIAGNOSTIC CHARACTERS OF THE STAGES OF SPERMATOGENESIS IN THE GREEN TURTLE (*Chelonia mydas*)

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Thirty-nine testicular biopsies of immature and adult *Chelonia mydas* were used to study maturation of the male gonad. Biopsies were collected via laparoscopy in Bocas del Toro Province, Panama, between 1989 and 1991 and prepared histologically at FMRI. It was possible to classify preparations from each individual into one of seven stages of spermatogenesis previously described in reptiles. Stage determinations were based on the presence and quantity of six types of cells in the seminiferous tubule: sertoli, spermatogonia, primary and secondary spermatocytes, spermatids, and spermatozoa. In stage one, a single horizon of sertoli cells and spermatogonia surround an occluded lumen. In stage two, several layers of sertoli cells and spermatogonia surround a partially occluded lumen. In stage three, primary spermatocytes are present in nearly every seminiferous tubule. In stages four through seven, primary and secondary spermatocytes, as well as spermatids and spermatozoa, are present in varying proportions. Stages four through seven are considered to be mature. Progression through stages one through four correlates with turtle size. These data have proven useful in identifying the size at sexual maturity in the green turtle.

SEA TURTLE NESTING ACTIVITY AT JUPITER/CARLIN PARKS IN NORTHERN PALM BEACH COUNTY, FLORIDA

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The purpose of this study is to conduct long term sea turtle monitoring in the Jupiter area to determine the effects of a proposed beach nourishment project on sea turtle nesting. This study will last at least three years and will collect data on reproductive success of sea turtles in the area. This report analyzes 1992 nesting data from the 1.56 mile (2.51 Km) Jupiter/Carlin survey area, compares the nesting to 1991 levels and provides baseline data from which to evaluate the effects of a beach nourishment project proposed to be constructed in 1994 on 1.1 mile (1.77 Km) of beach immediately south of Jupiter Inlet on the southeast coast of Florida. The data presented here is from the second year of monitoring for this project.

METHODS

The sea turtle monitoring program consisted of beach surveys, identification of crawls and nests by species, estimates of nest position relative to the dune and high water line, marking of a representative portion of the nests to follow through the season and to conduct nest content inventories. The survey area is a 1.56 mile (2.51 km) beach running south from the Jupiter Inlet located in southeast Florida.

The area was divided into 10 zones or reaches based on upland characteristics. Reach boundaries were determined by various landmarks and back-dune profiles, so that the effects of development and human activity on sea turtle utilization of the nesting habitat could be analyzed. The study area consists of two county parks, condos, a resort, and undeveloped land. Data collected included the species and beach position for all nests, false crawls and false digs above the most recent high water line. Nests were left *in situ* except for 6 which were relocated to a higher elevation on the beach because they were exposed due to erosion.

To evaluate the fate of nests through the entire incubation period, a representative portion of the nests were marked for tracking. An inventory of the nest contents to determine hatching success was conducted at least three days after the first hatchling emerged.

RESULTS AND DISCUSSION

Nesting Data

Table 1 shows that 1,402 (96%) of the nests in the survey area were loggerhead sea turtles (*Caretta caretta*), 44 (3%) of the nests were green turtles (*Chelonia mydas*) while 3 (<1%) of the nests were leatherbacks (*Dermochelys coriacea*).

Nesting density for loggerheads averaged 893 nests per mile (554 nests/km) but ranged from lows of 214 and 217 nests/mile (132 and 133 nest/km) in reach 1 (Dredge spoil area) and reach 4 (Jupiter Hilton), respectively, to a high of 1303 nests/mile (809 nest/km) in reach 6 (Carlin Park) (see table 2 and figure 2).

The Jupiter/Carlin area is a high density nesting beach and correlates well with the Juno Beach, Jupiter Island and south Brevard County nesting beaches which in 1991 had loggerhead nesting densities of at least 925, 832, and 736 nests/mile (575, 517, 457 nests/km), respectively (FDNR, 1991).

Table 1. Summary of 1991 and 1992 nesting activity.

	Caretta caretta		*Chelonia mydas*		*Dermochelys coriacea*	
YEAR	1991	1992	1991	1992	1991	1992
NESTS	1,111	1,402	3	44	4	3
FALSE CRAWLS	1,461	1,603	2	33	0	0

Because of the high nesting density, construction of the proposed beach nourishment project is scheduled to occur outside peak nesting season, i.e. between October 16 and May 15. If construction had occurred in 1992 (outside of peak nesting season), 46 nests would have had to be relocated for a spring project and 24 nests would have had to be relocated for a fall project.

Nesting success (number of nests / number of false crawls and false digs) for loggerheads in the survey area was 46.7% and, depending on the reach, ranged from 15.5% in reach 1 to 58.4% in reach 5 (Figure 3). Nesting success can be affected by any of the following factors: human disturbance, artificial lighting, horizon features and sand characteristics such as temperature, moisture, sand grain size , sand grain shape, sand grain orientation and compaction (Nelson, 1989).

The lowest nesting densities and nesting success occurred where turtles were blocked from access to the nesting beach. Nesting was limited at reach 1 by the formation of a steep scarp in early May. The scarp ranged in height from 3 to 10 feet and was the result of erosion of dredge spoil from the Intracoastal Waterway placed on the beach in February 1992 by the United States Army Corps of Engineers. Low nesting density in reaches 4 (Jupiter Hilton) and 5 (undeveloped park) were primarily a result of intertidal rock outcroppings with vertical relief of 1-3 feet which were present in up to 80% of the reaches. The low nesting density in reach 5 was unexpected; high nesting levels were anticipated since this is the darkest and most isolated stretch of beach.

Nesting density was higher in the project limits of the proposed nourishment area (reaches 2 through 6) at 1014 nests/mile compared to the "control" area (reaches 7 through 9) which had 878 nests/mile. Average beach width in the project area was 53 feet compared to 119 feet in the control area. Wider than average beaches (>72 feet) and narrower than average beaches (<72 feet) had similar nesting densities but nesting success was slightly higher on the narrower beaches (49.5%) compared to the wider beaches (44.4%).

One of the design considerations of the Jupiter/Carlin Shoreline Protection Project has been to minimize impacts to sea turtles by placing beach compatible sand on the beach using sand from the nearby ebb tidal shoal and tilling the fill area to reduce compaction levels. The mean grain size and silt/clay fraction of the borrow material (0.45 mm, 0.66% S/C) is a close match to the native nesting beach (0.46 mm, 0.2% S/C). It is expected that there will be minimal negative impact to nesting success as a result of this sand compatibility.

Hatch Data

To provide baseline data on hatching success and hatchling emergence, the contents of 54 of the *in situ* loggerhead nests were inventoried. Twenty eight of the nests were marked (triangulated) and 26 of the nests were unmarked (random) resulting in evaluating 3.8% of the loggerhead nests. Average incubation time for loggerheads was 56.9 days and average clutch size was 110. Hatching success of the loggerhead nests was 90.1%. The hatchling emergence success rate for loggerheads was 85.0%. These results are similar to Raymond's (1984) results from Indialantic and Melbourne Beach in 1981 and 1982.

Nest Location

The location of the nests on the beach was established with reference to the dune vegetation line and the most recent high water line. The average beach width for the entire survey area for 1992 was 72 feet but varied greatly depending upon the reach with a low of 15 feet in reach 10 and highs of 125 feet and 127 feet in reaches 7 and 8, respectively.

Figures 4a and 4b are graphs of nest locations of loggerheads in two reaches that best depict the typical response on a wide beach and a narrow beach in the study area. Reach 7 had an average width of 125 feet and turtles tended to deposit nests closer to the HWL than the dune. Approximately 88% of the nests were laid within 45 feet of the average high water line while the remaining 12% were laid within 80 feet of the dune. Reach 5 had an average beach width of 44 feet and 83% of the nests were laid within 20 feet of the dune. It appears that having a wide beach does not necessarily mean that turtles will use the available beach equally.

Effects of Hurricane Andrew, Predation and Disorientation

Hurricane Andrew hit south Dade County (105 miles [169 km] south of Jupiter) on August 24 when 50% (701) of the season's nests were still incubating. The hurricane impacted (eroded or inundated) approximately 260 nests or 18.5% of the nests laid during the season. It is unknown how many of those nests were washed out but estimates are between 60 and 90 nests were lost. Loss of nests due to predation from raccoons was estimated to occur in 12% of the nests. Disorientation was reported for 25 (1.7%) of 1450 nests. Approximately 13% of the hatchlings from the 25 nests were disoriented within the survey area primarily as a result of residential and resort lighting in reaches 3, 4 and 9.

CONCLUSIONS

The beach where the Jupiter/Carlin Shoreline Protection Project is proposed to be constructed supports a high level of nesting by loggerhead sea turtles. Nesting density was lowest in the reaches that had upland development or were impacted as a result of dredge spoil. Hurricane Andrew had a minor effect on the study area beaches similar to the effects of a typical northeaster or passage of a tropical storm. On wide beaches, turtles tended to nest proportionally closer to the high water line than the dune. Nesting success was slightly higher on the narrower than average beaches compared to the wider than average beaches.

Monitoring of sea turtle nesting activity over a number of years prior to and after construction is necessary to evaluate the effects of nourishment and to be able to understand the natural variation in nesting and separate out any project related impacts. Information from this monitoring program will allow the County and local jurisdictions to more effectively manage this beach and balance its value as sea turtle nesting habitat with its recreational and storm protection benefits.

ACKNOWLEDGMENTS

Funding for this project was provided by the Tourist Development Council of Palm Beach County. Kevin McAllister and Kristine Hahn provided valuable assistance with the nesting surveys.

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Jupiter/Carlin Sea Turtle Nesting Activity 1992

LOGGERHEADS (Caretta caretta), 3/1/92 to 10/6/92

NESTS AND FALSE CRAWLS, BY REACH

		False Crawls		Nests		Success
Reach	Miles	Count	Count/mile	Count	Count/mile	%
1	0.140	163	1164.29	30	214.29	15.54
2	0.127	165	1299.21	144	1133.86	46.60
3	0.246	253	1028.46	307	1247.97	54.82
4	0.106	44	415.09	23	216.98	34.33
5	0.179	86	480.45	121	675.98	58.45
6	0.251	334	1330.68	327	1302.79	49.47
7	0.192	175	911.46	189	984.38	51.92
8	0.197	204	1035.53	158	802.03	43.65
9	0.054	58	1074.07	42	777.78	42.00
10	0.077	121	1571.43	61	792.21	33.52
Totals & Means:	1.569	1603	1021.67	1402	893.56	46.66

Table 2. Summary of loggerhead nesting activity by reach.

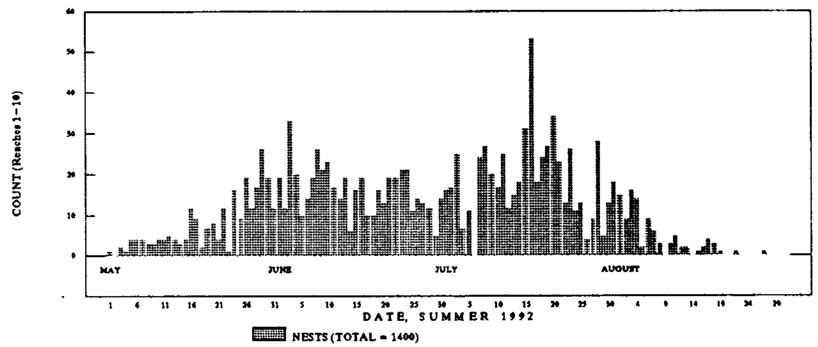

Figure 1. Loggerhead nest counts over time.

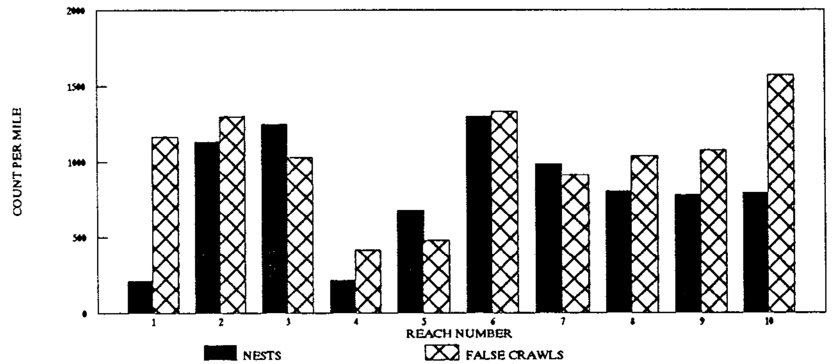

Figure 2. Loggerhead nest and false crawl density by reach.

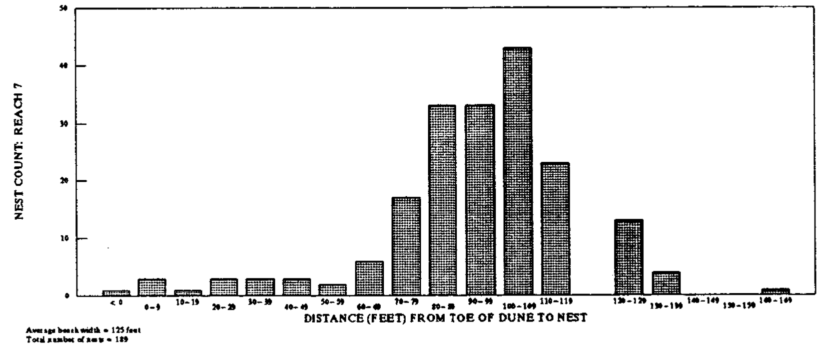

Figure 4a. Nest locations on wide beach.

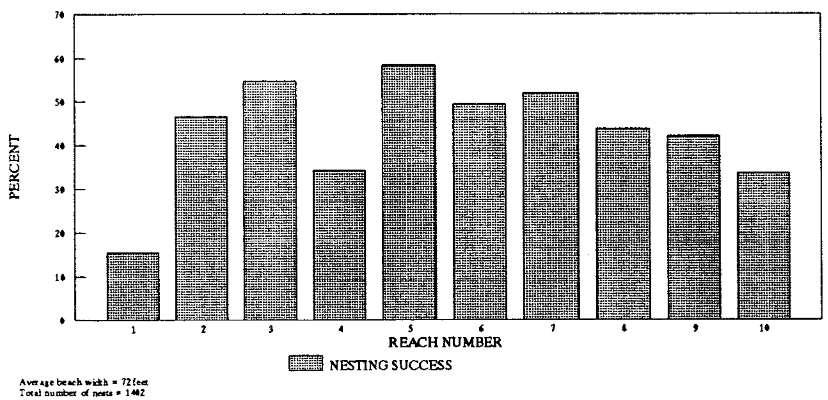

Figure 3. Loggerhead nesting success by reach.

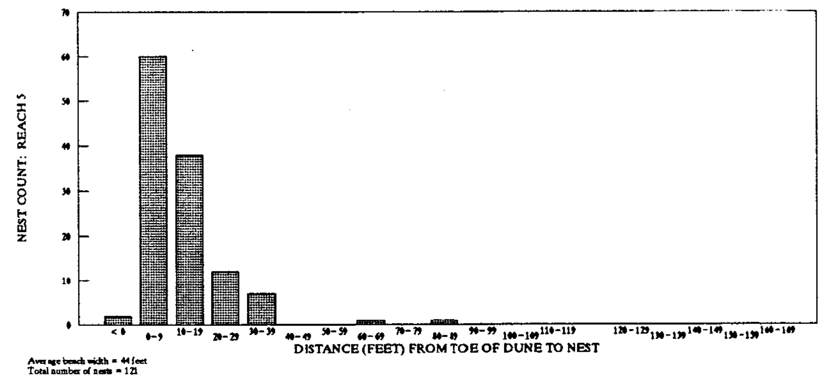

Figure 4b. Nest locations on a narrow beach.

EFFECTS OF HUMAN BEACH USAGE ON THE TEMPORAL DISTRIBUTION OF LOGGERHEAD NESTING ACTIVITIES

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Keith A. Rittmaster

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During the summers of 1990 through 1992 on South Core Banks of Cape Lookout National Seashore, North Carolina, we assisted the National Park Service in monitoring loggerhead turtle (*Caretta caretta*) nesting activity. This consisted of surveying the 36.8 kilometer stretch of ocean beach for crawls, digs, and nests and recording such data as date, location, and type of activity. As with nearly all ocean beaches in the southeast US, weekend beach use by humans is markedly greater than that during the 5-day workweek. With this increased visitation comes the associated vehicles, foot traffic, and lights at night. Typically, Sunday through Thursday is relatively quiet. This study sought to examine turtle beach activity patterns that might be related to the intra-weekly variations in human activity. Of the 378 activities recorded during the three year period, 168 were nests and 210 were digs or crawls. 46, or 35.1% of the activities on Friday and Saturday nights were nests while 121, or 49.6% of the activities on Sunday through Thursday nights were nests. The non-nest activities (digs or crawls) accounted for 55.6% of the total. 64.9% of weekend activities were digs or crawls, while 50.4% of the weekday activities were digs or crawls. These data suggest that the temporal distribution of loggerhead nesting activity is being altered by human activities on nesting beaches.

INTRODUCTION

South Core Banks is one of three barrier islands that comprise Cape Lookout National Seashore in the central coastal area of North Carolina. The island represents a significant northern nesting beach for the loggerhead sea turtle (*Caretta caretta*) (Conant, 1991). Each year Cape Lookout National Seashore rangers, resource managers, and volunteers monitor the 36.8 kilometers of ocean beach for sea turtle nesting activity.

The island is accessible only by boat. Park visitors come to the island via one of several ferries or on their private boats. Approximately 10 houses serve as private cottages and one fish camp rents cabins. Vehicles, which are brought over by ferry, are permitted on sand roads and ocean beaches throughout most of the island. Many visitors and most tenants at the summer cottages leave vehicles on the islands for their use when they arrive. Others bring vehicles just for the duration of their visit. Overnight tent and vehicle camping is permitted throughout most of the island's beaches. As is typical of most ocean beaches in the southeast United States, visitation on weekends is markedly greater than during the work week. Because human foot and vehicular activity on beaches at night has been known to adversely affect sea turtle nesting (National Research Council, 1990), this study sought to examine any turtle beach activity patterns that might be related to the intra-weekly variations in human activity.

METHODS

For this study we used beach nesting data for the nesting seasons of 1990, 1991, and 1992. Each morning, from May through August, a Park Service staff or volunteer patrolled the 36.8 kilometers of ocean beach for sea turtle activity (methods reported by Conant and Rikard, 1991). Once a turtle activity was found, data relevant to the time, location, and type of activity were recorded. The data recorded each day reflects the previous evening's activities, i.e. data recorded on Sunday represents activities from Saturday night. We considered weekdays Monday through Friday and weekends Saturday and Sunday. Activities, defined as either a crawl, dig, or nest, were identified as follows:

Crawl: turtle tracks not associated with any apparent digging activity by the turtle.

Dig: turtle tracks associated with an excavation in which large amounts of sand are disturbed but no eggs deposited. The area around all digs were further excavated systematically by the field observer to verify the absence of eggs.

Nest: a dig in which eggs were found.

For this study we combined the crawl and dig data as "non-nests". We used data provided by Park Service concessionaires to estimate the intra-weekly variations in human beach activity during the nesting season.

The data were analyzed by graphically comparing the human presence and types of turtle activities according to weekdays and weekends. We used a Chi Square statistical test (Schefler, 1979) to detect significant differences in the intra-weekly variations in types of sea turtle beach activities.

RESULTS

Sea turtle beach activities during the weekdays were approximately evenly distributed between nest (49.6%) and non-nest (50.4%)(Figure 1). Weekend activities showed a disproportionate increase in non-nest activities (64.9%) relative to nest activities (31.5%)(Figure 1).

We found a similar trend for weekdays in terms of average number of nest and non-nest activities (0.65 and 0.66 respectively) for each night during the nesting season (Figure 2). The weekend activities (Figure 2) also show a similar trend in that there are nearly twice as many non-nest activities (1.16) as nests (0.63). By comparing the average number of weekday nests and non-nest activities per night to those on the weekends, we see that the average number of nests are relatively consistent throughout the week (0.65 and 0.63 respectively) whereas the average number of non-nests activities is substantially greater on the weekend nights (1.16) as compared to the weekday nights (0.66) (Figure 2). Chi Square analysis showed no significant difference in nesting activity between weekdays and weekends. When comparing non-nest activity, however, the differences between weekends and weekdays were significant ($p<0.05$).

The limited available visitor data during our study period shows an increase on weekends versus weekdays in both the average numbers of vehicles (73 and 62 respectively) and overnight visitors (64 and 23 respectively) recorded at specific sites on the island (Figure 3).

DISCUSSION

The average number of turtle nests per night on South Core Banks during the nesting season was relatively consistent throughout the week while the number of non-nest activities increased dramatically on the weekends. This suggests that individual turtles may be coming on to the beach and turning back to the ocean without nesting more often on weekends than on weekdays. Female loggerhead turtles are known to return to the sea if disturbed by lights and\or moving shadows during the early stages of nesting (Caldwell et al., 1959 and Margaritoulis, 1985 as reported by U.S. Fish and Wildlife Service, 1988). Mann, 1978, suggested that automobile headlights may deter nesting.

The visitation data reflect higher weekend beach usage. Although human night beach activity data are lacking, we have repeatedly witnessed vehicles, campfires, flashlights, and other detectable human movement on beaches at night. Often visitors will congregate to the sight of a sea turtle on the beach at night.

We currently have no way of estimating the long term effects of these beach disturbances on the reproductive success of sea turtles. In the case of threatened and endangered sea turtle species, waiting for these data may not be timely. To better understand human beach activity at night, observers on beaches or perhaps questionnaires at the ferry docks would be helpful. We recommend comparing this study to a similar study on beaches that have limited human beach activity at night and no vehicles (perhaps Bald Head Island, NC) to test for corroborative results. The potential for nesting sea turtles to abort nesting attempts, shift nesting beaches, delay egg laying, and select poor nesting sites in response to nighttime human activity exists (National Research Counsel, 1990). Enforceable regulations and public education in the schools, workplaces, ferry docks, and on beaches, is critical in the effort to insure the future of these threatened and endangered species.

ACKNOWLEDGMENTS

Thanks to Mike Rikard and Jeff Cordes of Cape Lookout National Seashore for the data and opportunity to participate in the data collection and analysis. Thanks to Therese Conant of the North Carolina Non-Game Endangered Wildlife Program for the help with the graphics and her enthusiasm for our work and sea turtle research and conservation. Thanks to Victoria Thayer of the National Marine Fisheries Service for editorial assistance and scientific scrutiny.

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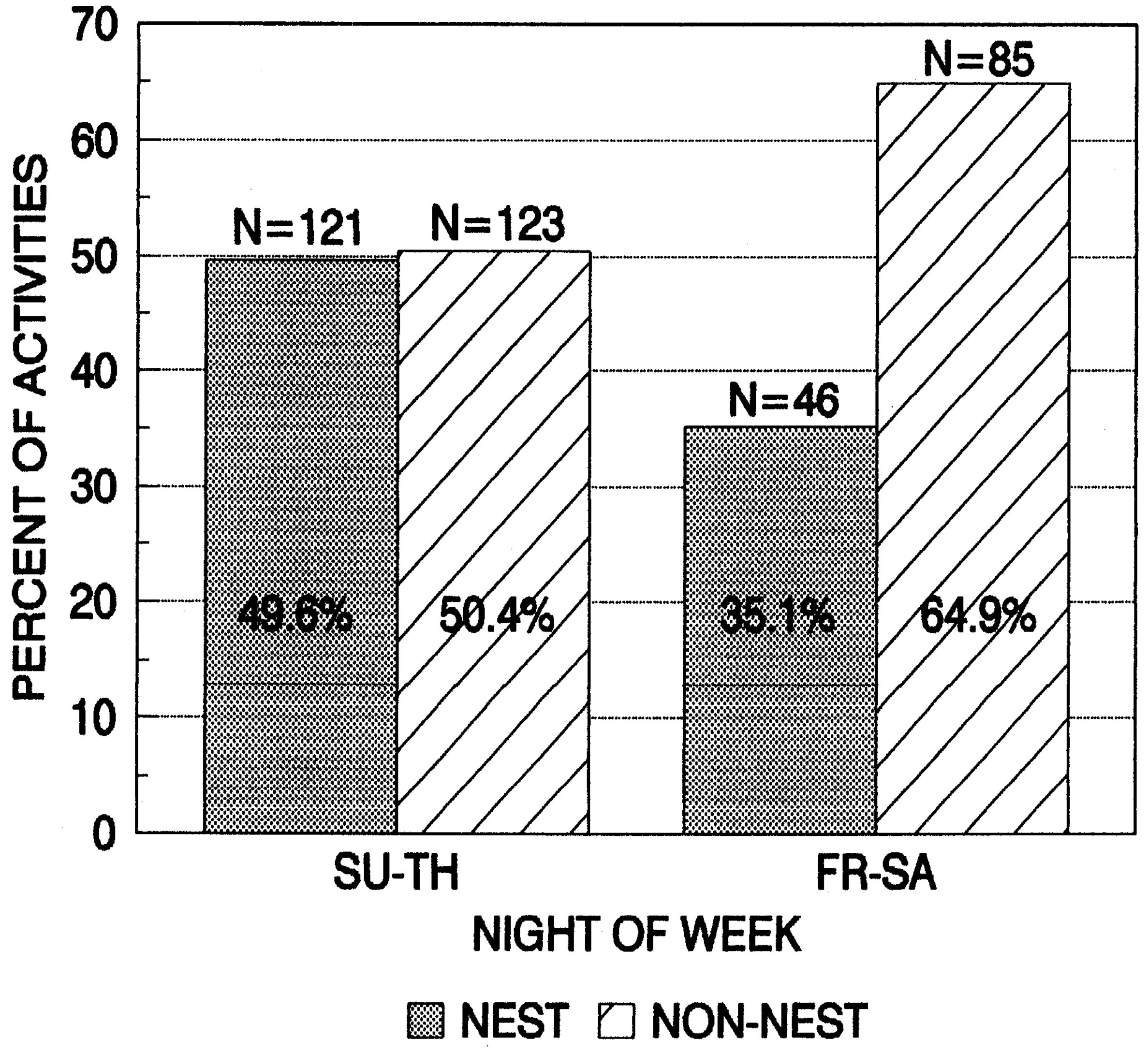

Figure 1. Relative frequency of loggerhead nest versus non-nest beach activities, South Core Banks, North Carolina 1990-1992.

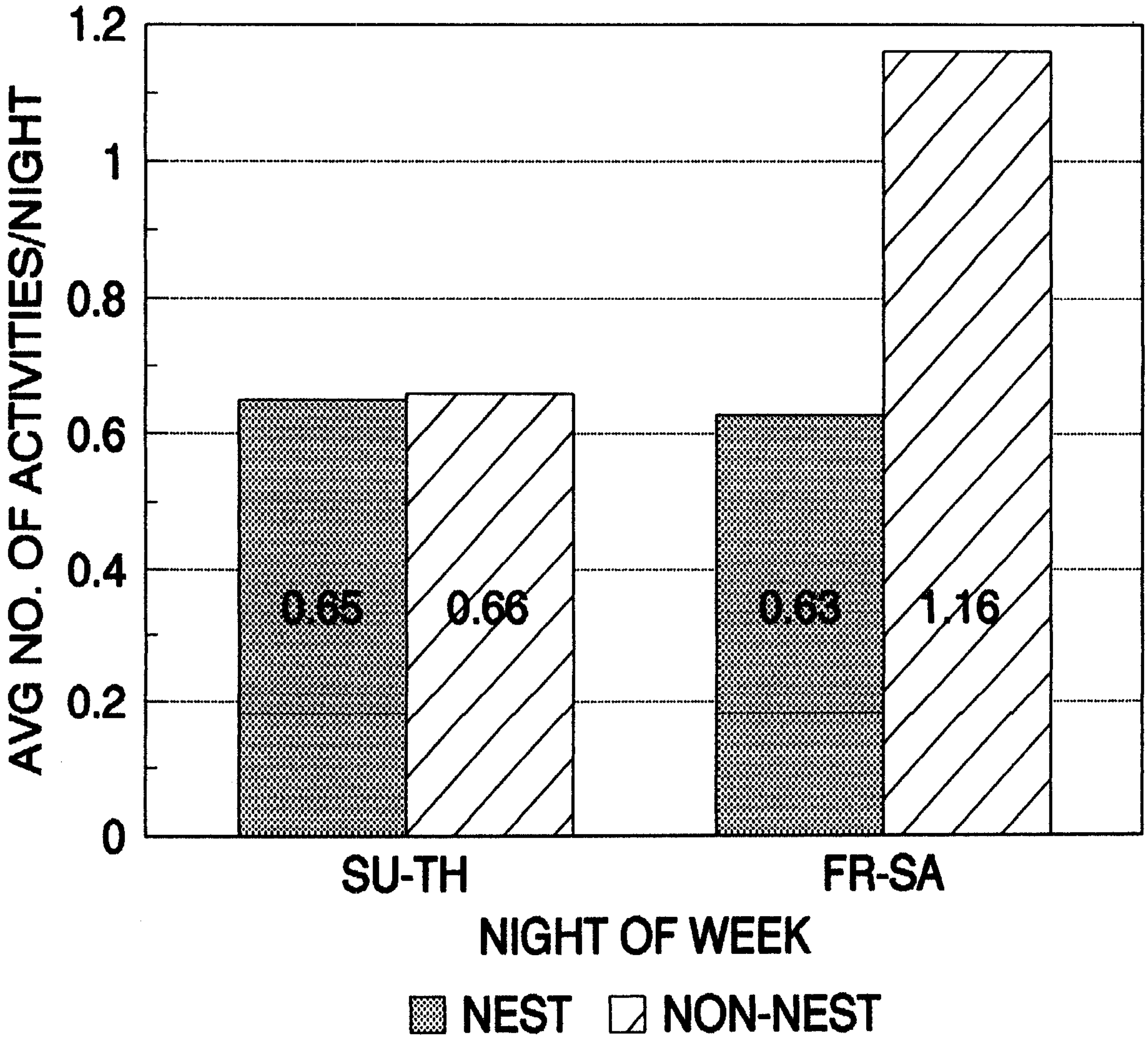

Figure 2. Loggerhead nesting activity, South Core Banks, North Carolina 1990-1992.

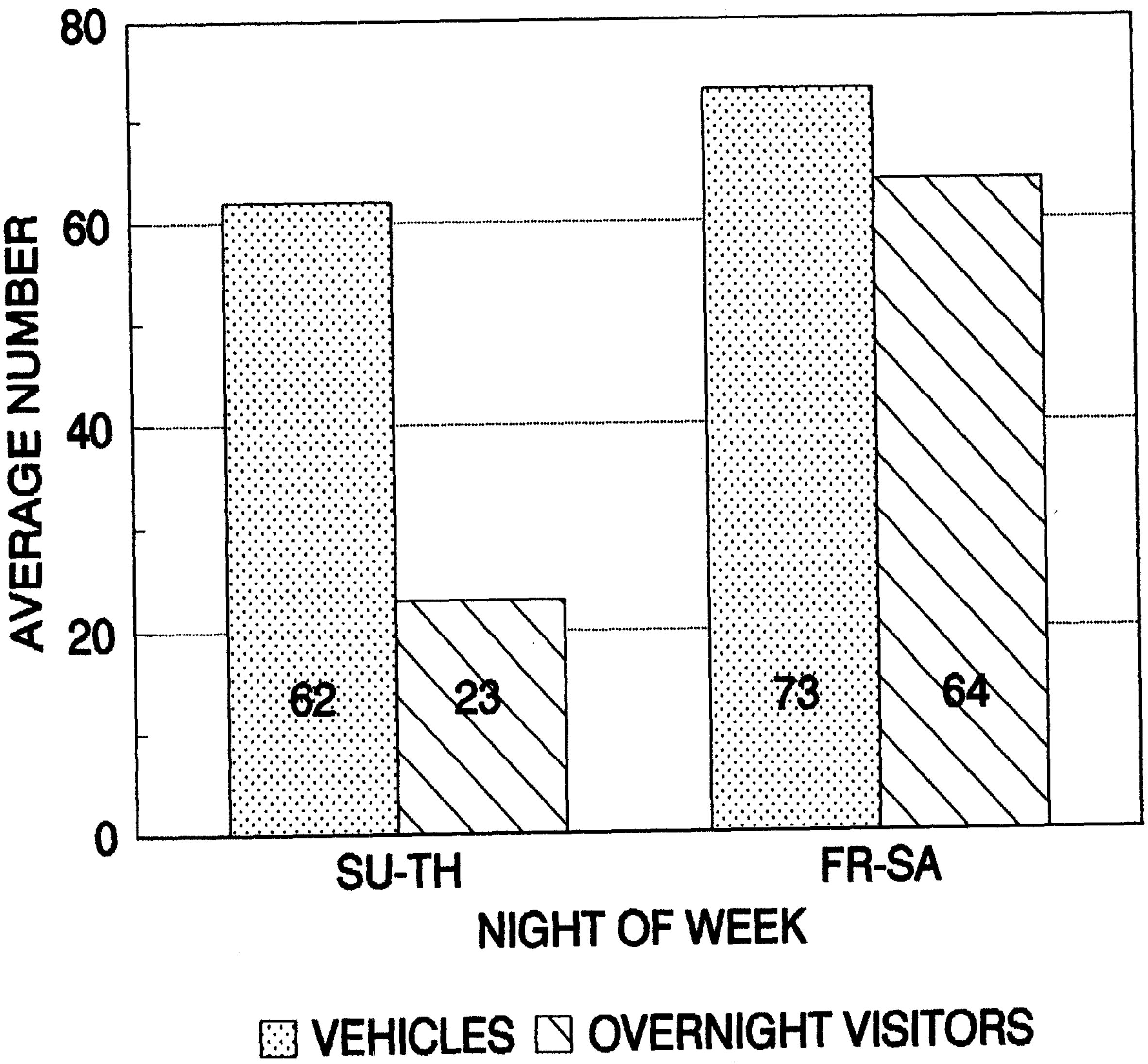

Figure 3. Visitation to South Core Banks, North Carolina
May 18 through July 24, 1992.

DETECTING H-Y ANTIGEN IN THE WHITE BLOOD CELLS OF LOGGERHEAD TURTLES (*Caretta caretta*): A POSSIBLE SEXING TECHNIQUE

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Because sexual differentiation in marine turtles is temperature-dependent, studies of hatchling sex ratios are essential. Unfortunately, these studies are hampered by a current inability to sex hatchlings of these endangered species without sacrificing them. I am investigating the possibility that the sex-specific H-Y antigen expressed on white blood cells (WBCs) may be used as an indicator of sex in hatchling loggerhead turtles (*Caretta caretta*). To confirm sex-specificity of this antigen, I have used three techniques to study H-Y antigen on the WBCs of adult loggerhead turtles: 1) indirect immunofluorescence of the H-Y antigen detected by fluorescence microscopy; 2) indirect immunofluorescence of the H-Y antigen detected by flow cytometry; and 3) enhanced chemiluminescence (ECL) of the H-Y antigen detected by X-ray film after Western Blot. So far, none of the techniques have reliably detected H-Y antigen. The results have been inconsistent both among the experimental samples and among the control samples. For example, control samples known to have H-Y antigen (positive controls) have tested both positive and negative for the antigen and negative controls have also tested both positive and negative for the antigen. However, because the H-Y antigen is a minor histocompatibility antigen and reacts very weakly with antibody, these type of inconsistencies are not uncommon. Continued refinement of the techniques may lead to more consistent results and an ability to properly evaluate the potential for use of the H-Y antigen as an indicator of sex in loggerhead turtles. Among the techniques used in my study, the Western Blot with ECL had certain attributes that made it the most promising for continued refinement as a method of detecting H-Y antigen.

SEA TURTLE PEN PALS: A PROPOSAL FOR INTERNATIONAL ENVIRONMENTAL EDUCATION

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BACKGROUND

Environmental issues are of concern to the citizens of most nations, but many basic environmental problems are still only partially appreciated - much less resolved. The severity, complexity and diversity of these problems continue to expand, while the human situation is in a precipitous decline, whether measured in terms of nutrition, health, shelter, material wealth, education, culture, aspirations for the future, or peace.

Because environmental problems are as a rule highly complex, involving a wide variety of human activities and ecological phenomena, it is difficult for the average person to arrive at more than a superficial understanding of the issues, causes, and alternatives for resolution. This conceptual difficulty is even greater in children, who lack wide experiences and an understanding of the complexities of the modern world.

An appreciation of the interdependency of human activities and human well-being on the one side, and environmental issues on the other, is fundamental to providing a true understanding of these issues and their potential resolutions. Involving children in this process is more than a means of ensuring better educated adults for the future: the guileless questions and innocent perceptions of children provide new avenues of discussion and innovative visions for solving problems.

Remarkably, efforts to educate the general public about global environmental matters are directed by adults, and in many ways focused on adults. Even basic information is often not explained to children, and their perceptions of the magnitude of environmental problems are badly restricted. It is essential that children be better informed and more involved in global discussions about environmental problems and also in just resolutions of these issues.

One of the most effective ways to involve children in this process is through educational programs. In public education, there is a need (at least at the outset) to focus attention on simplified, but key, environmental issues. An effective strategy to accomplish this is through the use of a "Flagship species"; this involves spotlighting a particular species that typically is charismatic, conspicuous, attractive to the general public and identified with ease. By protecting the flagship species, numerous requirements basic to other species, the ecological community, and critical ecological processes are assured. For many years now, marine turtles have taken on a role of international flagship species. In addition, there is a boundless variety of problems involved in the conservation and rational utilization of these animals. The conservation status of sea turtles is a valuable barometer of environmental conditions and human attitudes about safeguarding our global environment.

OBJECTIVES

The goals of Sea Turtle Pen Pals are to involve children from a variety of countries in active discussions and interchanges, about environmental issues. Sea turtles will be used as an international flagship species to draw attention to global problems. Through exposure to educational materials and specialized activities, and then the interchange of letters, it is hoped that the participants will become better informed about global concerns and take more active roles as world citizens. Their concerns will impact their parents, other adults, and in the end decision makers in their respective communities.

In addition, educational materials and activities will be developed, and environmental educators will be trained. Didactic materials formulated during the project will be systemized, edited and distributed for further educational activities.

METHODS

Networks of Pen Pals will be established by two methods. Conservationists directly involved in environmental education, and particularly those with some involvement with sea turtles, will be contacted in various countries. In most cases, these primary contacts will be colleagues, or ex-students, with whom the Principal Investigator has worked closely in the past on conservation and educational matters.

In addition, contacts will be made through the European Council of International Schools. This international network of schools is renowned for the high quality of education, the multinational student body, and involvement with the local community on matters of global concern. The existing newsletters which circulate among the scores of International Schools the world over provide an effective way to tie into an already existing educational network. In this way both teachers and students will be invited to participate in the project.

Those people who express interest in the project will be invited to send ideas on didactic materials, educational activities and also on organizational aspects of the project. They will be requested to send names and addresses of children from their respective communities who they judge most likely to have the interest and initiative to learn from the interchange of educational materials and activities and then to become active participants in the interchange of letters discussing environmental issues and possible solutions.

Two pen pal networks will be set up: an international network in English, and an American hemisphere network in Spanish. The latter will facilitate international communication over Latin America. The former will be used in all countries, including those in Latin America where Pen Pals want to exchange letters with peers outside of Latin America.

Each contact person will meet with children, explaining the objectives of the project, providing them with counsel, and helping with the interchange of educational materials and activities. Except for students in Europe, industrialized Asian countries, the USA and Canada, up to US$500.00 per contact will be provided for materials such as local picture postcards, stamps, pens, stationary, and organizational costs.

Educational materials will be solicited from international conservation organizations and distributed to contacts in different countries. Letters of endorsement from international organizations will be provided to network contacts to help them strengthen their institutional support at the local level.

Ultimately as many contacts and as many Pen Pals as possible from the greatest diversity of countries will be integrated. However, this ambitious objective will be attained by gradual, directed development and strengthening of the program. During the first year special attention will be given to supporting no more than 20 international contacts and the Pen Pals with whom they work.

In addition to cultivating the international contacts and Pen Pals, special emphasis will be given to developing environmental education programs in Mexico. This country has a unique and very special situation in regard to marine turtles: the greatest diversity of species, some of the largest breeding populations in the world, a wide variety of direct cultural and economic ties to marine turtles, and some of the most difficult and complex problems in regard to conservation and management of this resource. Also, there is a pressing need to consolidate and strengthen existing environmental education activities in Mexico. Both governmental and non-governmental organizations have been involved in educational programs, but frequently these lack continuity, clear objectives and adequate methods of evaluation and subsequent improvement.

The educational programs to be developed simultaneously with the Sea Turtle Pen Pals will include special activities and educational materials, which will be developed with children from both urban and rural backgrounds in Mexico. Attention will be focused on children in the yucatan Peninsula and Mexico City. On the basis of these experiences, didactic materials and activities will be designed and modified for the international networks.

A trimestral newsletter, explaining the objectives, advances and problems, will be distributed to participants. Remarkable cases of contacts, Pen Pals, and/or schools and other institutions will be described in order to explain and disseminate their techniques, to understand their reasons for success, and also to give them public acclamation and credit for good work.

At the end of the first year, diplomas will be awarded to students, contacts and schools and other institutions who participate actively in the program. Awards will be awarded to those participants who excel in certain criteria: e.g. those who show the best understanding of the issues, the most innovative ideas for solving environmental problems, and those who develop the strongest international ties with other Pen Pals.

The educational materials and activities developed will be made available to governmental departments responsible for formal education as well as other organizations involved in environmental education.

An inherent aspect of the program will be the sensitization of teachers and educators about the importance of environmental education. Teacher training activities will be provided (either informally or formally), notably for urban and rural schools in Mexico. University students will assist in the program, and at the same time be trained in techniques for teaching and evaluating environmental educational.

EVALUATION

The short term achievements of the project will be evaluated in several ways: 1) totaling the number of contacts and number of Pen Pals who initiate, and calculating the proportion that finish the first year; 2) selecting those Pen Pals, contacts, and educators who remain active throughout the first year and assessing the difference in environmental awareness at the beginning and at the end of the first year; 3) assessing any differences, before and after exposure to the program, in the effectiveness of educators in teaching environmental issues; 4) soliciting opinions about the strengths and weaknesses of the program from the contacts, educators and conservationists involved in various aspects of the project; 5) soliciting opinions from the Pen Pals themselves; 6) soliciting opinions (via the contacts) from community leaders.

The educational programs carried out in Mexico will be evaluated by comparing "before and after" levels of knowledge and awareness in environmental issues, and assessing "before and after" differences in attitudes and actions related to these issues. These investigations will be carried by means of interviews and spot inspections, which will be conducted with participating and non-participating children, their teachers and parents, and a small sample of people from their respective communities.

At the end of the first year coordination workshops will be held with Pen Pals, educators and institutional directors to discuss the results of the evaluations. On the basis of this information and the workshop results, the activities, materials, and organization will be improved and strengthened for future use.

A NEW AREA FOR MARINE TURTLE RESEARCH IN QUINTANA ROO, MEXICO

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For two consecutive years, research has been carried out in the central portion of the Biosphere Reserve of Sian Ka'an in Quintana Roo, Mexico. The beaches (14 km.) have been monitored during the 1991 and 1992 nesting seasons (May-September) for loggerhead (*Caretta caretta*) and green turtle (*Chelonia mydas*). Given the natural conditions prevailing in the nesting site, nesting conduct and conditions of incubation are maintained intact. According to Hildebrand (1987), only 32% of the mainland Mexican Caribbean coast or approximately 135 km are suitable for nesting marine turtles. This new area will increase this by 10%.

METHODS

The beaches patrolled nightly (22:00-02:00) from June to July 1992, comprised the first five km. beach section from Punta Pajaros to Punta Piedra. Upon encountering a nesting female, the date, location and species were recorded. Over the carapace length (OCL) and width (OCW) were measured using plastic measuring tapes and both front flippers were tagged using monel type tags.

Daily diurnal surveys were made of the entire 14 km. stretch of beach to register any nesting activities accomplished after the nightly patrols, and in the beach section that was not covered. Any nest having more than 50 days of incubation was located using a wooden probe and the nest contents were exhumed and examined. Beach cross sections were taken on a monthly basis (June-September) to assess morphological change of the beach front.

RESULTS AND DISCUSSION

During the 1991 nesting, 133 loggerhead crawls were registered, whilst 238 crawls were registered in 1992. Loggerheads nested primarily in the stretch of beach that was patrolled nightly having an average of 35.8 crawls/km (Figure 1). Many of these activities resulted in aborted nesting attempts, characteristic of the species (Dodd, 1988). Eight female loggerheads were tagged and no recaptures were reported. The average OCL was 96 cm; values below the average reported for nesting females in northern beaches such as Xcacel (Zurita, 1989). The reason for this discrepancy is unknown.

During the 1992 nesting season, no green turtle nestings were recorded (Garcia, 1991). The 1992 nesting season had 74 nesting activities. Further studies will provide information on the possibility of a single biannual nesting population.

The nesting season of both species is in accordance with those reported for the Caribbean (Fowler, 1979; Bjorndal and Carr, 1989; Marquez, 1990) and those reported for Quintana Roo (Zurita, 1989) (Figure 3).

Sixty four loggerhead and twenty seven green sea turtle nests were exhumed. Out of these, 7,299 loggerhead and 2,549 green turtle hatchlings were released. For both species in the 1991 and 1992 nesting seasons, the percentage of fertile eggs and the hatch success was above 80% (Figure 3). Nest predation was basically limited to small mammals and man, accounting for 5.5% of nests in the area.

Beach dynamics play an important role in nest success in the area (Hopkins, 1988). The beach morphology changed drastically in June, losing approximately 5 m. of the original beach width. This change affected the first nesting activities of loggerhead sea turtles (approximately 25% of the total amount of nests laid) but did not affect Green turtle nestings as these occurred after the change in beach morphology.

The bottom of Bahia Ascencion has wide areas of marine grass and extensive algal beds. Juvenile stages of hawksbill and green sea turtles are found. Future studies will reveal the importance of this area as a refuge for juvenile stages of marine turtles.

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SOME ASPECTS OF A SHORT COURSE ON SEA TURTLE BIOLOGY AND CONSERVATION HELD AT ISLA DE MARGARITA, VENEZUELA

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Because it is necessary to involve many people in sea turtle conservation and research, a short course on sea turtle biology and conservation was implemented. The course was held between July 30 and August 2, 1992, at the Universidad de Oriente (Guatamare, Nueva Esparta Nucleous). It was sponsored by the Instituto Nacional de Parques (INPARQUES), Centro de Conservacionismo y Excursionismo y Universitario (CCEXU), Universidad de Oriente (UDO-NE) and the Wider Caribbean Sea Turtle Conservation Network (WIDECAST).

The course was comprised of lectures and technical sessions. The lectures included: 1) history, taxonomy and world distribution; 2) general aspects of biology, 3) direct and indirect identification of the different species; 4) methods of tagging, weighing, types of census, determination of the sex, observations on the reproductive behavior, counting of eggs and marking of nests; 5) registering of the field data (tracks, nests, stranded turtles), necropsies, use of interviews, guidelines for the nightly observations; 6) translocation of nests, hatcheries, liberation of hatchlings; 7) marine behavior observations; 8) stomach and blood sampling, laparoscopy; 9) problems affecting the survival of the marine turtles; 10) national laws and international agreements on the protection of the sea turtles; 11) strategies of conservation in Venezuela; 12) programs of research and conservation in Venezuela; 13) needs of research and conservation of the sea turtles in the Isla de Margarita; 14) audiovisual presentation: TAMAR Project (Brazil).

The technical sessions included: 1) measurements and identification with collection material and captive sea turtles; 2) diurnal field work to recognize the sea turtle tracks and nests; 3) necropsy; 4) evaluation. The course was taken mainly by undergraduate students, but moreover, we had participants from two governmental offices, related to sea turtle conservation: the Ministry of the Environment and Natural Renewable Resources and the Ministry of Agriculture and Husbandry. We are planning at least two more courses more in 1993. One of them will again be held at Isla de Margarita, but with participation of students of the mainland nucleous of the University. We hope to have at least one day more for the course, in order to have more field work and to incorporate lectures from people from governmental and non-governmental organizations.

SEA TURTLE CONSERVATION PROGRAM AT BARRA DE SANTIAGO, EL SALVADOR

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This report presents the results achieved throughout the development of the third consecutive season of efforts on behalf of the sea turtle population which nests at Barra de Santiago through the Sea Turtle Conservation Project at Barra de Santiago, El Salvador-1991. Sea turtle conservation projects have been developed in a sporadic, non-continuous manner since 1974 and at very few beaches in El Salvador. Past efforts have focused primarily on hatchling production through processes such as the prohibition of egg gathering and buying eggs from egg gatherers (poachers) and have not been executed as joint efforts between the institution responsible for the project and the local community. Since 1989, the Sea Turtle Conservation Project in Barra de Santiago (August-December) has been an ongoing project financed by the U.S. Fish and Wildlife Service and the World Wildlife Fund for Nature, and executed jointly between a local non-governmental organization (Amigos del Arbol, AMAR), the National Parks and Wildlife Service (CENREN), and the Natural History Museum of El Salvador. The project actively involves the local community in the difficult task of implementing an adequate sea turtle management system, promoting the ecological recovery of this species.

METHODS

Barra de Santiago is a 9 km sandy beach which divides the Pacific Ocean waters from Barra de Santiago's estuary and mangrove ecosystem. It is located on the western tip of El Salvador, 35 km east of the Guatemalan-Salvadorean border (13° 42' N and 90° 02' W). It is utilized as a nesting beach by *Lepidochelys olivacea* and *Dermochelys coriacea*. The project integrates three strategic components: environmental education, research, and dissemination.

Environmental Education

The project considers the local school as its nucleus. Environmental education activities were developed in and outside the classroom. Talks, group dynamics and arts and crafts contests were held involving not only the schoolchildren but their parents as well. Three turtle egg hatcheries were built at the school playground which is located on the ocean front. A cement tank (3 x 1 m) was built next to the hatcheries in order to headstart thirty *Lepidochelys olivacea* hatchlings. Turtle eggs were voluntarily buried by egg gatherers in exchange for staple food and first necessity items through a local Turtle Market Barter System. Each egg gatherer exchanged a minimum of 30 eggs for a product equivalent to its price (1 egg = 1 point = $0.12 US) and a dozen more eggs as a donation totalling 42 eggs. At the end of the turtle season (December) the hatchlings headstarted by the schoolchildren were released as an eco-theological symbolic retribution to the ocean, an activity which was named "a christmas gift to the ocean."

Research

The local egg gatherers, 142 in total, received a biological kit consisting of a notebook, a tape measure and a pencil in order to obtain adult female turtle measurements (curved carapace length, curved carapace width, head width) and timing in relation to nesting (tide, moon phase, weather conditions). In addition, hatchery thermodynamics and sand humidity were monitored. The three hatcheries were subject to different degrees of shading (no shade, partial shade, total shade). Hatch success was evaluated. Growth patterns of thirty *Lepidochelys olivacea* hatchlings were monitored through a one year period (carapace length and width, head width, weight). Treatment for fungus growth, *Candida albicans*, on hatchlings was tested using clotrimazol, dexamethasone and azidamfenicol. Nesting turtles were tagged.

Dissemination

As a means of educating people that generate the demand for turtle eggs as well as to create a general expectation and public opinion in relation to the sea turtle recovery program, TV and radio spots were broadcasted and turtle news was published in the national press.

RESULTS AND DISCUSSION

Environmental Education

Through the active participation of the school children, parents and egg gatherers in the development of the project, the local community as a whole, assimilates with greater ease the concept of sustainable use and management of sea turtles. The paintings and crafts made by the schoolchildren indicate their knowledge on sea turtle problems and the actions they must take to solve these. The success of the environmental education program must depend on the degree by which the project incorporates the community in participating in the recovery of the species in mention, and on the continuity of the program. A total of 152 nests containing 6,991 eggs were buried at the school hatcheries by local egg gatherers. These nests represents 56% of the total nests detected.

Research

A total of 82 nesting turtles, *Lepidochelys olivacea*, were measured obtaining an average curved carapace length of 69.5 cm, an average curved carapace width of 70.1 cm, and an average head width of 10.9 cm. A direct relationship between turtle size and number of eggs laid was observed (r=0.912). The total of nestings through the projects period, August-December, rose during the month of September and were detected mostly on the new moon phase (39%) followed by quarter moon phase (23%). The average hatch success was 69.7% with an average of 46 eggs per nest. Hatchery No. 1 (no shade) averaged a 40% hatch success and an average incubation time of 47 days. Hatchery No. 2 (total shade) averaged a 90.2% hatch success and an average incubation time of 53 days. Hatchery No. 3 (partial shade) averaged a 79% hatch success and an average incubation time of 44 days. Total Shade Hatchery thermodynamics were: 32.5 C average temperature in August, 29.0 C in October, and 31.1 C in November. Hatchery sand humidity was 10.5%. Through a period of 12 months, the thirty headstarted turtles averaged 22.1 cm in curved carapace length and an average weight of 1387 g. A 70% success was observed with clotrimazol, dexamethasone, azidamfenicol treatment for fungus.

Dissemination

The activities under the present project were broadcast through four TV channels, three main national newspapers, and two radio stations, throughout the project period. These efforts focused mainly on the urgent need to approve a sound legislation for the protection and conservation of sea turtles, to promote the use of Turtle Excluder Devices in shrimp boats and to reduce the general demand for turtle eggs.

The success of the present project can only be monitored on a long term basis. Additional continuous efforts are necessary in order to further organize the local community in the adequate management of the sea turtle population. Sea turtle research is needed not only in Barra de Santiago but on all Salvadorean beaches for the elaboration of a national sea turtle recovery program.

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PROGRESS IN THE EXPERIMENTAL TRANSMISSION OF GREEN TURTLE FIBROPAPILLOMATOSIS

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Green Turtle Fibropapilloma (GTFP) disease has become a worldwide threat to green sea turtle populations. In an effort to discover the etiology and understand the pathogenesis of this disease an ongoing series of transmission experiments have been undertaken at The Turtle Hospital, Marathon, Florida. This is a progress report.

Nine one-year old captive-reared green sea turtles were exposed by various routes to GTFP or possible etiologic agents. Three turtles were injected with eggs of spirorchid trematodes at various body locations to test the hypothesis that eggs may cause or enhance tumor development. Three turtles were allowed to swim and have physical contact with a GTFP bearing animal. Two turtles received GTFP tumor that had been treated in various ways: (1) whole tumor (dermis + epidermis) transplants, (2) tumor dermis transplants, (3) tumor tissue homogenate, and (4) tumor homogenate that had undergone two freeze-thaw cycles. One turtle was maintained as a control whose only exposure would be via filtered Florida Bay/Gulf water.

None of the control, contact exposed, or trematode egg treated turtles have developed disease in the 12 months since the experiment began. Both turtles inoculated with GTFP tumor developed tumors only at the site where they were injected with twice freeze-thawed tumor homogenate. Tumor growth became apparent within 5-6 months and progressed rapidly with the coincident seasonal rise in water temperature. Once in log-phase growth, tumors reached approximately 2cm in diameter in one animal and 5 cm in the other before they were surgically debulked.

The success of the freeze-thaw treatment suggests that a virus may be involved because this treatment should lyse cells and release virus. However, we cannot preclude the possibility that some intact and viable tumor cells were transplanted in this treatment. Further experiments are under way to reproduce these results and differentiate between tumor cell transplantation and virus transmission. At this time it seems unlikely that trematode eggs are a primary cause of GTFP.

INCIDENTAL CAPTURE OF SEA TURTLES IN THE SOUTHERN PART OF QUINTANA ROO, MEXICO

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Incidental catch or take is defined as the capture of species other than those towards which a particular fishery is directed (Hopkins and Richardson, 1984). The incidental catch of sea turtles by shrimp and fish trawl vessels from Yucatan state have been reported in the northern zone of the state of Quintana Roo (Zurita 1985). This paper is based largely on research conducted by Herrera in his thesis work (Herrera 1991).The evaluation of the incidental capture of sea turtles (in the commercial fisheries carried out by fish traps, gill nets and shark nets) was conducted from May 1989 to February 1990, in the southern part of the mexican Caribbean.

RESULTS AND DISCUSSION

In 1989, 35 traps (beach weirs) were weekly surveyed from Mahahual to Xcalac, Quintana Roo, Mexico. The local independent fishermen operate them from September to December. Six additional weirs were located in the bay of Chetumal, which were used from May to July. Beach weirs ("trampas de corazón y cola"), have been used along the southern coast for at least thirty years (Miller,1982); their numbers have been increasing during the last 10 years (Herrera, 1991). Incidental capture of sea turtles in beach weirs has not shown any records of mortality. On the other hand, the use of shark nets and gill nets (> 15 cm mesh) are considered to cause high mortality. Therefore, their future numbers to be used is critical in the conservation of the resources of the region. Presently, cooperative fishermen catch lobster and conch in the same fishing grounds. We suggest a tagging program, supervised by the biologists working in this area with the help of the fishermen, because it is a major feeding area for juveniles through adult for both the green, *Chelonia mydas* and hawksbill, *Eretmochelys imbricata*, and for subadult through adult loggerheads, *Caretta caretta*. We suggest that this area may be a sea turtle corridor between Mexico and Belize. Thus, we propose to implement an agreement between both countries that help research and sea turtle protection, considering that fishing techniques are similar in both countries.

ACKNOWLEDGEMENTS

We thank to the fishermen of Southern Quintana Roo for their support during field work.

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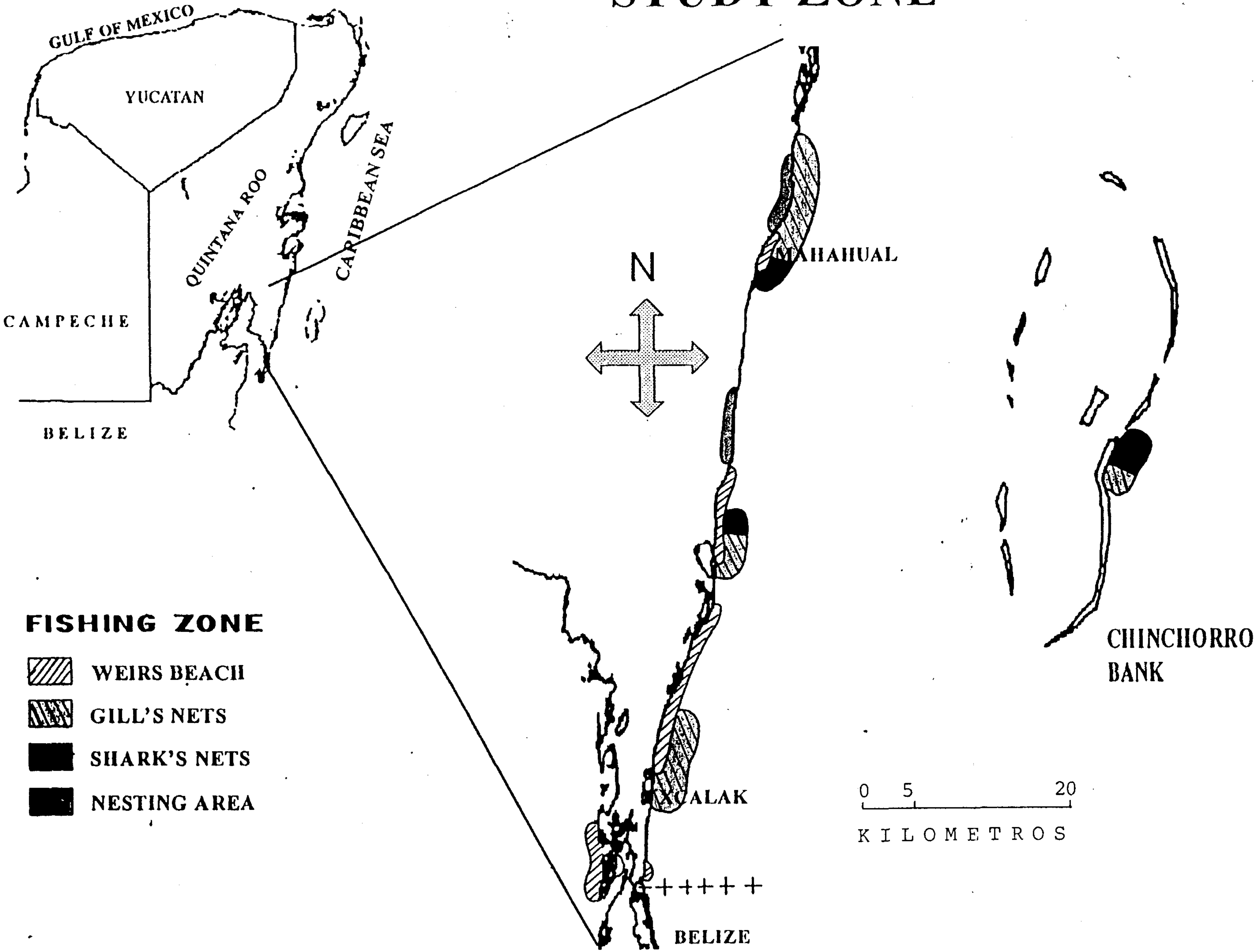
STUDY ZONE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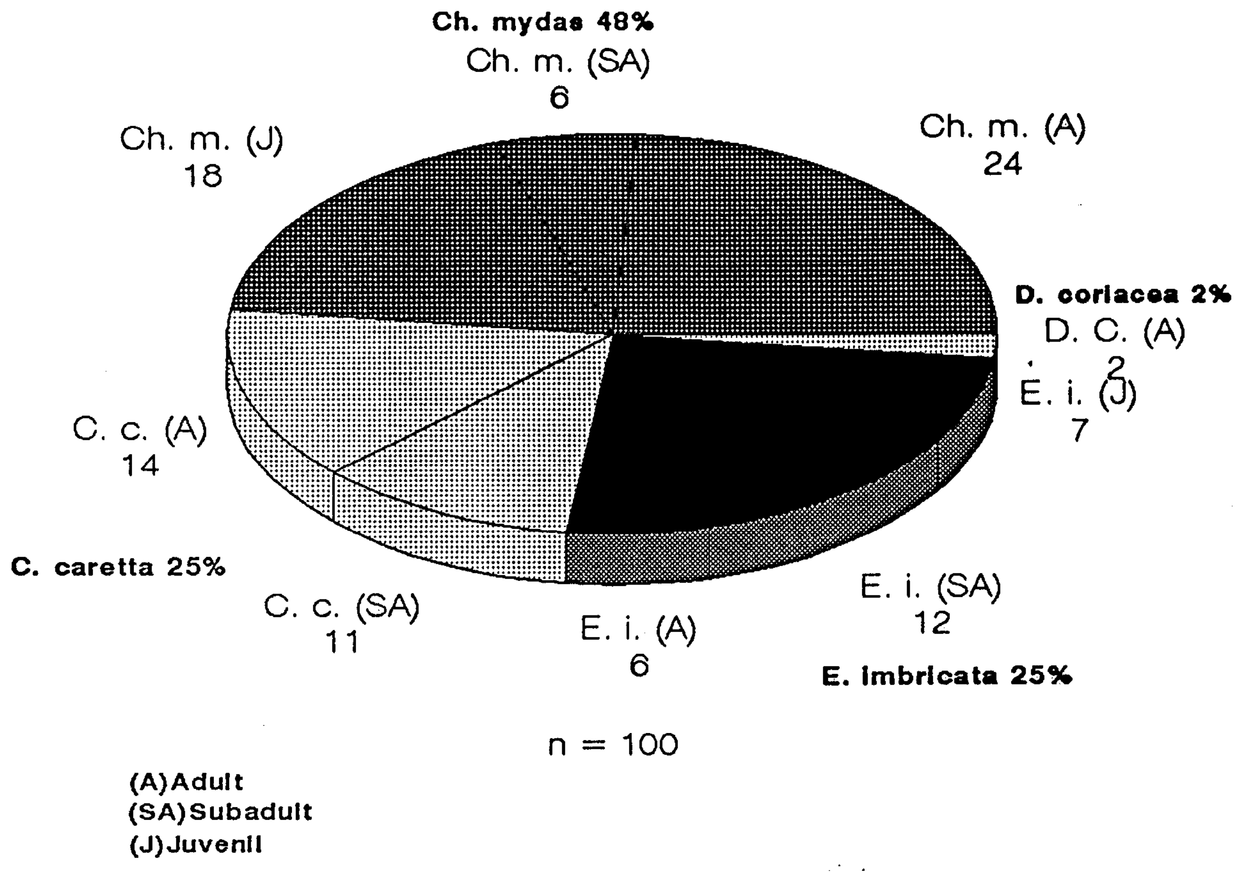
GILL'S NETS
SHARK'S NETS
NESTING AREA

Figure 2 Proportion of sea turtles recorded in southern Quintana Roo



THE FIRST FIVE YEARS AT BUCK ISLAND REEF NATIONAL MONUMENT - THE HAWKSBILL STORY

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The end of the 1992 nesting season marks the completion of five field seasons of nocturnal research on the hawksbill sea turtles nesting at Buck Island Reef NM (BUIS). Through the years, the program has increasingly emphasized a complete census of the nesting hawksbills, determination of their nesting requirements, and their overall nesting success. We continue to monitor the recovery of the nesting beach from hurricane Hugo and its effects on sea turtle nesting. The 1992 season was the first year several tagged hawksbills were observed for their third nesting season and their nesting site fidelity was closely monitored.

METHODS

The methods used on BUIS to monitor the nesting hawksbills have been described in Hillis & Mackay, 1989. Patrol nights have ranged from 40 nights in 1988 to 95 nights in 1991. This year, 79 nights were spent on the nesting beaches, and as in all prior seasons the beaches were monitored daily prior to and after the nocturnal research period to keep an accurate record of total number of sea turtle activities for the year. As always, volunteer assistance was essential to maintaining the 7 nights per week coverage.

RESULTS AND DISCUSSION

Annually, nocturnal observation of nesting hawksbill sea turtles (*Eretmochelys imbricata*) begins the end of June and continues through the end of September. Each year this has covered the peak months of nesting activity, July, August, September, however nesting frequently continues through December. The number of hawksbill activities recorded each year has ranged from 113 to 240, including nests, suspected nests, and dry runs/nest attempts. Figure 1 illustrates our improvement in accurate nest identification over the 5 years at BUIS. We attribute this improvement to both an increased understanding of hawksbill nesting behavior and the increased number of patrol nights on the nesting beaches (Table 1).

In the 6 years of concentrated monitoring, and 5 years of nocturnal research, BUIS has observed an overall hatch success of 77.8% with clutch sizes ranging from 59 to 223 eggs. The overall mean clutch size for the 6 seasons, 1988 to 1992, was 147.3 eggs. The average number of hawksbill hatchlings produced is 6243 per year. By the end of the 1992 season a total of 73 female hawksbills have been recorded nesting on BUIS. Both two and three year nesting cycles have been observed. In all re-migrant hawksbills some carapace growth was observed. Using the length measurement only, 2 year re-migrants average growth was 0.64 cm (n = 5, SD = 0.42), and in 3 year re-migrants average growth was 1.7 cm (n = 4, SD = 1.2).

Of the original 12 hawksbills tagged in 1988, a year when only one inconel tag was placed in the front left flipper, 75% of these animals have been observed nesting at BUIS again. 69% of the 1989 hawksbills have been observed again, and to date only 16% of 1990 hawksbills. The remigrant percentages of hawksbills to BUIS and separately to Jumby Bay, Antigua (Corliss, et al, 1990) both indicate a strong nesting beach fidelity for hawksbills.

There has been a large number of successful seasonal re-migrants to BUIS, and just as impressive are the individual females fidelity to a section of the nesting beach. Nest site fidelity has been observed in both remigrants and newly tagged hawksbills every season. In some instances, females returned to BUIS not only within days of when they arrived 2 and 3 years prior, but nested within one meter of their last season's nest site and all their subsequent nests of the season were along the same section of beach. Others, between 10 - 30%, do move great distances between nest sites, sometimes over 1000 meters, and nest on different sides of the island. But overall fidelity to a nest site, a segment of shoreline, is the normal tendency for BUIS hawksbills.

The nesting distribution on the three principle beaches, Northshore, West Beach, and Southshore/Turtle Bay, has remained relatively stable, both before and after hurricane Hugo. On average over the 6 years, the Northshore has received 38% of the activities, West Beach 14%, and Southshore/Turtle Bay 48%. These distributions may indicate a hawksbills "preference" for a nesting habitat of beach forest with near shore coral reefs, over the open sand beaches of BUIS. The only change in this habitat utilization distribution came after the hurricane when both beach forest nesting habitats were inaccessible for nesting and hawksbill's use of West Beach increased to 22% for that year only.

The average number of nesting activities for the 3 years prior to hurricane Hugo was 147.3 and the nest/dry run ratio was a mean of 0.55 to 1. Prior to the hurricane hawksbills were able to nest on their first visit to the nesting beach. After the hurricane, with increased berm slopes, exposed root tangles, and fallen trees the average number of activities for the following three years was 215 with a nest/dry run ratio of 1.6 to 1. Post-hurricane hawksbills were making one and one half visits to the beach before successfully nesting (Figure 1). This inability to nest on a first attempt may have had a detrimental effect on the gravid females which may be one possible explanation for the overall decline in hatch success post-Hugo (Table 1).

Prior to 1989 no nests were relocated from possible threat of erosion. After hurricane Hugo we began relocating nests when hawksbills were not able to climb above the eroded berm to nest and were laying nests in the erosion zone. In the 5 years, the number of nests moved after laying was small - 8% in 1990, 19% in 1991, and 10% in 1992. A total of 12% of all the nests laid at BUIS have been relocated. The overall emergence success of these nests is on par with the nests left *in situ*, except for a few nests buried too deeply or unfortunately moved to an area which was unpredictably lost to late season storm surge. Overall the 1992 season has shown some improvement in the beach, and fewer nests were moved by technicians. The Park staff will continue to do minimal shoreline clearing of dead material which could be hazardous to visitors, both human and sea turtles.

The accomplishments of the past 5 years of nocturnal research on hawksbills nesting at BUIS has been summarized in Table 1. Since 1988 the number of nights spent on the nesting beach has doubled, as have the number of hawksbill activities observed. This increased effort in time and personnel has greatly improved our ability to monitor the hawksbills and collect the necessary information needed to understand hawksbills and their unique nesting beach requirements at Buck Island Reef NM.

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Table 1. Annual Hawksbill Sea Turtle Project Results, Buck Island Reef NM, St. Croix, U.S. Virgin Islands, 1987 - 1992.

	NIGHTS ON BEACH	# HB ACT. PER YR	# HB ACT. OBS/YR	% NESTING BEACH DISTR.			AVERAGE CLUTCH SIZE		# OF HB-LINGS^	% HATCH SUCC
YEAR		JAN - DEC		NS	WB	SS/TB				
							n	x		x
1992	79	204	98	30	19	51	67	153.3	6842	71.5
1991	95	240	101	42	16	42	77	147.2	7281	66.2
1990	58	203	59	30	12	58	60	151.6	6041	81.4
1989	47	171	34	34	22	44	45	148.8	5700	83.7
1988	40	158	23	41	12	47	75	140.3	6800	80.9
1987	--	113	--	53	3	44	40	142.3	4793	83.5

^HB-LINGS = HATCHLINGS.

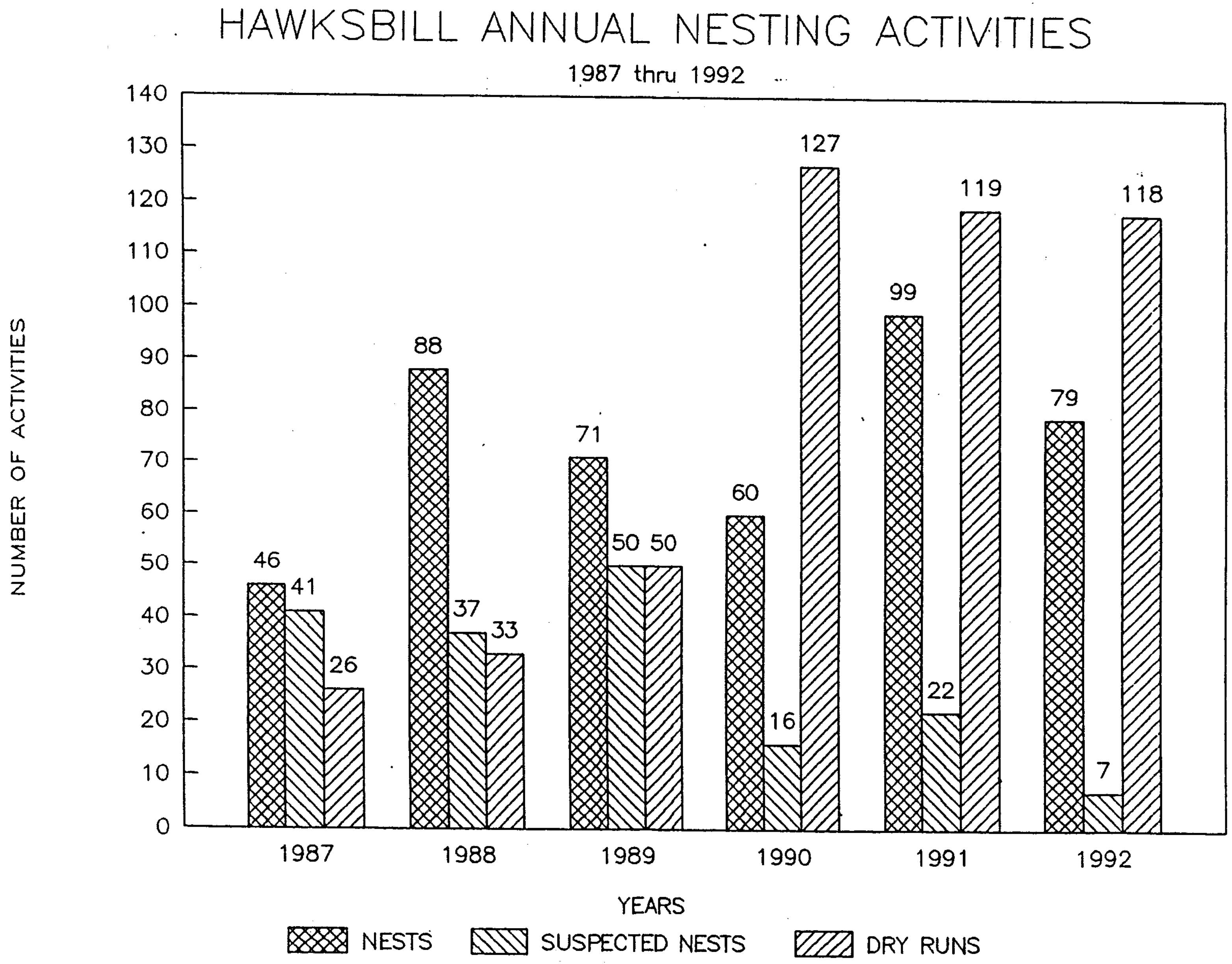

Figure 1. Annual Hawksbill Nesting Activities, Buck Island Reef NM, St. Croix, U.S. Virgin Islands, from 1987 - 1992.

SOME "LOST-YEAR" TURTLES FOUND

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Sea turtle hatchlings emerge from their nests, crawl down beaches, and enter the ocean to begin their pelagic "lost years" at sea. Because open-ocean research is difficult and small turtles are inconspicuous, the pelagic phase remains the central enigma of sea turtle life history. The pelagic phase has been best studied in the Atlantic loggerhead (*Caretta caretta*). Numerous second-hand accounts (Carr, 1986b) and first-hand observations (Richardson and McGillivary, 1991; Witherington, in press) record the presence of neonate loggerheads within patches of *Sargassum* offshore. Although much attention has been focussed on the significance of convergence fronts and *Sargassum* to the ecology of young sea turtles (Caldwell, 1969; Carr and Meylan, 1980; Witham, 1980; Carr, 1986a), there have been no detailed studies describing how neonate turtles behave and what they encounter within these areas. The purpose of this study was to begin collecting baseline data on the behavioral ecology of pelagic neonate loggerhead turtles.

METHODS

Two regions in the Atlantic Ocean off Central Florida, USA, were searched for neonate loggerheads, approximately 2 NM east of Sebastian Inlet, Florida, and 6-20 NM east of Cape Canaveral, Florida. Searches were made aboard a 7-m outboard boat on three days: 2 August, 11 September, and 21 September 1992. The loggerhead hatching season in Florida occurs from July through October. Convergence fronts and areas of *Sargassum* were targeted as areas suspected to hold turtles. Turtles sighted were captured with a small dip net. Information gathered from each capture included time, location (determined with a Magellan NAV 5000 GPS), turtle behavior, straight-line plastron and carapace measurements, and notes on sea state and objects floating nearby. Stomach contents of two turtles were sampled by sea-water stomach lavage. Lavage was conducted with a 5-cm diameter rubber bulb (human ear wash bulb) attached to a 3-mm outside diameter flexible vinyl tube. Contents were separated with a fine-mesh cloth sieve, examined, sorted, fixed in 10% buffered formalin, and stored in 70% ethanol. All turtles were released where captured. Thirty loggerhead hatchlings from nests at Melbourne Beach, Florida, were measured on the night of their nest-emergence for comparison with turtles captured offshore.

RESULTS AND DISCUSSION

Fifty-six neonate loggerheads were captured and released during the three searches offshore. The catch-per-unit-effort (captures/search time) ranged from 1.7 to 7.7 turtles per hour. The highest capture rate occurred at a convergence front with *Sargassum* at the western edge of the Gulf Stream off Cape Canaveral. There were 44 turtles captured at this front, which extended approximately 1 NM on a N-S line.

The small sizes of the loggerheads captured (Fig. 1) suggest that they hatched during the most recent nesting season. However, many had grown substantially from hatchling size and carried with them additional evidence (healed wounds, algal growth, and *Lepas* barnacle attachment) that they had spent time at sea. As a group, loggerheads captured at sea (mean = 48.3 mm standard straight carapace length, SSCL) were significantly larger than hatchlings newly emerged from Florida nests (mean = 44.5 mm SSCL; $df = 78$, $t = 5.24$, $P < 0.0001$). The largest post-hatchling was 59.0 mm SSCL.

Of the 56 loggerheads captured, 41 were in a tuck when first observed. Turtles in a tuck float at the surface with their fore flippers flattened over the carapace and rear flippers folded overlapping the tail. All but two turtles in a tuck were near *Sargassum* patches. Ten turtles were found swimming with a rear-flipper kick pattern near *Sargassum* patches. With the rear-flipper kick stroke, fore flippers are held as in a tuck, and rear flippers are moved simultaneously to propel the turtle slowly forward. Three turtles were found in a rear-flipper kick pattern away from any flotsam, one turtle was found crawling on top of a *Sargassum* patch, and one turtle was found in a powerstroke pattern (fore-flipper stroke) away from any recognizable convergence or flotsam.

Items discharged from the two turtles during lavage included the following: a culicine mosquito (7.1 mm greatest diameter), unidentified animal tissue (1.5 mm), a blue plastic chip (4.5 mm), a partial *Sargassum* float (3.2 mm), a larval hippolytid shrimp (2.5 mm), a *Portunus sayi* crab meropodite (2.9 mm), a probable ctenophore (9.0 mm), and a sliver of woody plant tissue (3.2 mm).

The preceding evidence indicates that neonate loggerheads can live and grow in the Atlantic west of the Gulf Stream. The turtles found at sea most likely came from Florida's east coast, which is by far the closest major nesting area for loggerheads. This being the case, the loggerheads that were larger than hatchling size must have attained their growth between the Gulf Stream and the mainland. Turtles entering the Gulf Stream would exit the area quickly; the Gulf Stream flows north at approximately 100 NM per day. Waters west of the Gulf Stream may provide an important beginning to a loggerhead's pelagic existence.

Evidence on how neonate loggerheads behave and what they eat fits the profile of a low-energy-expenditure "float-and-wait" forager. It is not surprising that a buoyant animal living within a concentration of slow-moving floating food would allocate minimum resources for activity, thus, saving greater resources for growth.

How pelagic loggerheads disperse at sea is an important but poorly known part of their biology. To elucidate dispersal, one should understand both the behavior of surface currents and turtles. Surface currents are commonly modeled using information from the release and collection of drift bottles. But before surface-current models can be used to predict neonate turtle dispersal, one must understand when young turtles behave like drift bottles and when they do not. Hatchlings leaving the beach in bouts of frenzied swimming make considerable progress on their own (Wyneken and Salmon, 1992; Witherington, in press). Relatively inactive turtles within convergence fronts also may partially govern their own dispersal. Rather than simple drift bottles, young loggerheads may behave as "smart" drift bottles. Being at the convergence of currents as young turtles are, subtle movements from one side of a front to the other could considerably alter where they travel.

ACKNOWLEDGEMENTS

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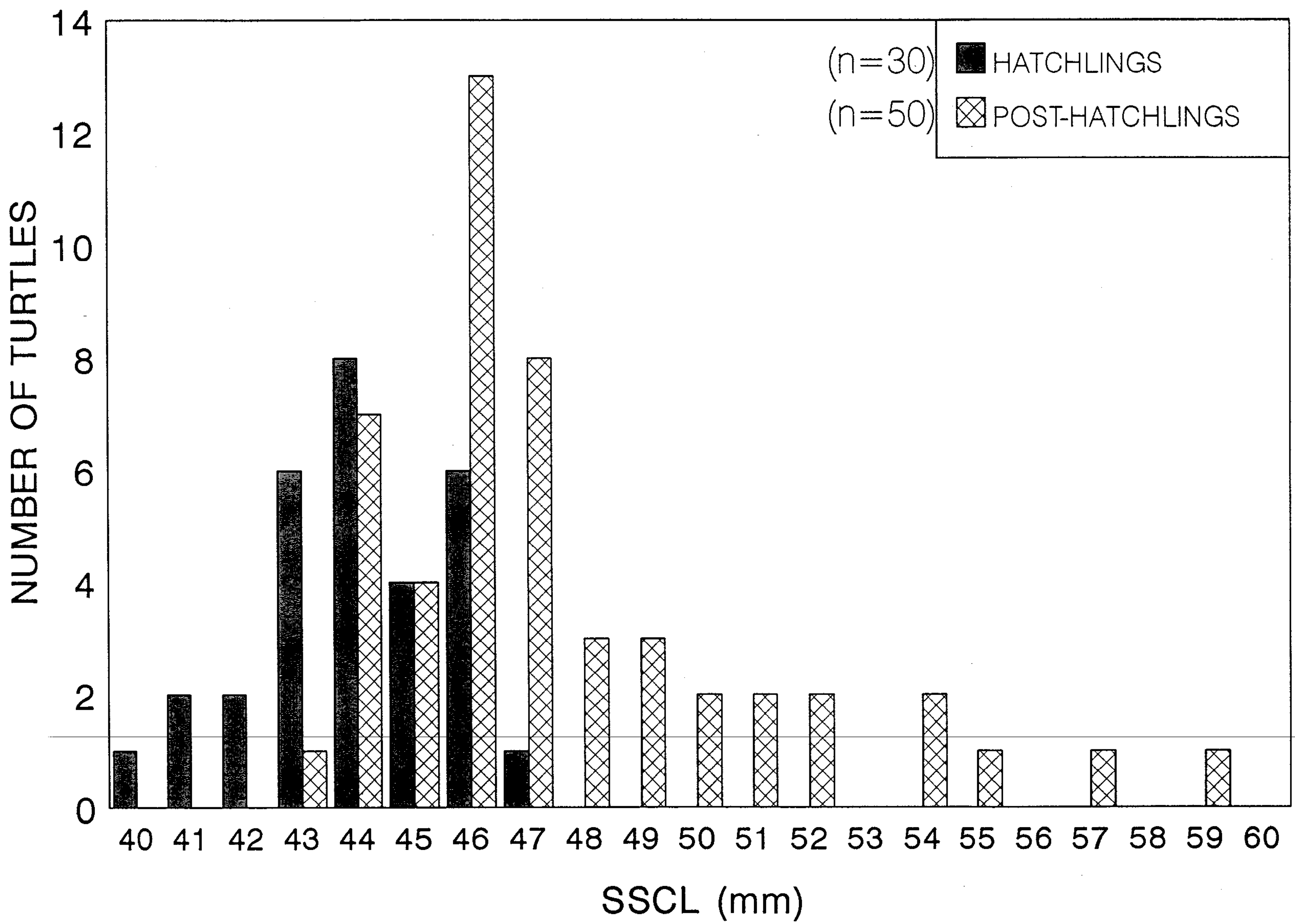

Figure 1. Standard straight carapace length (SSCL) of loggerhead turtles newly emerged from Florida nests (hatchlings) and captured at sea in the Atlantic Ocean off Florida (post-hatchlings) in August and September, 1992.

PART II: POSTER PRESENTATIONS

MARINE TURTLE NESTING ACTIVITY ON EGLIN AFB, FLORIDA, 1987-1992

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Eglin Air Force Base encompasses 463,448 acres of land in Santa Rosa, Okaloosa, and Walton counties in northwest Florida. The area surveyed for marine turtle nesting activity is confined to the 17 miles of federal beach on Santa Rosa Island which, due to property ownership, is divided into two sections (Figure 1).

Since 1987, a total of 131 loggerhead (*Caretta caretta*) and 22 green turtle (*Chelonia mydas*) nests have been documented on Eglin AFB (Figure 2). Although green turtle nests comprise only 14.4% of the total, this is felt to be significant as the species is not known to nest anywhere else along the northern Gulf coast of Florida.

Nesting by both species has occurred the last week of May through the third week in August. Mean incubation length for loggerhead nests is 66.5 days, with a range of 50 to 81 days; green turtle nests have a mean incubation length of 62.6 days and a range of 51 to 83 days. Clutch sizes for loggerhead turtles range from 53 to 170 eggs, with a mean of 116.5; mean clutch size for green turtles is 130.5, with a range of 76 to 172 eggs.

Reproductive success for each nest is determined by the percentage of yolked eggs per clutch that result in released or emergent hatchlings. Figures 3 and 4 represent the inventory results from 127 loggerhead and 22 green turtle nests. With the exception of 1988 and 1992, overall nesting success for loggerhead turtles has been relatively constant and ranges from 75.0% to 82.4%. One nest in 1990, and two nests in 1991, did not hatch due to low ambient temperatures; success rates without these impacted nests are 84.1% and 84.6%, respectively. A low nesting success of 56.3% for 1992 is primarily attributed to tidal inundations from three separate storm events, with secondary impacts from low ambient temperatures. Two nests were destroyed by storm tides and five did not hatch, apparently due to sand compaction around the eggs. Nesting success without the inundated nests is 79.5%. It is suspected a success rate of 52.6% for 1988 can be attributed to similar inundations caused by Hurricane Florence.

The reproductive success rate for green turtle nests has been significantly lower than that of loggerhead nests, with a much higher percentage of unhatched eggs having no apparent signs of development. Overall nesting success for green turtles ranges from 13.1% to 47.6%. In 1992, four nests did not hatch due to both tidal inundations and low ambient temperatures; the success rate without these nests is 57.2%. Although it is not known what specifically is causing decreased viability in green turtle nests, eggs from both the 1990 and 1992 nesting seasons have been collected for the US Fish and Wildlife Service to conduct possible contaminants analysis at a later date.

Mammalian predators are common along the western section of Santa Rosa Island and include domestic dog, coyote (*Canis latrans*), and raccoon (*Procyon lotor*). Depredation by mammalian predators accounts for less than 1% of mortality, as does depredation by ghost crabs (*Ocypode quadrata*). Root damage, both from penetration and matting, affected 1.7% of loggerhead and 3.0% of green turtle eggs. Impacts were primarily caused by sea oats (*Uniola paniculata*) and beach pennywort (*Hydrocotyle bonariensis*).

Continued daily monitoring of marine turtle nesting activity on Eglin AFB is necessary to provide accurate information regarding nesting densities and reproductive success rates. Daily monitoring enables success-limiting factors to be immediately recognized and corrected, and allows for accomplishment of Air Force mission requirements without impact to nesting marine turtles.

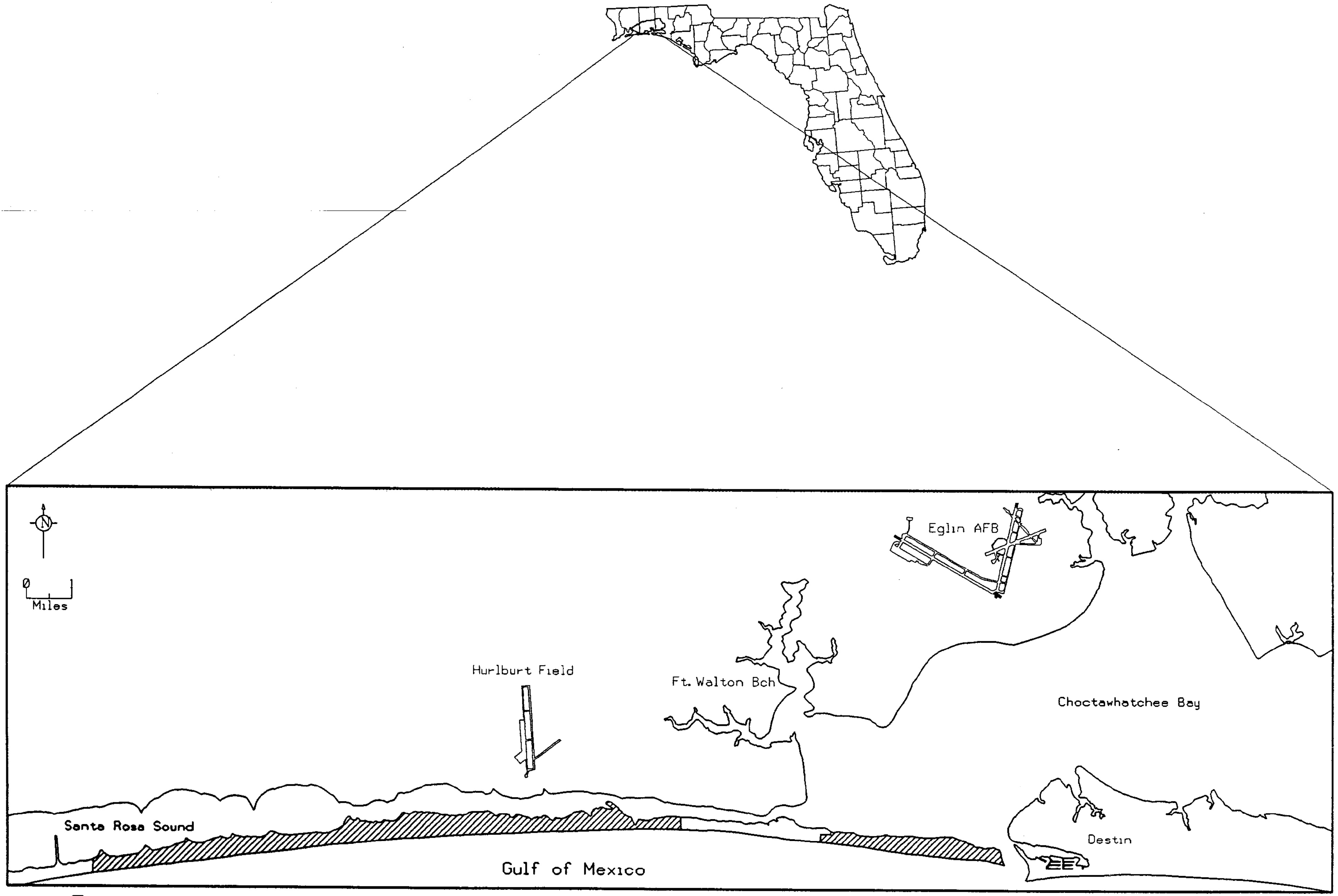

Figure 1. Survey area for marine turtle nesting activity on Eglin AFB, Florida.

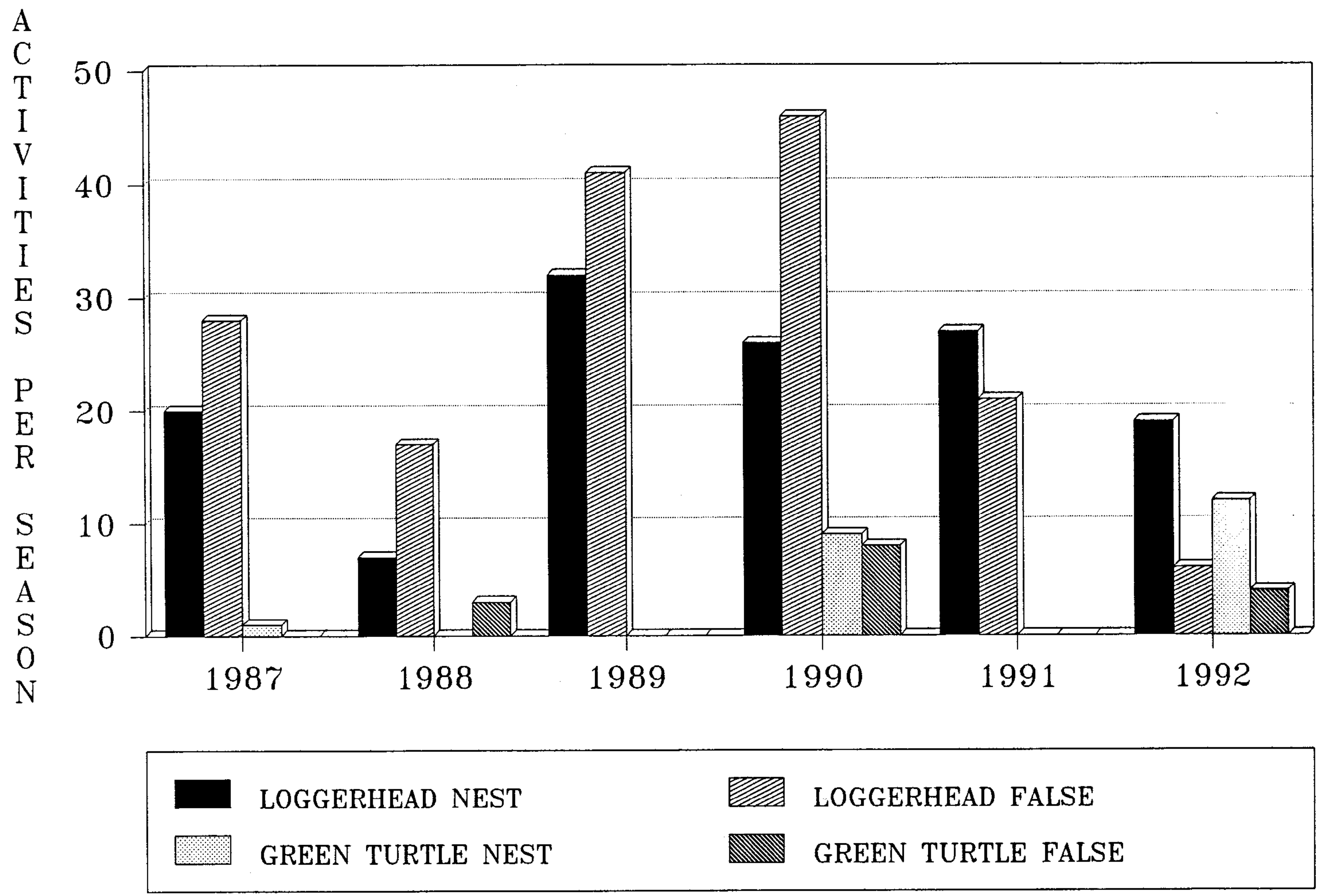

FIGURE 2. MARINE TURTLE NESTING ACTIVITY ON EGLIN AFB, FLORIDA, 1987 THROUGH 1992.

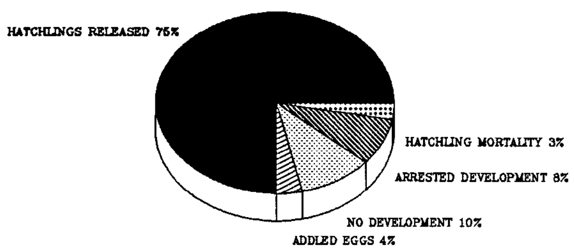

FIGURE 3. ASSESSMENT OF REPRODUCTIVE SUCCESS
FOR LOGGERHEAD NESTS DEPOSITED ON EGLIN AFB, FLORIDA
1987 THROUGH 1992

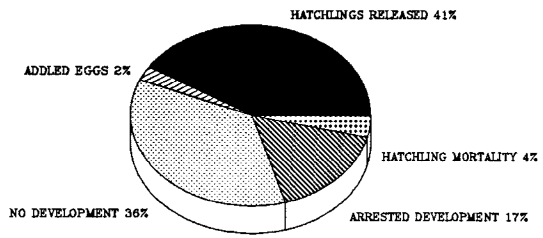

FIGURE 4. ASSESSMENT OF REPRODUCTIVE SUCCESS
FOR GREEN TURTLE NESTS DEPOSITED ON EGLIN AFB, FLORIDA
1987 THROUGH 1992

HOMEWARD BOUND: SATELLITE TRACKING OF HAWAIIAN GREEN TURTLES FROM NESTING BEACHES TO FORAGING PASTURES

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Telonics ST-3 satellite transmitters linked to the Argos system were deployed on three green turtles, *Chelonia mydas,* nesting at East Island, French Frigate Shoals (FFS) during August 1992. The objectives of this study were to determine 1) migratory pathways to the foraging areas; 2) degree of fixation on a foraging area; 3) diving behaviors during the migrations; and 4) differences in migratory abilities between healthy turtles and ones moderately afflicted with fibropapillomas.

The intensive flipper tagging of nesting females and basking males has been underway in the Hawaiian Islands since 1973. Results show that reproductive migrations are carried out between FFS and numerous distant foraging areas throughout the 2400-km span of the archipelago (Balazs 1976, 1983). Isolated Johnston Atoll, situated 830 km to the south, also constitutes one of the foraging areas (Balazs 1985).

METHODS

A safe and secure method of attaching the transmitters was pretested on captive green turtles at Sea Life Park Hawaii. Silicone Elasatomer, a two-part compound, was first used to firmly position the transmitter against the contour of the carapace along the second central scute. This product cures within five minutes and produces no heat. Final attachment was then achieved by applying two layers of fiberglass cloth and resin, similar to what has been used by Beavers et al. (1992) and Renaud (1990). A sturdy plywood container was devised to place around the turtle to safely hold her in a prone position during the attachment process.

Two of the three turtles selected for satellite telemetry were already identified with flipper tags that had been applied at Johnston Atoll (U306) and Kaneohe Bay, Oahu (U260). The third turtle (U236) had not been tagged and was moderately afflicted with fibropapillomas. This tumorous disease is of major concern for green turtle populations in Hawaii, Florida, and elsewhere worldwide (Balazs and Pooley 1991). However, severe cases of the disease are seldom seen in the breeding assemblage at FFS. This is presumably due to the inability of heavily diseased individuals to achieve reproductive readiness and accomplish the required migration. The duty cycle of the transmitters used on U260 and U236 was 6 hours on, 6 hours off. The duty cycle of U306 was 10 hours on, 50 hours off.

The study was initiated during the latter part of the nesting season to increase the chances of the turtles leaving on their homeward voyage shortly after transmitter attachment. Short-range radio telemetry of green turtles within FFS had already been conducted in 1980 early in the nesting season to determine habitat utilization during internesting intervals (Dizon and Balazs 1982).

RESULTS AND DISCUSSION

All three turtles were successfully tracked by satellite during their homeward migrations. Two of the turtles, (U260 and U236) departed within four days of one another and swam in excess of 1100 km against prevailing winds and currents to Kaneohe Bay (Fig. 1). Instead of using the islands and shoals of the archipelago as navigational guideposts, as might be expected, both turtles followed similar paths to the south of the chain, beyond sight of land over water thousands of meters deep. The third turtle (U306) also traveled across open ocean, but directly south to Johnston Atoll (Fig. 2). The navigational system used on these voyages remains unknown. However, olfactory reception of chemical cues carried by currents from the islands is a plausible component to the piloting process (Carr 1972).

Both of the previously tagged turtles migrated to the same foraging area where they had been encountered earlier. The turtle with tumors took a less direct path, traveling 130 km farther than the healthy turtle, to arrive at the same foraging area of Kaneohe Bay. Short diving times for all three turtles indicated that they were mainly swimming close to the surface during their migration. However, mean submergence intervals regularly recorded by the transmitter over 12-hour periods revealed they were only at the surface 4-5% of the time.

This is the first reported study where green turtles have been successfully tracked on their high-seas migrations from a nesting beach to nearshore foraging areas (see Byles and Keinath 1990).

TURTLE U260 SUMMARY--This healthy 87 cm turtle covered a distance of 1130 km averaging 2.0 km/hr during her 23-day migration from FFS to Kaneohe Bay. During this transit the average dive times ranged from 2.3-5.1 min. Five individual dives were registered lasting 11-34 min. Ambient temperatures during the migration, as recorded by a sensor in the transmitter unit, ranged from 26-27° C. Transmissions from U260 continued for 3.5 months after the migration was completed, during which time the turtle remained within Kaneohe Bay.

The tagging history of U260 showed that she had been first encountered nesting on East Island during the 1989 season. In March 1992 she was hand-captured by the author in Kaneohe Bay while resting under a coral ledge at a depth of 5 m. In June 1992 she was seen back at East Island where four nestings occurred prior to transmitter attachment in August 1992. These data demonstrate two lengthy return trips to the same nearshore area of Kaneohe Bay, thereby suggesting a strong affinity for this particular foraging location.

TURTLE U236 SUMMARY--This 85 cm previously untagged turtle had 12 tumors ranging from 1-6 cm in diameter on her front flippers, neck, and eyes. Three nestings took place on East Island in 1992 prior to transmitter attachment. In addition, the turtle was seen ashore attempting to nest on 7 other nights. U236 traveled 1260 km averaging 2.0 km/hr during the 26 days it took to reach Kaneohe Bay. During this voyage average dive times ranged from 2.2-3.3 min. Four individual dives were registered lasting 26-29 min. Ambient temperatures ranged from 24-27° C.

Since her arrival, U236 has made at least one round trip excursion outside of Kaneohe Bay along Oahu's coastline to a reef area 11 km away. Transmissions were still being received from this turtle in April 1993, 8 months after deployment.

TURTLE U306 SUMMARY--This healthy 91 cm turtle had been originally captured by net and tagged nearly 9 years earlier at Johnston Atoll when she measured 87 cm (Balazs 1985). The principal foraging area for green turtles at Johnston Atoll is adjacent to a chemical munitions disposal facility operated by the U.S. Army.

Unlike the other two turtles tracked in this study, U306 nested at least once on East Island after the transmitter was attached. She was also seen nesting on three earlier occasions during the 1992 season. She departed FFS in mid-September 1992, about one month after transmitter attachment. The 830 km trip directly to Johnston Atoll took about 22 days at an average speed of 1.6 km/hr. However, during the last 70 km of the voyage the swimming speed was only 0.5 km/hr. The average dive times ranged from 2.3-3.3 min and were very similar to those exhibited by turtle U236. Two individual dives of 28 and 29 min were registered during the migration. Ambient temperatures ranged from 26-29° C. Transmissions from U306 at Johnston Atoll ceased during late February 1993, 6 months after deployment.

ACKNOWLEDGMENTS

This research and similar tracking planned for the future is dedicated to the memory of Dr. Archie Carr. Many years ago Dr. Carr was the first to recognize that satellites would eventually be used to unlock the mysteries of green turtle migrations. Much remains to be accomplished to fulfill this goal, but the technology is now at our disposal in a simplified form at relatively low cost.

The following individuals and organizations are acknowledged for their generous contributions to this study: R. Byles, T. Clark, W. Gilmartin, G. Gitschlag, S. Kaiser, S. Koga, K. McDermond, R. Miya, R. Morris, L. Ogren, J. Pappas, P. Plotkin, T. Ragen, M. Renaud, C. Rowland, A. Ward, M. Webber, B. Winton, D. Yamaguchi, the U.S. Fish and Wildlife Service, and Sea Life Park Hawaii. Special gratitude is expressed to Sally Beavers for traveling to Hawaii to share her considerable expertise in attaching satellite transmitters to sea turtles.

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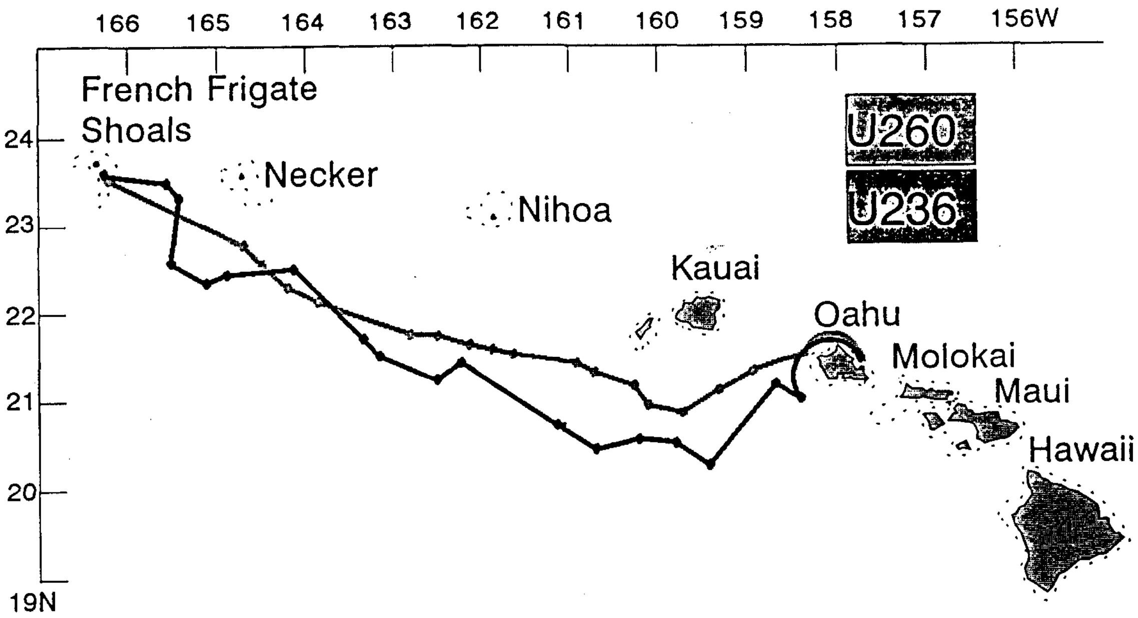

Figure 1. Migratory pathways taken by healthy turtle U260 and tumored turtle U236.

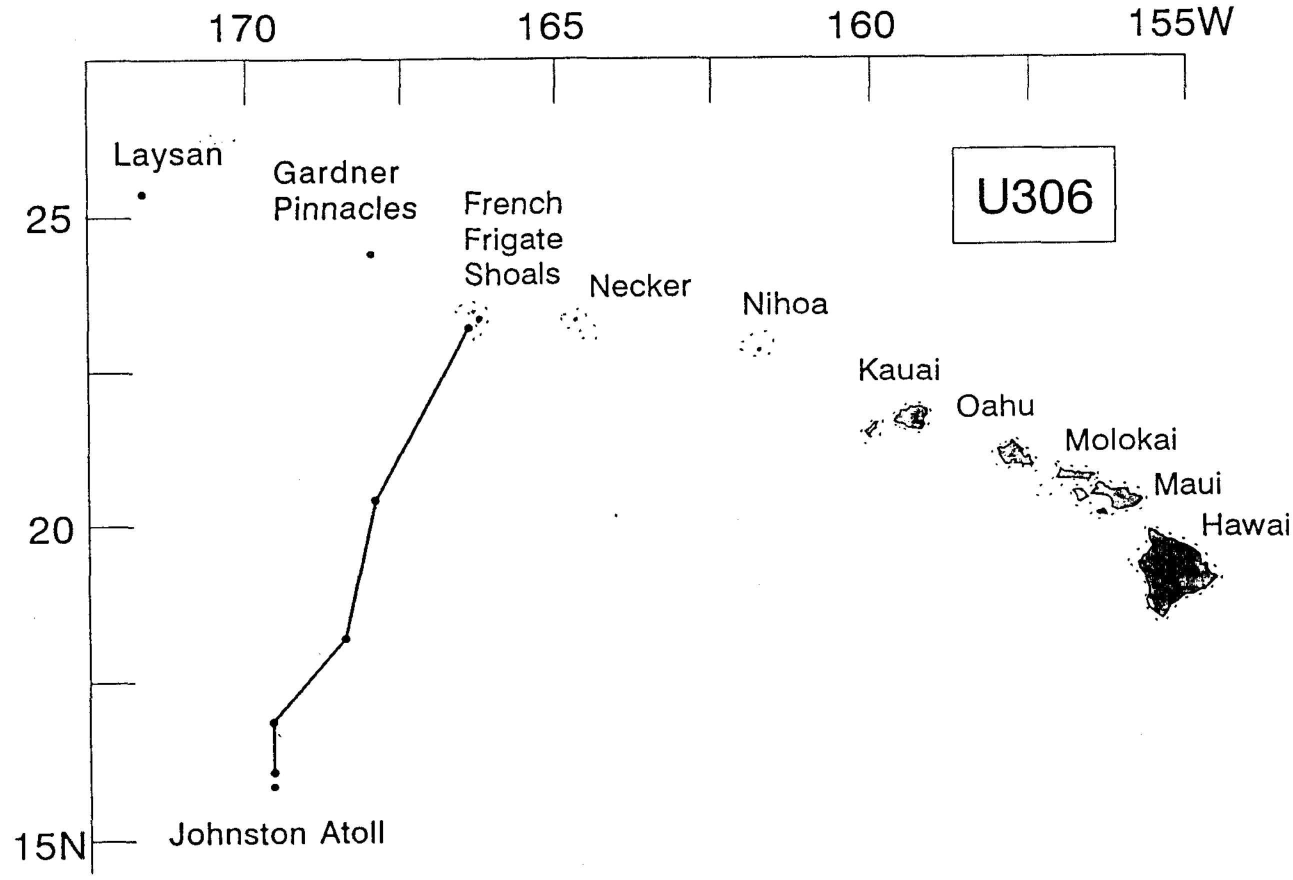

Figure 2. Migratory pathway taken by healthy turtle U306.

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The Archie Carr Center for Sea Turtle Research (ACCSTR) at the University of Florida has developed the "Sea Turtle Bibliographic Database." This bibliographic database can be accessed worldwide free of charge via a computer network called Internet. This on-line bibliography includes all aspects of sea turtle biology, conservation and management. Citations are from recognized bibliographic sources as well as "grey literature." Any changes to the on-line bibliography will be announced in CTURTLE and the Marine Turtle Newsletter. Unfortunately, at present, we cannot conduct searches for those investigators who cannot access the system.

Curating a database of this magnitude is a dynamic process. The database is continually being edited and updated. If you find an error in a citation or know of a citation that has been omitted, please send us the correct information. To help us maintain a comprehensive library, we would appreciate receiving a reprint of any of your sea turtle publications. Our address is:

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Bartram Hall
University of Florida
Gainesville, FL 32611

FAX: (904)392-9166
E-mail (Internet): ACCSTR@zoo.ufl.edu

1) How to Access Via Internet

These procedures assume you know how to access the Internet. It is important for you to know what action to take in response to local system messages. Contact your local data center for additional information.

Signing on using the telnet command (or your host's equivalent)

enter:telnet nervm.nerdc.ufl.edu
or
enter:tn3270 nervm.nerdc.ufl.edu

2) How to Access Via Modem

To connect via dial-up terminals using ASCII terminal emulation, the telephone numbers are (Florida Suncom prefix for all 392 numbers is 622):

1200 baud: (904)392-7450

2400 baud: (904)392-9177

9600 baud: (904)392-2749 or 392-9942

3) After Connection to the University of Florida System

system display:NERVM logo
move cursor to command line
enter:dial vtam

system display:NERDC VTAM is active
enter:nerluis

system display:sign-on complete
(briefly displayed)

system display:LUIS user menu

4) Bibliography Main Menu

Once you have accessed the LUIS user main menu, select no. 15 (Additional Information Resources); then select no. 14 (Sea Turtle Bibliography). Follow the menu choices. You may search on the author or title fields as well as using keywords. Help is available for author (A), title (T), and keyword (K) searches by typing EXP followed by A, T, or K. For example, help information for keyword searches is accessed by typing EXP K. The truncation character is "?" without the quotation marks.

5) To Sign-Off

When you have completed the search process, type stop; select 30; then select 30 again; at NERDC VTAM is active screen, type: undial. You will now be back in your host system.

ACKNOWLEDGMENTS

Development of the Sea Turtle Bibliographic Database has been made possible by the generous support of the U.S. Fish and Wildlife Service (Earl Possardt and Jack Woody), U.S. National Marine Fisheries Service (Charles Oravetz and Terry Henwood), and the Japanese Sea Turtle Association (Naoki Kamezaki). Marjorie Carr, C. Kenneth Dodd, Greg Forbes, John R. Hendrickson, David Owens, and Anders Rhodin (The Chelonian Research Foundation) have provided valuable reference collections for our use. Staff at the University of Florida Libraries and the Florida Center for Library Automation have provided inspiration, knowledge and technical assistance with the LUIS system. Graduate students of the ACCSTR have assisted with the compilation of the database; Peter Eliazar is currently curating the database.

CTURTLE: AN EMAIL INFORMATION NETWORK FOR SEA TURTLE BIOLOGY AND CONSERVATION

Alan B. Bolten
Karen A. Bjorndal

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To improve communication among individuals around the world who are interested in sea turtle biology and conservation, the Archie Carr Center for Sea Turtle Research at the University of Florida has established CTURTLE -- an email conference and bulletin board. CTURTLE is a LISTSERV managed email list on BITNET, an academic and research computer network, which is connected to many other computer networks worldwide.

CTURTLE takes advantage of computer technology to facilitate communication. Anyone who has access to an email network (for example, Internet, BITNET, OMNET, CompuServe, MCI, etc.) can subscribe to CTURTLE. Participation in CTURTLE is free of charge. Some individuals, however, who are not connected to an Internet network, may have telecommunication charges to the nearest Internet/BITNET server as well as on-line charges.

Once you have subscribed, you can post messages/information to the CTURTLE email system that will electronically and almost instantly send your message/information to all other CTURTLE subscribers. The possibilities and benefits are enormous for information exchange. CTURTLE provides the opportunity to respond to conservation issues when time is a critical factor. When an ecological crisis involving sea turtles or their habitat occurs, you can inform the worldwide sea turtle community instantly. CTURTLE can become a forum for ideas, an avenue to announce job opportunities and volunteer programs, or a vehicle for discussion of research and conservation ideas or problems. The possibilities are limited only by the imagination of the participants. We will also be abstracting information from other LISTSERV lists that may be of interest to subscribers to CTURTLE. Please let us know if you have any suggestions.

The success of CTURTLE depends on its members and their participation. It is truly a democratic system. Everyone's voice can be heard. The more people that subscribe, the greater the database of information.

1. To subscribe from an Internet address:

   Send an email message to LISTSERV@nervm.nerdc.ufl.edu
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   SUBSCRIBE CTURTLE (your first name) (your last name)

2. To post information to other subscribers on the list, send an email message to CTURTLE@nervm.nerdc.ufl.edu

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   GET LISTSERV REFCARD

Please note that you send only commands (for example SUBSCRIBE) to the LISTSERV@nervm.nerdc.ufl.edu address and that you send messages to be distributed to all subscribers to the CTURTLE@nervm.nerdc.ufl.edu address.

If you experience difficulty connecting to CTURTLE, talk with your email manager or send an email message describing the problem to us at ACCSTR@zoo.ufl.edu

INTRASEASONAL NESTING ACTIVITY OF LOGGERHEAD SEA TURTLES ON BALD HEAD ISLAND, NORTH CAROLINA

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Activities of loggerhead sea turtles (*Caretta caretta*) nesting on Bald Head Island, North Carolina were monitored using tagging methods to determine intraseasonal nesting patterns. Research conducted in recent years on nesting sites for loggerhead sea turtles indicates Bald Head Island represents the northernmost nesting concentration along the east coast of the United States and where the largest number of nests are reported annually (Crouse, 1984; Hopkins and Richardson, 1984; Schwartz, 1989). Numbers of nests per year have ranged from 72 to 196 (Crouse, 1984; Brooks, 1989). Although nest records have been kept since 1980, data on nesting patterns by individual turtles was relatively unknown. Preliminary efforts to identify individual nesting females began in 1983 with phototagging, a method which involves taking a photograph of the turtle's carapace from a standard point posterior to the nesting turtle and using barnacle patterns and prominent scars on the carapace to match in the photographs of individuals. This form of tagging often proved to be unreliable during the span of the nesting season due to changes in barnacle patterns. Only turtles with distinct scars were identified by photographs for interseasonal records. Dependable tagging methods were not fully incorporated into the turtle monitoring program on Bald Head Island until 1991. During the nesting seasons of 1991 and 1992, nesting females were photographed and tagged with monel flipper tags in both foreflippers after completion of their nesting activities. Phototagging was useful in allowing us to identify turtles that had lost their flipper tags during the nesting season. Using both tagging methods provided data necessary to determine intraseasonal nesting patterns by individual turtles.

METHODS

Beaches of Bald Head Island were patrolled nightly during the nesting season, May through August, from dusk until dawn using two ATVs to cover approximately 18 km of beach. A dual patrol method was used to ensure all possible nesting sites were monitored approximately once each hour. All female turtles encountered while nesting were photographed and were tagged with at least two tags in the distal edge of the foreflipper (one tag in each foreflipper) upon completion of nesting, as recommended in the "Manual of Sea Turtle Research and Conservation Techniques" (Pritchard et al., 1983). Turtles were generally tagged during the last stage of nesting, while the turtle was covering her nest with sand. For turtles returning to nest, badly corroded or damaged tags were replaced with new tags, and turtles returning with only one tag were given an additional tag so that all turtles had at least two durable tags upon leaving the beach. Data collected on each turtle including tag numbers, number of nests, and date and time of nesting were used to determine intraseasonal nesting patterns.

RESULTS

A total of 123 females were tagged and photographed, which accounted for 83% of the 319 nests laid during the 1991 and 1992 nesting seasons. Intraseasonal nesting patterns were consistent for both years; most females (53%) nested once, 13% nested twice, 15% nested three times, 7% nested four times, 10% nested five times, and 2% nested six times (Figure 1). The internesting interval averaged 13.9 days (range 10-20 days) for both years (Figure 2). Incorporating all possible nesting individuals into annual nesting population estimates, 1991 had a population range of 69 to 108 nesting females that produced 182 nests. The range for 1992 was 54 to 73 nesting females that produced 137 nests. Monel flipper tags provided means for volunteer turtle watchers on Oak Island (2 miles distant) to report a nesting by one turtle that had nested previously and was tagged on Bald Head Island in the summer of 1992.

DISCUSSION

Loggerheads in the northernmost part of their range in the western North Atlantic exhibit intraseasonal nesting patterns that are similar to those exhibited by populations elsewhere in the range of the species. Future goals of the sea turtle monitoring program on Bald Head Island will be to increase the saturation efficiency (intercept more nesting turtles) to ensure thorough data for determining intra- and interseasonal nesting patterns and to better estimate population size of turtles nesting on Bald Head Island. An efficient tagging and monitoring program must be continued for at least six years in order to develop population estimates and other models, as outlined in "A Recovery Plan for Marine Turtles" (Hopkins and Richardson, 1984). The efficiency of the tagging program on Bald Head Island may not be known until the nesting seasons of 1993 or later to verify that any turtles tagged in 1991 or 1992 return to nest with monel flipper tags. The highly efficient tagging and monitoring methods used in Richardson's study (1982) involved the use of several types of tags with application of six tags per turtle, compared to only two tags given to turtles on Bald Head Island. Observed nestings over the next few years may determine the need for alternative tagging methods for turtles nesting on Bald Head Island.

ACKNOWLEDGEMENTS

The author would like to acknowledge the North Carolina Wildlife Resources Commission, the National Marine Fisheries Service, the Bald Head Island Conservancy, and the University of North Carolina at Wilmington for materials and financial support. I especially want to thank all the university students who assisted in this project over the last three years. This project would not have been possible without their dedication and hard work.

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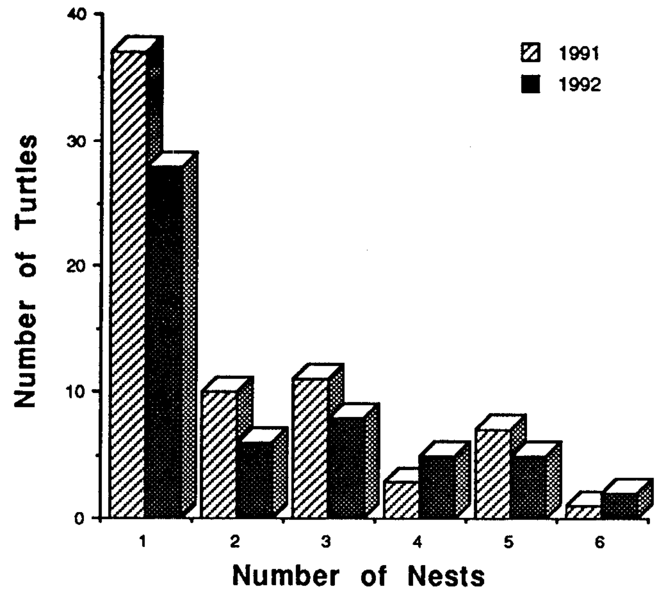

Figure 1. Intraseasonal nesting frequencies of turtles in 1991 and 1992. 83 % of nesters are reoresented.

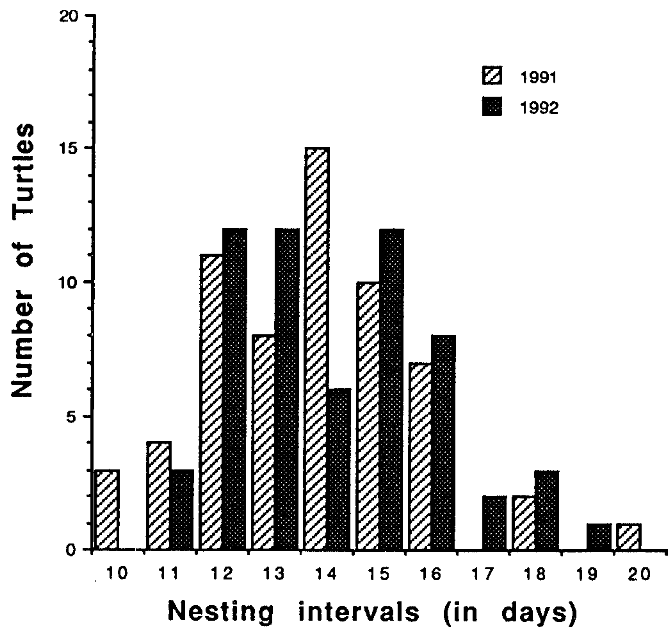

Figure 2. Intraseasonal nesting intervals by multiple nesters in 1991 and in 1992. Interval for both years averaged 13.9 days. (x=13.9)

DIAGNOSTIC CHARACTERS OF THE STAGES OF SPERMATOGENESIS IN THE GREEN TURTLE (*Chelonia mydas*)

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Thirty-nine testicular biopsies of immature and adult *Chelonia mydas* were used to study maturation of the male gonad. Biopsies were collected via laparoscopy in Bocas del Toro Province, Panama, between 1989 and 1991 and prepared histologically at FMRI. It was possible to classify preparations from each individual into one of seven stages of spermatogenesis previously described in reptiles. Stage determinations were based on the presence and quantity of six types of cells in the seminiferous tubule: sertoli, spermatogonia, primary and secondary spermatocytes, spermatids, and spermatozoa. In stage one, a single horizon of sertoli cells and spermatogonia surround an occluded lumen. In stage two, several layers of sertoli cells and spermatogonia surround a partially occluded lumen. In stage three, primary spermatocytes are present in nearly every seminiferous tubule. In stages four through seven, primary and secondary spermatocytes, as well as spermatids and spermatozoa, are present in varying proportions. Stages four through seven are considered to be mature. Progression through stages one through four correlates with turtle size. These data have proven useful in identifying the size at sexual maturity in the green turtle.

SEA TURTLE NESTING ACTIVITY AT JUPITER/CARLIN PARKS IN NORTHERN PALM BEACH COUNTY, FLORIDA

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The purpose of this study is to conduct long term sea turtle monitoring in the Jupiter area to determine the effects of a proposed beach nourishment project on sea turtle nesting. This study will last at least three years and will collect data on reproductive success of sea turtles in the area. This report analyzes 1992 nesting data from the 1.56 mile (2.51 Km) Jupiter/Carlin survey area, compares the nesting to 1991 levels and provides baseline data from which to evaluate the effects of a beach nourishment project proposed to be constructed in 1994 on 1.1 mile (1.77 Km) of beach immediately south of Jupiter Inlet on the southeast coast of Florida. The data presented here is from the second year of monitoring for this project.

METHODS

The sea turtle monitoring program consisted of beach surveys, identification of crawls and nests by species, estimates of nest position relative to the dune and high water line, marking of a representative portion of the nests to follow through the season and to conduct nest content inventories. The survey area is a 1.56 mile (2.51 km) beach running south from the Jupiter Inlet located in southeast Florida.

The area was divided into 10 zones or reaches based on upland characteristics. Reach boundaries were determined by various landmarks and back-dune profiles, so that the effects of development and human activity on sea turtle utilization of the nesting habitat could be analyzed. The study area consists of two county parks, condos, a resort, and undeveloped land. Data collected included the species and beach position for all nests, false crawls and false digs above the most recent high water line. Nests were left *in situ* except for 6 which were relocated to a higher elevation on the beach because they were exposed due to erosion.

To evaluate the fate of nests through the entire incubation period, a representative portion of the nests were marked for tracking. An inventory of the nest contents to determine hatching success was conducted at least three days after the first hatchling emerged.

RESULTS AND DISCUSSION

Nesting Data

Table 1 shows that 1,402 (96%) of the nests in the survey area were loggerhead sea turtles (*Caretta caretta*), 44 (3%) of the nests were green turtles (*Chelonia mydas*) while 3 (<1%) of the nests were leatherbacks (*Dermochelys coriacea*).

Nesting density for loggerheads averaged 893 nests per mile (554 nests/km) but ranged from lows of 214 and 217 nests/mile (132 and 133 nest/km) in reach 1 (Dredge spoil area) and reach 4 (Jupiter Hilton), respectively, to a high of 1303 nests/mile (809 nest/km) in reach 6 (Carlin Park) (see table 2 and figure 2).

The Jupiter/Carlin area is a high density nesting beach and correlates well with the Juno Beach, Jupiter Island and south Brevard County nesting beaches which in 1991 had loggerhead nesting densities of at least 925, 832, and 736 nests/mile (575, 517, 457 nests/km), respectively (FDNR, 1991).

Table 1. Summary of 1991 and 1992 nesting activity.

	Caretta caretta		*Chelonia mydas*		*Dermochelys coriacea*	
YEAR	1991	1992	1991	1992	1991	1992
NESTS	1,111	1,402	3	44	4	3
FALSE CRAWLS	1,461	1,603	2	33	0	0

Because of the high nesting density, construction of the proposed beach nourishment project is scheduled to occur outside peak nesting season, i.e. between October 16 and May 15. If construction had occurred in 1992 (outside of peak nesting season), 46 nests would have had to be relocated for a spring project and 24 nests would have had to be relocated for a fall project.

Nesting success (number of nests / number of false crawls and false digs) for loggerheads in the survey area was 46.7% and, depending on the reach, ranged from 15.5% in reach 1 to 58.4% in reach 5 (Figure 3). Nesting success can be affected by any of the following factors: human disturbance, artificial lighting, horizon features and sand characteristics such as temperature, moisture, sand grain size , sand grain shape, sand grain orientation and compaction (Nelson, 1989).

The lowest nesting densities and nesting success occurred where turtles were blocked from access to the nesting beach. Nesting was limited at reach 1 by the formation of a steep scarp in early May. The scarp ranged in height from 3 to 10 feet and was the result of erosion of dredge spoil from the Intracoastal Waterway placed on the beach in February 1992 by the United States Army Corps of Engineers. Low nesting density in reaches 4 (Jupiter Hilton) and 5 (undeveloped park) were primarily a result of intertidal rock outcroppings with vertical relief of 1-3 feet which were present in up to 80% of the reaches. The low nesting density in reach 5 was unexpected; high nesting levels were anticipated since this is the darkest and most isolated stretch of beach.

Nesting density was higher in the project limits of the proposed nourishment area (reaches 2 through 6) at 1014 nests/mile compared to the "control" area (reaches 7 through 9) which had 878 nests/mile. Average beach width in the project area was 53 feet compared to 119 feet in the control area. Wider than average beaches (>72 feet) and narrower than average beaches (<72 feet) had similar nesting densities but nesting success was slightly higher on the narrower beaches (49.5%) compared to the wider beaches (44.4%).

One of the design considerations of the Jupiter/Carlin Shoreline Protection Project has been to minimize impacts to sea turtles by placing beach compatible sand on the beach using sand from the nearby ebb tidal shoal and tilling the fill area to reduce compaction levels. The mean grain size and silt/clay fraction of the borrow material (0.45 mm, 0.66% S/C) is a close match to the native nesting beach (0.46 mm, 0.2% S/C). It is expected that there will be minimal negative impact to nesting success as a result of this sand compatibility.

Hatch Data

To provide baseline data on hatching success and hatchling emergence, the contents of 54 of the *in situ* loggerhead nests were inventoried. Twenty eight of the nests were marked (triangulated) and 26 of the nests were unmarked (random) resulting in evaluating 3.8% of the loggerhead nests. Average incubation time for loggerheads was 56.9 days and average clutch size was 110. Hatching success of the loggerhead nests was 90.1%. The hatchling emergence success rate for loggerheads was 85.0%. These results are similar to Raymond's (1984) results from Indialantic and Melbourne Beach in 1981 and 1982.

Nest Location

The location of the nests on the beach was established with reference to the dune vegetation line and the most recent high water line. The average beach width for the entire survey area for 1992 was 72 feet but varied greatly depending upon the reach with a low of 15 feet in reach 10 and highs of 125 feet and 127 feet in reaches 7 and 8, respectively.

Figures 4a and 4b are graphs of nest locations of loggerheads in two reaches that best depict the typical response on a wide beach and a narrow beach in the study area. Reach 7 had an average width of 125 feet and turtles tended to deposit nests closer to the HWL than the dune. Approximately 88% of the nests were laid within 45 feet of the average high water line while the remaining 12% were laid within 80 feet of the dune. Reach 5 had an average beach width of 44 feet and 83% of the nests were laid within 20 feet of the dune. It appears that having a wide beach does not necessarily mean that turtles will use the available beach equally.

Effects of Hurricane Andrew, Predation and Disorientation

Hurricane Andrew hit south Dade County (105 miles [169 km] south of Jupiter) on August 24 when 50% (701) of the season's nests were still incubating. The hurricane impacted (eroded or inundated) approximately 260 nests or 18.5% of the nests laid during the season. It is unknown how many of those nests were washed out but estimates are between 60 and 90 nests were lost. Loss of nests due to predation from raccoons was estimated to occur in 12% of the nests. Disorientation was reported for 25 (1.7%) of 1450 nests. Approximately 13% of the hatchlings from the 25 nests were disoriented within the survey area primarily as a result of residential and resort lighting in reaches 3, 4 and 9.

CONCLUSIONS

The beach where the Jupiter/Carlin Shoreline Protection Project is proposed to be constructed supports a high level of nesting by loggerhead sea turtles. Nesting density was lowest in the reaches that had upland development or were impacted as a result of dredge spoil. Hurricane Andrew had a minor effect on the study area beaches similar to the effects of a typical northeaster or passage of a tropical storm. On wide beaches, turtles tended to nest proportionally closer to the high water line than the dune. Nesting success was slightly higher on the narrower than average beaches compared to the wider than average beaches.

Monitoring of sea turtle nesting activity over a number of years prior to and after construction is necessary to evaluate the effects of nourishment and to be able to understand the natural variation in nesting and separate out any project related impacts. Information from this monitoring program will allow the County and local jurisdictions to more effectively manage this beach and balance its value as sea turtle nesting habitat with its recreational and storm protection benefits.

ACKNOWLEDGMENTS

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Jupiter/Carlin Sea Turtle Nesting Activity 1992

LOGGERHEADS (Caretta caretta), 3/1/92 to 10/6/92

NESTS AND FALSE CRAWLS, BY REACH

Reach	Miles	False Crawls Count	False Crawls Count/mile	Nests Count	Nests Count/mile	Success %
1	0.140	163	1164.29	30	214.29	15.54
2	0.127	165	1299.21	144	1133.86	46.60
3	0.246	253	1028.46	307	1247.97	54.82
4	0.106	44	415.09	23	216.98	34.33
5	0.179	86	480.45	121	675.98	58.45
6	0.251	334	1330.68	327	1302.79	49.47
7	0.192	175	911.46	189	984.38	51.92
8	0.197	204	1035.53	158	802.03	43.65
9	0.054	58	1074.07	42	777.78	42.00
10	0.077	121	1571.43	61	792.21	33.52
Totals & Means:	1.569	1603	1021.67	1402	893.56	46.66

Table 2. Summary of loggerhead nesting activity by reach.

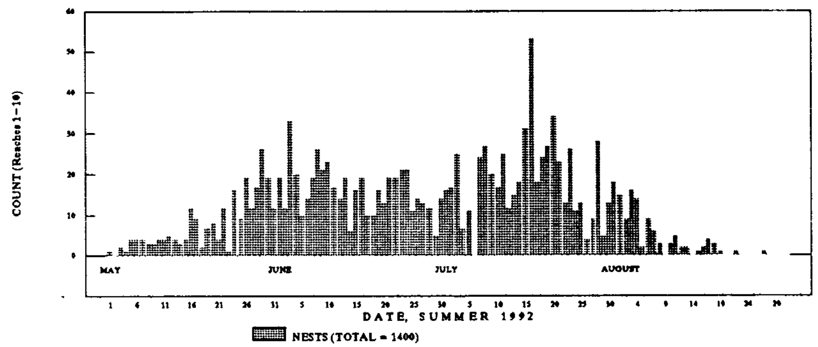

Figure 1. Loggerhead nest counts over time.

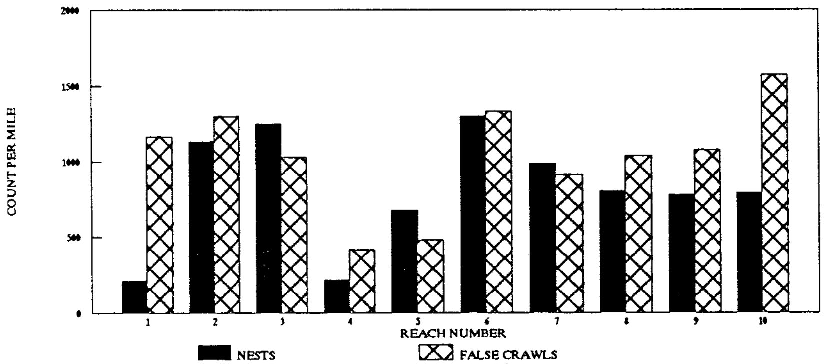

Figure 2. Loggerhead nest and false crawl density by reach.

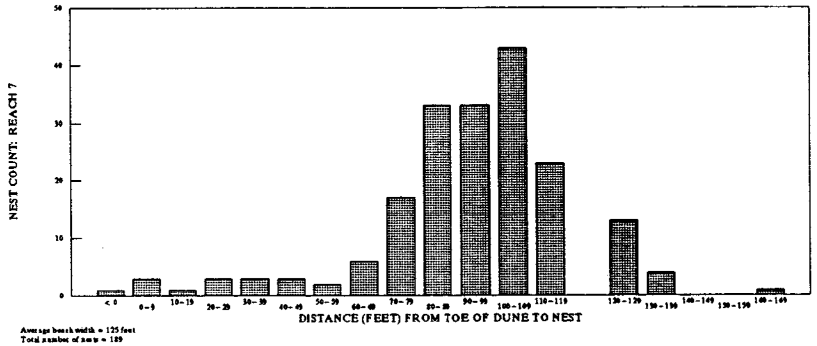

Figure 4a. Nest locations on wide beach.

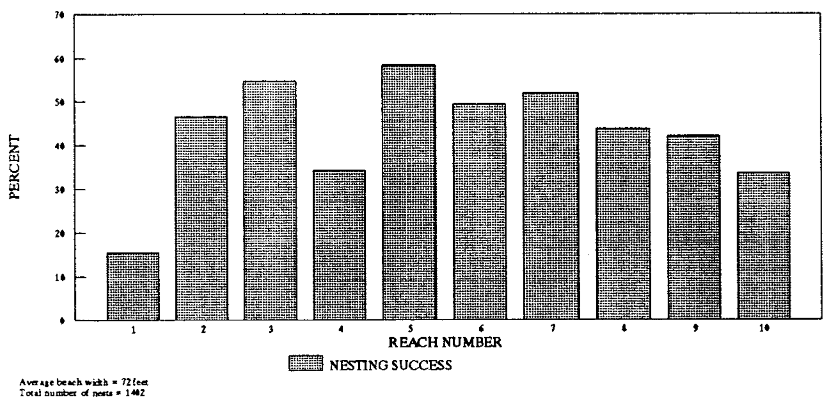

Figure 3. Loggerhead nesting success by reach.

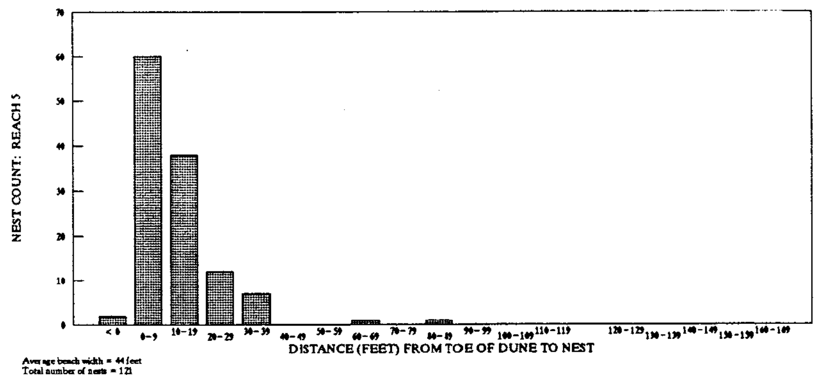

Figure 4b. Nest locations on a narrow beach.

EFFECTS OF HUMAN BEACH USAGE ON THE TEMPORAL DISTRIBUTION OF LOGGERHEAD NESTING ACTIVITIES

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Keith A. Rittmaster

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During the summers of 1990 through 1992 on South Core Banks of Cape Lookout National Seashore, North Carolina, we assisted the National Park Service in monitoring loggerhead turtle (*Caretta caretta*) nesting activity. This consisted of surveying the 36.8 kilometer stretch of ocean beach for crawls, digs, and nests and recording such data as date, location, and type of activity. As with nearly all ocean beaches in the southeast US, weekend beach use by humans is markedly greater than that during the 5-day workweek. With this increased visitation comes the associated vehicles, foot traffic, and lights at night. Typically, Sunday through Thursday is relatively quiet. This study sought to examine turtle beach activity patterns that might be related to the intra-weekly variations in human activity. Of the 378 activities recorded during the three year period, 168 were nests and 210 were digs or crawls. 46, or 35.1% of the activities on Friday and Saturday nights were nests while 121, or 49.6% of the activities on Sunday through Thursday nights were nests. The non-nest activities (digs or crawls) accounted for 55.6% of the total. 64.9% of weekend activities were digs or crawls, while 50.4% of the weekday activities were digs or crawls. These data suggest that the temporal distribution of loggerhead nesting activity is being altered by human activities on nesting beaches.

INTRODUCTION

South Core Banks is one of three barrier islands that comprise Cape Lookout National Seashore in the central coastal area of North Carolina. The island represents a significant northern nesting beach for the loggerhead sea turtle (*Caretta caretta*) (Conant, 1991). Each year Cape Lookout National Seashore rangers, resource managers, and volunteers monitor the 36.8 kilometers of ocean beach for sea turtle nesting activity.

The island is accessible only by boat. Park visitors come to the island via one of several ferries or on their private boats. Approximately 10 houses serve as private cottages and one fish camp rents cabins. Vehicles, which are brought over by ferry, are permitted on sand roads and ocean beaches throughout most of the island. Many visitors and most tenants at the summer cottages leave vehicles on the islands for their use when they arrive. Others bring vehicles just for the duration of their visit. Overnight tent and vehicle camping is permitted throughout most of the island's beaches. As is typical of most ocean beaches in the southeast United States, visitation on weekends is markedly greater than during the work week. Because human foot and vehicular activity on beaches at night has been known to adversely affect sea turtle nesting (National Research Council, 1990), this study sought to examine any turtle beach activity patterns that might be related to the intra-weekly variations in human activity.

METHODS

For this study we used beach nesting data for the nesting seasons of 1990, 1991, and 1992. Each morning, from May through August, a Park Service staff or volunteer patrolled the 36.8 kilometers of ocean beach for sea turtle activity (methods reported by Conant and Rikard, 1991). Once a turtle activity was found, data relevant to the time, location, and type of activity were recorded. The data recorded each day reflects the previous evening's activities, i.e. data recorded on Sunday represents activities from Saturday night. We considered weekdays Monday through Friday and weekends Saturday and Sunday. Activities, defined as either a crawl, dig, or nest, were identified as follows:

Crawl: turtle tracks not associated with any apparent digging activity by the turtle.

Dig: turtle tracks associated with an excavation in which large amounts of sand are disturbed but no eggs deposited. The area around all digs were further excavated systematically by the field observer to verify the absence of eggs.

Nest: a dig in which eggs were found.

For this study we combined the crawl and dig data as "non-nests". We used data provided by Park Service concessionaires to estimate the intra-weekly variations in human beach activity during the nesting season.

The data were analyzed by graphically comparing the human presence and types of turtle activities according to weekdays and weekends. We used a Chi Square statistical test (Schefler, 1979) to detect significant differences in the intra-weekly variations in types of sea turtle beach activities.

RESULTS

Sea turtle beach activities during the weekdays were approximately evenly distributed between nest (49.6%) and non-nest (50.4%)(Figure 1). Weekend activities showed a disproportionate increase in non-nest activities (64.9%) relative to nest activities (31.5%)(Figure 1).

We found a similar trend for weekdays in terms of average number of nest and non-nest activities (0.65 and 0.66 respectively) for each night during the nesting season (Figure 2). The weekend activities (Figure 2) also show a similar trend in that there are nearly twice as many non-nest activities (1.16) as nests (0.63). By comparing the average number of weekday nests and non-nest activities per night to those on the weekends, we see that the average number of nests are relatively consistent throughout the week (0.65 and 0.63 respectively) whereas the average number of non-nests activities is substantially greater on the weekend nights (1.16) as compared to the weekday nights (0.66) (Figure 2). Chi Square analysis showed no significant difference in nesting activity between weekdays and weekends. When comparing non-nest activity, however, the differences between weekends and weekdays were significant ($p<0.05$).

The limited available visitor data during our study period shows an increase on weekends versus weekdays in both the average numbers of vehicles (73 and 62 respectively) and overnight visitors (64 and 23 respectively) recorded at specific sites on the island (Figure 3).

DISCUSSION

The average number of turtle nests per night on South Core Banks during the nesting season was relatively consistent throughout the week while the number of non-nest activities increased dramatically on the weekends. This suggests that individual turtles may be coming on to the beach and turning back to the ocean without nesting more often on weekends than on weekdays. Female loggerhead turtles are known to return to the sea if disturbed by lights and\or moving shadows during the early stages of nesting (Caldwell et al., 1959 and Margaritoulis, 1985 as reported by U.S. Fish and Wildlife Service, 1988). Mann, 1978, suggested that automobile headlights may deter nesting.

The visitation data reflect higher weekend beach usage. Although human night beach activity data are lacking, we have repeatedly witnessed vehicles, campfires, flashlights, and other detectable human movement on beaches at night. Often visitors will congregate to the sight of a sea turtle on the beach at night.

We currently have no way of estimating the long term effects of these beach disturbances on the reproductive success of sea turtles. In the case of threatened and endangered sea turtle species, waiting for these data may not be timely. To better understand human beach activity at night, observers on beaches or perhaps questionnaires at the ferry docks would be helpful. We recommend comparing this study to a similar study on beaches that have limited human beach activity at night and no vehicles (perhaps Bald Head Island, NC) to test for corroborative results. The potential for nesting sea turtles to abort nesting attempts, shift nesting beaches, delay egg laying, and select poor nesting sites in response to nighttime human activity exists (National Research Counsel, 1990). Enforceable regulations and public education in the schools, workplaces, ferry docks, and on beaches, is critical in the effort to insure the future of these threatened and endangered species.

ACKNOWLEDGMENTS

Thanks to Mike Rikard and Jeff Cordes of Cape Lookout National Seashore for the data and opportunity to participate in the data collection and analysis. Thanks to Therese Conant of the North Carolina Non-Game Endangered Wildlife Program for the help with the graphics and her enthusiasm for our work and sea turtle research and conservation. Thanks to Victoria Thayer of the National Marine Fisheries Service for editorial assistance and scientific scrutiny.

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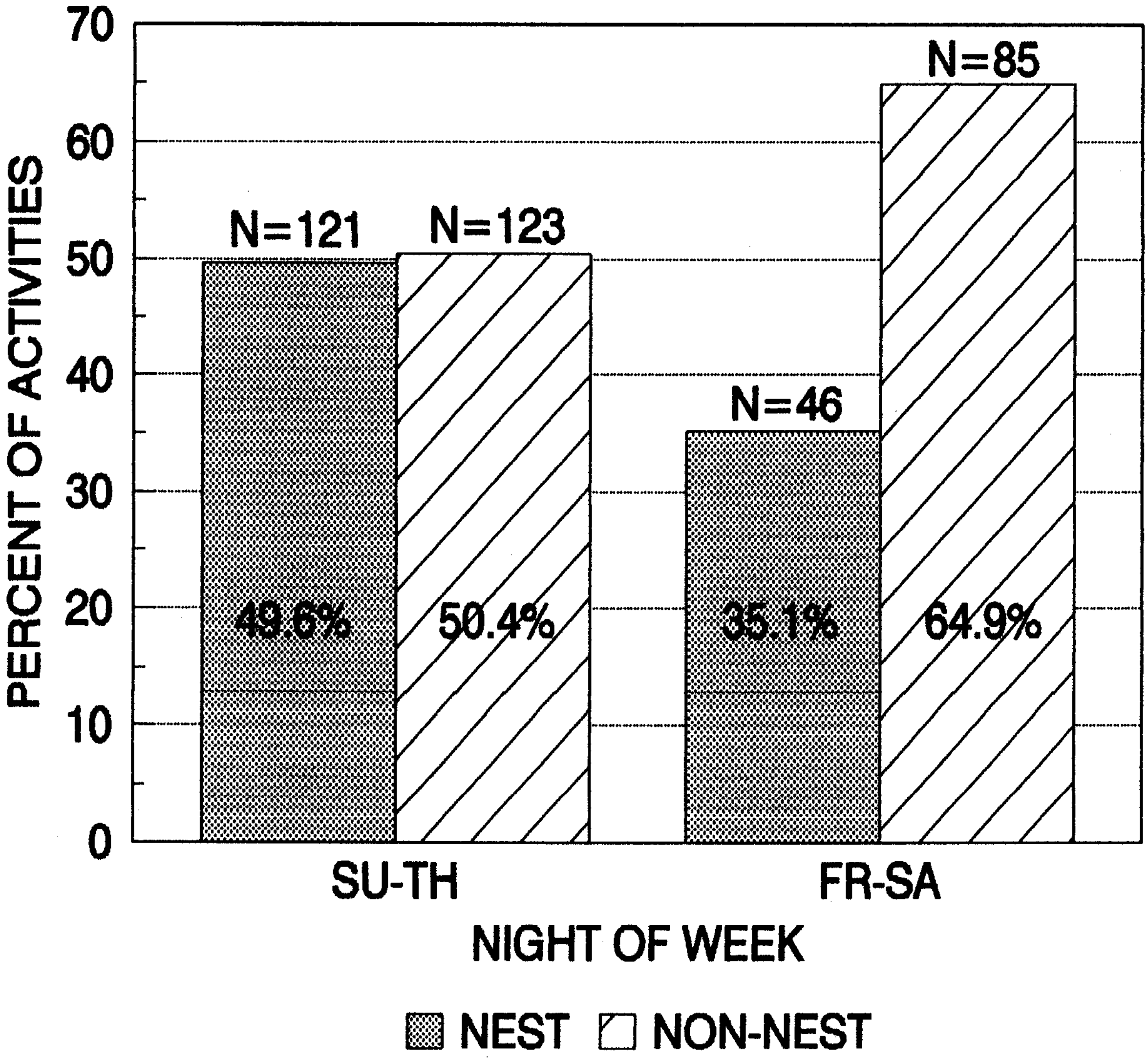

Figure 1. Relative frequency of loggerhead nest versus non-nest beach activities, South Core Banks, North Carolina 1990-1992.

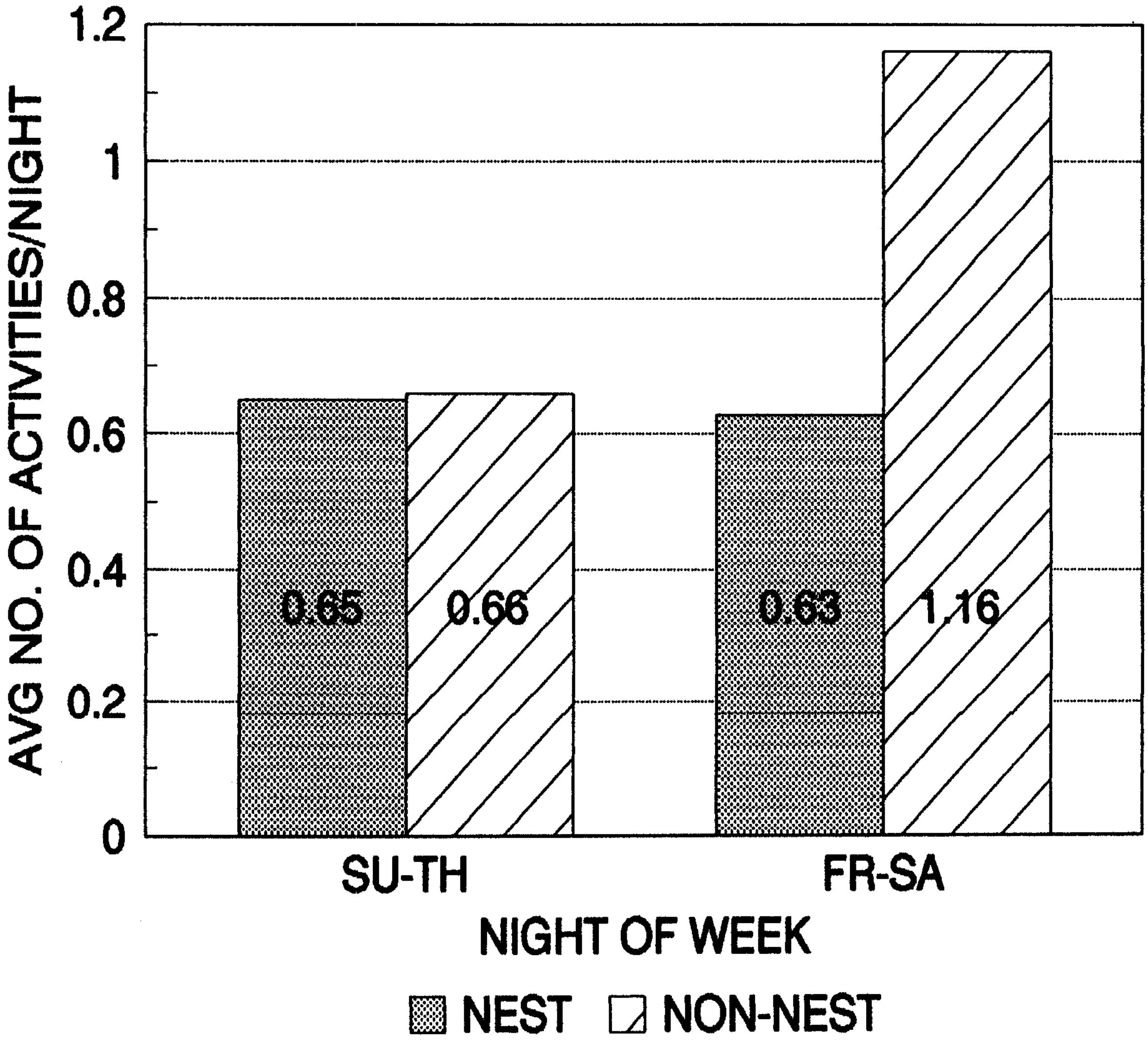

Figure 2. Loggerhead nesting activity, South Core Banks, North Carolina 1990-1992.

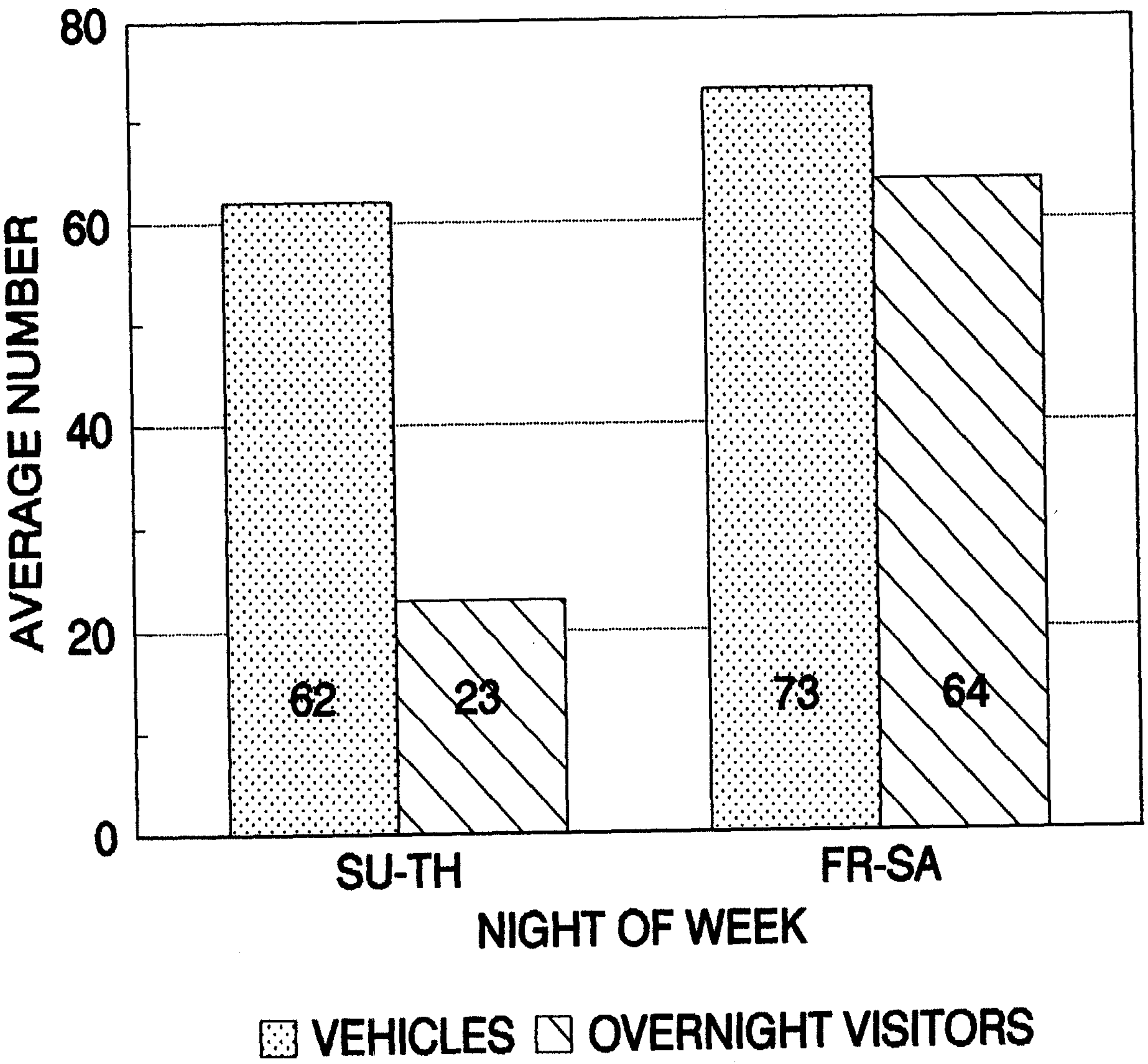

Figure 3. Visitation to South Core Banks, North Carolina
May 18 through July 24, 1992.

DETECTING H-Y ANTIGEN IN THE WHITE BLOOD CELLS OF LOGGERHEAD TURTLES (*Caretta caretta*): A POSSIBLE SEXING TECHNIQUE

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Because sexual differentiation in marine turtles is temperature-dependent, studies of hatchling sex ratios are essential. Unfortunately, these studies are hampered by a current inability to sex hatchlings of these endangered species without sacrificing them. I am investigating the possibility that the sex-specific H-Y antigen expressed on white blood cells (WBCs) may be used as an indicator of sex in hatchling loggerhead turtles (*Caretta caretta*). To confirm sex-specificity of this antigen, I have used three techniques to study H-Y antigen on the WBCs of adult loggerhead turtles: 1) indirect immunofluorescence of the H-Y antigen detected by fluorescence microscopy; 2) indirect immunofluorescence of the H-Y antigen detected by flow cytometry; and 3) enhanced chemiluminescence (ECL) of the H-Y antigen detected by X-ray film after Western Blot. So far, none of the techniques have reliably detected H-Y antigen. The results have been inconsistent both among the experimental samples and among the control samples. For example, control samples known to have H-Y antigen (positive controls) have tested both positive and negative for the antigen and negative controls have also tested both positive and negative for the antigen. However, because the H-Y antigen is a minor histocompatibility antigen and reacts very weakly with antibody, these type of inconsistencies are not uncommon. Continued refinement of the techniques may lead to more consistent results and an ability to properly evaluate the potential for use of the H-Y antigen as an indicator of sex in loggerhead turtles. Among the techniques used in my study, the Western Blot with ECL had certain attributes that made it the most promising for continued refinement as a method of detecting H-Y antigen.

SEA TURTLE PEN PALS: A PROPOSAL FOR INTERNATIONAL ENVIRONMENTAL EDUCATION

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BACKGROUND

Environmental issues are of concern to the citizens of most nations, but many basic environmental problems are still only partially appreciated - much less resolved. The severity, complexity and diversity of these problems continue to expand, while the human situation is in a precipitous decline, whether measured in terms of nutrition, health, shelter, material wealth, education, culture, aspirations for the future, or peace.

Because environmental problems are as a rule highly complex, involving a wide variety of human activities and ecological phenomena, it is difficult for the average person to arrive at more than a superficial understanding of the issues, causes, and alternatives for resolution. This conceptual difficulty is even greater in children, who lack wide experiences and an understanding of the complexities of the modern world.

An appreciation of the interdependency of human activities and human well-being on the one side, and environmental issues on the other, is fundamental to providing a true understanding of these issues and their potential resolutions. Involving children in this process is more than a means of ensuring better educated adults for the future: the guileless questions and innocent perceptions of children provide new avenues of discussion and innovative visions for solving problems.

Remarkably, efforts to educate the general public about global environmental matters are directed by adults, and in many ways focused on adults. Even basic information is often not explained to children, and their perceptions of the magnitude of environmental problems are badly restricted. It is essential that children be better informed and more involved in global discussions about environmental problems and also in just resolutions of these issues.

One of the most effective ways to involve children in this process is through educational programs. In public education, there is a need (at least at the outset) to focus attention on simplified, but key, environmental issues. An effective strategy to accomplish this is through the use of a "Flagship species"; this involves spotlighting a particular species that typically is charismatic, conspicuous, attractive to the general public and identified with ease. By protecting the flagship species, numerous requirements basic to other species, the ecological community, and critical ecological processes are assured. For many years now, marine turtles have taken on a role of international flagship species. In addition, there is a boundless variety of problems involved in the conservation and rational utilization of these animals. The conservation status of sea turtles is a valuable barometer of environmental conditions and human attitudes about safeguarding our global environment.

OBJECTIVES

The goals of Sea Turtle Pen Pals are to involve children from a variety of countries in active discussions and interchanges, about environmental issues. Sea turtles will be used as an international flagship species to draw attention to global problems. Through exposure to educational materials and specialized activities, and then the interchange of letters, it is hoped that the participants will become better informed about global concerns and take more active roles as world citizens. Their concerns will impact their parents, other adults, and in the end decision makers in their respective communities.

In addition, educational materials and activities will be developed, and environmental educators will be trained. Didactic materials formulated during the project will be systemized, edited and distributed for further educational activities.

METHODS

Networks of Pen Pals will be established by two methods. Conservationists directly involved in environmental education, and particularly those with some involvement with sea turtles, will be contacted in various countries. In most cases, these primary contacts will be colleagues, or ex-students, with whom the Principal Investigator has worked closely in the past on conservation and educational matters.

In addition, contacts will be made through the European Council of International Schools. This international network of schools is renowned for the high quality of education, the multinational student body, and involvement with the local community on matters of global concern. The existing newsletters which circulate among the scores of International Schools the world over provide an effective way to tie into an already existing educational network. In this way both teachers and students will be invited to participate in the project.

Those people who express interest in the project will be invited to send ideas on didactic materials, educational activities and also on organizational aspects of the project. They will be requested to send names and addresses of children from their respective communities who they judge most likely to have the interest and initiative to learn from the interchange of educational materials and activities and then to become active participants in the interchange of letters discussing environmental issues and possible solutions.

Two pen pal networks will be set up: an international network in English, and an American hemisphere network in Spanish. The latter will facilitate international communication over Latin America. The former will be used in all countries, including those in Latin America where Pen Pals want to exchange letters with peers outside of Latin America.

Each contact person will meet with children, explaining the objectives of the project, providing them with counsel, and helping with the interchange of educational materials and activities. Except for students in Europe, industrialized Asian countries, the USA and Canada, up to US$500.00 per contact will be provided for materials such as local picture postcards, stamps, pens, stationary, and organizational costs.

Educational materials will be solicited from international conservation organizations and distributed to contacts in different countries. Letters of endorsement from international organizations will be provided to network contacts to help them strengthen their institutional support at the local level.

Ultimately as many contacts and as many Pen Pals as possible from the greatest diversity of countries will be integrated. However, this ambitious objective will be attained by gradual, directed development and strengthening of the program. During the first year special attention will be given to supporting no more than 20 international contacts and the Pen Pals with whom they work.

In addition to cultivating the international contacts and Pen Pals, special emphasis will be given to developing environmental education programs in Mexico. This country has a unique and very special situation in regard to marine turtles: the greatest diversity of species, some of the largest breeding populations in the world, a wide variety of direct cultural and economic ties to marine turtles, and some of the most difficult and complex problems in regard to conservation and management of this resource. Also, there is a pressing need to consolidate and strengthen existing environmental education activities in Mexico. Both governmental and non-governmental organizations have been involved in educational programs, but frequently these lack continuity, clear objectives and adequate methods of evaluation and subsequent improvement.

The educational programs to be developed simultaneously with the Sea Turtle Pen Pals will include special activities and educational materials, which will be developed with children from both urban and rural backgrounds in Mexico. Attention will be focused on children in the yucatan Peninsula and Mexico City. On the basis of these experiences, didactic materials and activities will be designed and modified for the international networks.

A trimestral newsletter, explaining the objectives, advances and problems, will be distributed to participants. Remarkable cases of contacts, Pen Pals, and/or schools and other institutions will be described in order to explain and disseminate their techniques, to understand their reasons for success, and also to give them public acclamation and credit for good work.

At the end of the first year, diplomas will be awarded to students, contacts and schools and other institutions who participate actively in the program. Awards will be awarded to those participants who excel in certain criteria: e.g. those who show the best understanding of the issues, the most innovative ideas for solving environmental problems, and those who develop the strongest international ties with other Pen Pals.

The educational materials and activities developed will be made available to governmental departments responsible for formal education as well as other organizations involved in environmental education.

An inherent aspect of the program will be the sensitization of teachers and educators about the importance of environmental education. Teacher training activities will be provided (either informally or formally), notably for urban and rural schools in Mexico. University students will assist in the program, and at the same time be trained in techniques for teaching and evaluating environmental educational.

EVALUATION

The short term achievements of the project will be evaluated in several ways: 1) totaling the number of contacts and number of Pen Pals who initiate, and calculating the proportion that finish the first year; 2) selecting those Pen Pals, contacts, and educators who remain active throughout the first year and assessing the difference in environmental awareness at the beginning and at the end of the first year; 3) assessing any differences, before and after exposure to the program, in the effectiveness of educators in teaching environmental issues; 4) soliciting opinions about the strengths and weaknesses of the program from the contacts, educators and conservationists involved in various aspects of the project; 5) soliciting opinions from the Pen Pals themselves; 6) soliciting opinions (via the contacts) from community leaders.

The educational programs carried out in Mexico will be evaluated by comparing "before and after" levels of knowledge and awareness in environmental issues, and assessing "before and after" differences in attitudes and actions related to these issues. These investigations will be carried by means of interviews and spot inspections, which will be conducted with participating and non-participating children, their teachers and parents, and a small sample of people from their respective communities.

At the end of the first year coordination workshops will be held with Pen Pals, educators and institutional directors to discuss the results of the evaluations. On the basis of this information and the workshop results, the activities, materials, and organization will be improved and strengthened for future use.

A NEW AREA FOR MARINE TURTLE RESEARCH IN QUINTANA ROO, MEXICO

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For two consecutive years, research has been carried out in the central portion of the Biosphere Reserve of Sian Ka'an in Quintana Roo, Mexico. The beaches (14 km.) have been monitored during the 1991 and 1992 nesting seasons (May-September) for loggerhead (*Caretta caretta*) and green turtle (*Chelonia mydas*). Given the natural conditions prevailing in the nesting site, nesting conduct and conditions of incubation are maintained intact. According to Hildebrand (1987), only 32% of the mainland Mexican Caribbean coast or approximately 135 km are suitable for nesting marine turtles. This new area will increase this by 10%.

METHODS

The beaches patrolled nightly (22:00-02:00) from June to July 1992, comprised the first five km. beach section from Punta Pajaros to Punta Piedra. Upon encountering a nesting female, the date, location and species were recorded. Over the carapace length (OCL) and width (OCW) were measured using plastic measuring tapes and both front flippers were tagged using monel type tags.

Daily diurnal surveys were made of the entire 14 km. stretch of beach to register any nesting activities accomplished after the nightly patrols, and in the beach section that was not covered. Any nest having more than 50 days of incubation was located using a wooden probe and the nest contents were exhumed and examined. Beach cross sections were taken on a monthly basis (June-September) to assess morphological change of the beach front.

RESULTS AND DISCUSSION

During the 1991 nesting, 133 loggerhead crawls were registered, whilst 238 crawls were registered in 1992. Loggerheads nested primarily in the stretch of beach that was patrolled nightly having an average of 35.8 crawls/km (Figure 1). Many of these activities resulted in aborted nesting attempts, characteristic of the species (Dodd, 1988). Eight female loggerheads were tagged and no recaptures were reported. The average OCL was 96 cm; values below the average reported for nesting females in northern beaches such as Xcacel (Zurita, 1989). The reason for this discrepancy is unknown.

During the 1992 nesting season, no green turtle nestings were recorded (Garcia, 1991). The 1992 nesting season had 74 nesting activities. Further studies will provide information on the possibility of a single biannual nesting population.

The nesting season of both species is in accordance with those reported for the Caribbean (Fowler, 1979; Bjorndal and Carr, 1989; Marquez, 1990) and those reported for Quintana Roo (Zurita, 1989) (Figure 3).

Sixty four loggerhead and twenty seven green sea turtle nests were exhumed. Out of these, 7,299 loggerhead and 2,549 green turtle hatchlings were released. For both species in the 1991 and 1992 nesting seasons, the percentage of fertile eggs and the hatch success was above 80% (Figure 3). Nest predation was basically limited to small mammals and man, accounting for 5.5% of nests in the area.

Beach dynamics play an important role in nest success in the area (Hopkins, 1988). The beach morphology changed drastically in June, losing approximately 5 m. of the original beach width. This change affected the first nesting activities of loggerhead sea turtles (approximately 25% of the total amount of nests laid) but did not affect Green turtle nestings as these occurred after the change in beach morphology.

The bottom of Bahia Ascencion has wide areas of marine grass and extensive algal beds. Juvenile stages of hawksbill and green sea turtles are found. Future studies will reveal the importance of this area as a refuge for juvenile stages of marine turtles.

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SOME ASPECTS OF A SHORT COURSE ON SEA TURTLE BIOLOGY AND CONSERVATION HELD AT ISLA DE MARGARITA, VENEZUELA

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Because it is necessary to involve many people in sea turtle conservation and research, a short course on sea turtle biology and conservation was implemented. The course was held between July 30 and August 2, 1992, at the Universidad de Oriente (Guatamare, Nueva Esparta Nucleous). It was sponsored by the Instituto Nacional de Parques (INPARQUES), Centro de Conservacionismo y Excursionismo y Universitario (CCEXU), Universidad de Oriente (UDO-NE) and the Wider Caribbean Sea Turtle Conservation Network (WIDECAST).

The course was comprised of lectures and technical sessions. The lectures included: 1) history, taxonomy and world distribution; 2) general aspects of biology, 3) direct and indirect identification of the different species; 4) methods of tagging, weighing, types of census, determination of the sex, observations on the reproductive behavior, counting of eggs and marking of nests; 5) registering of the field data (tracks, nests, stranded turtles), necropsies, use of interviews, guidelines for the nightly observations; 6) translocation of nests, hatcheries, liberation of hatchlings; 7) marine behavior observations; 8) stomach and blood sampling, laparoscopy; 9) problems affecting the survival of the marine turtles; 10) national laws and international agreements on the protection of the sea turtles; 11) strategies of conservation in Venezuela; 12) programs of research and conservation in Venezuela; 13) needs of research and conservation of the sea turtles in the Isla de Margarita; 14) audiovisual presentation: TAMAR Project (Brazil).

The technical sessions included: 1) measurements and identification with collection material and captive sea turtles; 2) diurnal field work to recognize the sea turtle tracks and nests; 3) necropsy; 4) evaluation. The course was taken mainly by undergraduate students, but moreover, we had participants from two governmental offices, related to sea turtle conservation: the Ministry of the Environment and Natural Renewable Resources and the Ministry of Agriculture and Husbandry. We are planning at least two more courses more in 1993. One of them will again be held at Isla de Margarita, but with participation of students of the mainland nucleous of the University. We hope to have at least one day more for the course, in order to have more field work and to incorporate lectures from people from governmental and non-governmental organizations.

SEA TURTLE CONSERVATION PROGRAM AT BARRA DE SANTIAGO, EL SALVADOR

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This report presents the results achieved throughout the development of the third consecutive season of efforts on behalf of the sea turtle population which nests at Barra de Santiago through the Sea Turtle Conservation Project at Barra de Santiago, El Salvador-1991. Sea turtle conservation projects have been developed in a sporadic, non-continuous manner since 1974 and at very few beaches in El Salvador. Past efforts have focused primarily on hatchling production through processes such as the prohibition of egg gathering and buying eggs from egg gatherers (poachers) and have not been executed as joint efforts between the institution responsible for the project and the local community. Since 1989, the Sea Turtle Conservation Project in Barra de Santiago (August-December) has been an ongoing project financed by the U.S. Fish and Wildlife Service and the World Wildlife Fund for Nature, and executed jointly between a local non-governmental organization (Amigos del Arbol, AMAR), the National Parks and Wildlife Service (CENREN), and the Natural History Museum of El Salvador. The project actively involves the local community in the difficult task of implementing an adequate sea turtle management system, promoting the ecological recovery of this species.

METHODS

Barra de Santiago is a 9 km sandy beach which divides the Pacific Ocean waters from Barra de Santiago's estuary and mangrove ecosystem. It is located on the western tip of El Salvador, 35 km east of the Guatemalan-Salvadorean border (13° 42' N and 90° 02' W). It is utilized as a nesting beach by *Lepidochelys olivacea* and *Dermochelys coriacea*. The project integrates three strategic components: environmental education, research, and dissemination.

Environmental Education

The project considers the local school as its nucleus. Environmental education activities were developed in and outside the classroom. Talks, group dynamics and arts and crafts contests were held involving not only the schoolchildren but their parents as well. Three turtle egg hatcheries were built at the school playground which is located on the ocean front. A cement tank (3 x 1 m) was built next to the hatcheries in order to headstart thirty *Lepidochelys olivacea* hatchlings. Turtle eggs were voluntarily buried by egg gatherers in exchange for staple food and first necessity items through a local Turtle Market Barter System. Each egg gatherer exchanged a minimum of 30 eggs for a product equivalent to its price (1 egg = 1 point = $0.12 US) and a dozen more eggs as a donation totalling 42 eggs. At the end of the turtle season (December) the hatchlings headstarted by the schoolchildren were released as an eco-theological symbolic retribution to the ocean, an activity which was named "a christmas gift to the ocean."

Research

The local egg gatherers, 142 in total, received a biological kit consisting of a notebook, a tape measure and a pencil in order to obtain adult female turtle measurements (curved carapace length, curved carapace width, head width) and timing in relation to nesting (tide, moon phase, weather conditions). In addition, hatchery thermodynamics and sand humidity were monitored. The three hatcheries were subject to different degrees of shading (no shade, partial shade, total shade). Hatch success was evaluated. Growth patterns of thirty *Lepidochelys olivacea* hatchlings were monitored through a one year period (carapace length and width, head width, weight). Treatment for fungus growth, *Candida albicans*, on hatchlings was tested using clotrimazol, dexamethasone and azidamfenicol. Nesting turtles were tagged.

Dissemination

As a means of educating people that generate the demand for turtle eggs as well as to create a general expectation and public opinion in relation to the sea turtle recovery program, TV and radio spots were broadcasted and turtle news was published in the national press.

RESULTS AND DISCUSSION

Environmental Education

Through the active participation of the school children, parents and egg gatherers in the development of the project, the local community as a whole, assimilates with greater ease the concept of sustainable use and management of sea turtles. The paintings and crafts made by the schoolchildren indicate their knowledge on sea turtle problems and the actions they must take to solve these. The success of the environmental education program must depend on the degree by which the project incorporates the community in participating in the recovery of the species in mention, and on the continuity of the program. A total of 152 nests containing 6,991 eggs were buried at the school hatcheries by local egg gatherers. These nests represents 56% of the total nests detected.

Research

A total of 82 nesting turtles, *Lepidochelys olivacea*, were measured obtaining an average curved carapace length of 69.5 cm, an average curved carapace width of 70.1 cm, and an average head width of 10.9 cm. A direct relationship between turtle size and number of eggs laid was observed (r=0.912). The total of nestings through the projects period, August-December, rose during the month of September and were detected mostly on the new moon phase (39%) followed by quarter moon phase (23%). The average hatch success was 69.7% with an average of 46 eggs per nest. Hatchery No. 1 (no shade) averaged a 40% hatch success and an average incubation time of 47 days. Hatchery No. 2 (total shade) averaged a 90.2% hatch success and an average incubation time of 53 days. Hatchery No. 3 (partial shade) averaged a 79% hatch success and an average incubation time of 44 days. Total Shade Hatchery thermodynamics were: 32.5 C average temperature in August, 29.0 C in October, and 31.1 C in November. Hatchery sand humidity was 10.5%. Through a period of 12 months, the thirty headstarted turtles averaged 22.1 cm in curved carapace length and an average weight of 1387 g. A 70% success was observed with clotrimazol, dexamethasone, azidamfenicol treatment for fungus.

Dissemination

The activities under the present project were broadcast through four TV channels, three main national newspapers, and two radio stations, throughout the project period. These efforts focused mainly on the urgent need to approve a sound legislation for the protection and conservation of sea turtles, to promote the use of Turtle Excluder Devices in shrimp boats and to reduce the general demand for turtle eggs.

The success of the present project can only be monitored on a long term basis. Additional continuous efforts are necessary in order to further organize the local community in the adequate management of the sea turtle population. Sea turtle research is needed not only in Barra de Santiago but on all Salvadorean beaches for the elaboration of a national sea turtle recovery program.

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PROGRESS IN THE EXPERIMENTAL TRANSMISSION OF GREEN TURTLE FIBROPAPILLOMATOSIS

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Green Turtle Fibropapilloma (GTFP) disease has become a worldwide threat to green sea turtle populations. In an effort to discover the etiology and understand the pathogenesis of this disease an ongoing series of transmission experiments have been undertaken at The Turtle Hospital, Marathon, Florida. This is a progress report.

Nine one-year old captive-reared green sea turtles were exposed by various routes to GTFP or possible etiologic agents. Three turtles were injected with eggs of spirorchid trematodes at various body locations to test the hypothesis that eggs may cause or enhance tumor development. Three turtles were allowed to swim and have physical contact with a GTFP bearing animal. Two turtles received GTFP tumor that had been treated in various ways: (1) whole tumor (dermis + epidermis) transplants, (2) tumor dermis transplants, (3) tumor tissue homogenate, and (4) tumor homogenate that had undergone two freeze-thaw cycles. One turtle was maintained as a control whose only exposure would be via filtered Florida Bay/Gulf water.

None of the control, contact exposed, or trematode egg treated turtles have developed disease in the 12 months since the experiment began. Both turtles inoculated with GTFP tumor developed tumors only at the site where they were injected with twice freeze-thawed tumor homogenate. Tumor growth became apparent within 5-6 months and progressed rapidly with the coincident seasonal rise in water temperature. Once in log-phase growth, tumors reached approximately 2cm in diameter in one animal and 5 cm in the other before they were surgically debulked.

The success of the freeze-thaw treatment suggests that a virus may be involved because this treatment should lyse cells and release virus. However, we cannot preclude the possibility that some intact and viable tumor cells were transplanted in this treatment. Further experiments are under way to reproduce these results and differentiate between tumor cell transplantation and virus transmission. At this time it seems unlikely that trematode eggs are a primary cause of GTFP.

INCIDENTAL CAPTURE OF SEA TURTLES IN THE SOUTHERN PART OF QUINTANA ROO, MEXICO

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Incidental catch or take is defined as the capture of species other than those towards which a particular fishery is directed (Hopkins and Richardson, 1984). The incidental catch of sea turtles by shrimp and fish trawl vessels from Yucatan state have been reported in the northern zone of the state of Quintana Roo (Zurita 1985). This paper is based largely on research conducted by Herrera in his thesis work (Herrera 1991).The evaluation of the incidental capture of sea turtles (in the commercial fisheries carried out by fish traps, gill nets and shark nets) was conducted from May 1989 to February 1990, in the southern part of the mexican Caribbean.

RESULTS AND DISCUSSION

In 1989, 35 traps (beach weirs) were weekly surveyed from Mahahual to Xcalac, Quintana Roo, Mexico. The local independent fishermen operate them from September to December. Six additional weirs were located in the bay of Chetumal, which were used from May to July. Beach weirs ("trampas de corazón y cola"), have been used along the southern coast for at least thirty years (Miller,1982); their numbers have been increasing during the last 10 years (Herrera, 1991). Incidental capture of sea turtles in beach weirs has not shown any records of mortality. On the other hand, the use of shark nets and gill nets (> 15 cm mesh) are considered to cause high mortality. Therefore, their future numbers to be used is critical in the conservation of the resources of the region. Presently, cooperative fishermen catch lobster and conch in the same fishing grounds. We suggest a tagging program, supervised by the biologists working in this area with the help of the fishermen, because it is a major feeding area for juveniles through adult for both the green, *Chelonia mydas* and hawksbill, *Eretmochelys imbricata*, and for subadult through adult loggerheads, *Caretta caretta*. We suggest that this area may be a sea turtle corridor between Mexico and Belize. Thus, we propose to implement an agreement between both countries that help research and sea turtle protection, considering that fishing techniques are similar in both countries.

ACKNOWLEDGEMENTS

We thank to the fishermen of Southern Quintana Roo for their support during field work.

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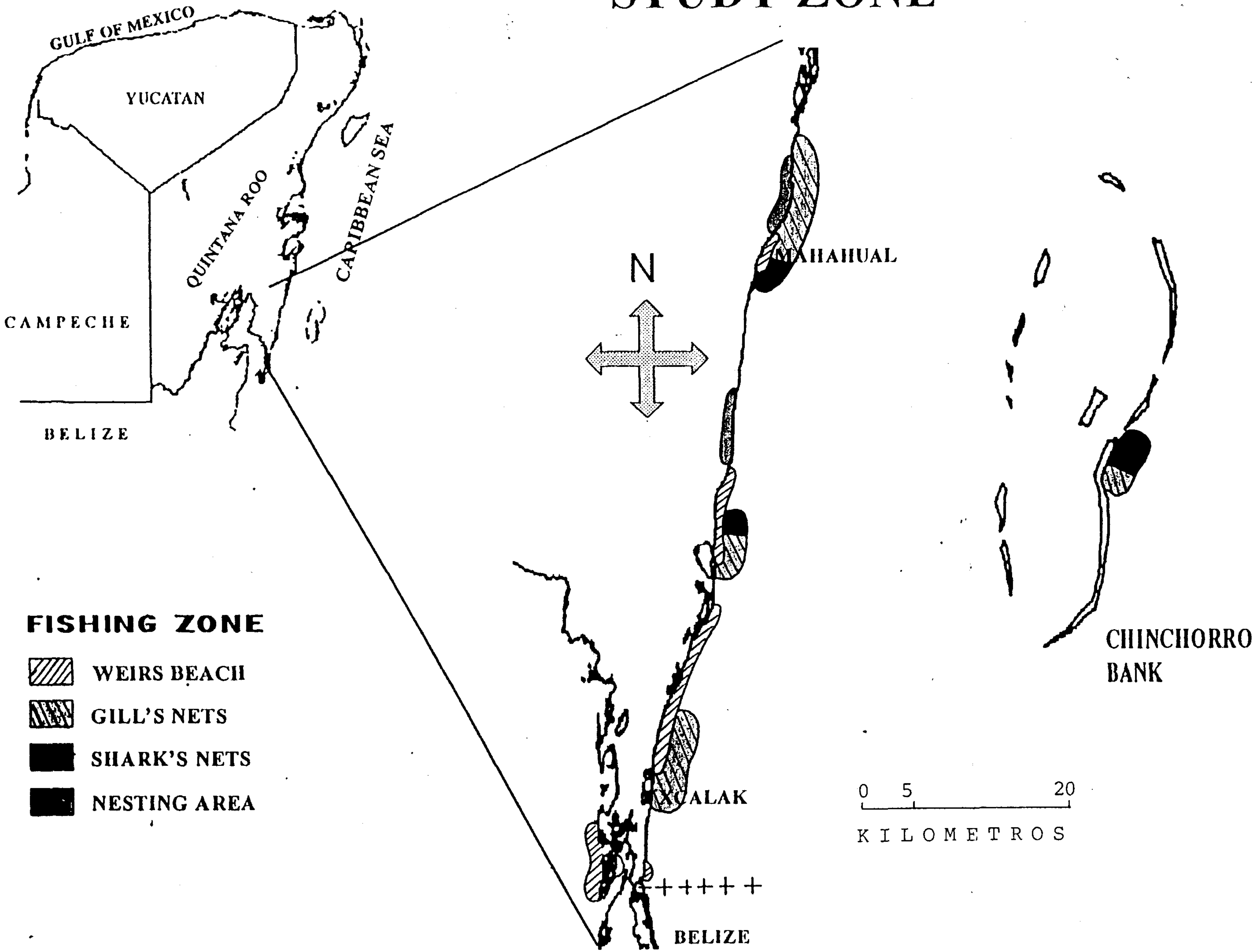
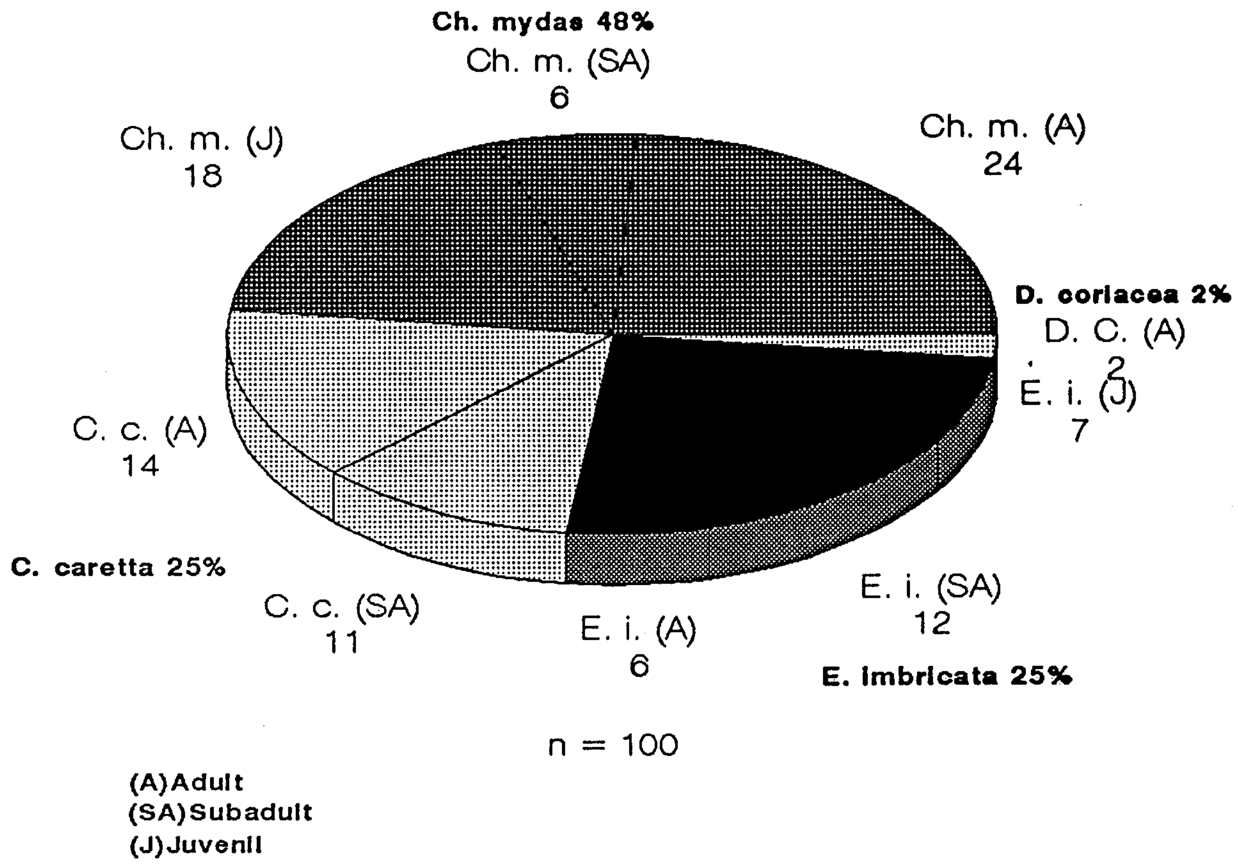
STUDY ZONE



GULF OF MEXICO
YUCATAN
CAMPECHE
QUINTANA ROO
CARIBBEAN SEA
BELIZE
N
MAHAHUAL
XCALAK
BELIZE
CHINCHORRO
BANK
0 5 20
KILOMETROS
FISHING ZONE
WEIRS BEACH
GILL'S NETS
SHARK'S NETS
NESTING AREA

Figure 2 Proportion of sea turtles recorded in southern Quintana Roo



THE FIRST FIVE YEARS AT BUCK ISLAND REEF NATIONAL MONUMENT - THE HAWKSBILL STORY

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The end of the 1992 nesting season marks the completion of five field seasons of nocturnal research on the hawksbill sea turtles nesting at Buck Island Reef NM (BUIS). Through the years, the program has increasingly emphasized a complete census of the nesting hawksbills, determination of their nesting requirements, and their overall nesting success. We continue to monitor the recovery of the nesting beach from hurricane Hugo and its effects on sea turtle nesting. The 1992 season was the first year several tagged hawksbills were observed for their third nesting season and their nesting site fidelity was closely monitored.

METHODS

The methods used on BUIS to monitor the nesting hawksbills have been described in Hillis & Mackay, 1989. Patrol nights have ranged from 40 nights in 1988 to 95 nights in 1991. This year, 79 nights were spent on the nesting beaches, and as in all prior seasons the beaches were monitored daily prior to and after the nocturnal research period to keep an accurate record of total number of sea turtle activities for the year. As always, volunteer assistance was essential to maintaining the 7 nights per week coverage.

RESULTS AND DISCUSSION

Annually, nocturnal observation of nesting hawksbill sea turtles (*Eretmochelys imbricata*) begins the end of June and continues through the end of September. Each year this has covered the peak months of nesting activity, July, August, September, however nesting frequently continues through December. The number of hawksbill activities recorded each year has ranged from 113 to 240, including nests, suspected nests, and dry runs/nest attempts. Figure 1 illustrates our improvement in accurate nest identification over the 5 years at BUIS. We attribute this improvement to both an increased understanding of hawksbill nesting behavior and the increased number of patrol nights on the nesting beaches (Table 1).

In the 6 years of concentrated monitoring, and 5 years of nocturnal research, BUIS has observed an overall hatch success of 77.8% with clutch sizes ranging from 59 to 223 eggs. The overall mean clutch size for the 6 seasons, 1988 to 1992, was 147.3 eggs. The average number of hawksbill hatchlings produced is 6243 per year. By the end of the 1992 season a total of 73 female hawksbills have been recorded nesting on BUIS. Both two and three year nesting cycles have been observed. In all re-migrant hawksbills some carapace growth was observed. Using the length measurement only, 2 year re-migrants average growth was 0.64 cm ($n = 5$, $SD = 0.42$), and in 3 year re-migrants average growth was 1.7 cm ($n = 4$, $SD = 1.2$).

Of the original 12 hawksbills tagged in 1988, a year when only one inconel tag was placed in the front left flipper, 75% of these animals have been observed nesting at BUIS again. 69% of the 1989 hawksbills have been observed again, and to date only 16% of 1990 hawksbills. The remigrant percentages of hawksbills to BUIS and separately to Jumby Bay, Antigua (Corliss, et al, 1990) both indicate a strong nesting beach fidelity for hawksbills.

There has been a large number of successful seasonal re-migrants to BUIS, and just as impressive are the individual females fidelity to a section of the nesting beach. Nest site fidelity has been observed in both remigrants and newly tagged hawksbills every season. In some instances, females returned to BUIS not only within days of when they arrived 2 and 3 years prior, but nested within one meter of their last season's nest site and all their subsequent nests of the season were along the same section of beach. Others, between 10 - 30%, do move great distances between nest sites, sometimes over 1000 meters, and nest on different sides of the island. But overall fidelity to a nest site, a segment of shoreline, is the normal tendency for BUIS hawksbills.

The nesting distribution on the three principle beaches, Northshore, West Beach, and Southshore/Turtle Bay, has remained relatively stable, both before and after hurricane Hugo. On average over the 6 years, the Northshore has received 38% of the activities, West Beach 14%, and Southshore/Turtle Bay 48%. These distributions may indicate a hawksbills "preference" for a nesting habitat of beach forest with near shore coral reefs, over the open sand beaches of BUIS. The only change in this habitat utilization distribution came after the hurricane when both beach forest nesting habitats were inaccessible for nesting and hawksbill's use of West Beach increased to 22% for that year only.

The average number of nesting activities for the 3 years prior to hurricane Hugo was 147.3 and the nest/dry run ratio was a mean of 0.55 to 1. Prior to the hurricane hawksbills were able to nest on their first visit to the nesting beach. After the hurricane, with increased berm slopes, exposed root tangles, and fallen trees the average number of activities for the following three years was 215 with a nest/dry run ratio of 1.6 to 1. Post-hurricane hawksbills were making one and one half visits to the beach before successfully nesting (Figure 1). This inability to nest on a first attempt may have had a detrimental effect on the gravid females which may be one possible explanation for the overall decline in hatch success post-Hugo (Table 1).

Prior to 1989 no nests were relocated from possible threat of erosion. After hurricane Hugo we began relocating nests when hawksbills were not able to climb above the eroded berm to nest and were laying nests in the erosion zone. In the 5 years, the number of nests moved after laying was small - 8% in 1990, 19% in 1991, and 10% in 1992. A total of 12% of all the nests laid at BUIS have been relocated. The overall emergence success of these nests is on par with the nests left *in situ*, except for a few nests buried too deeply or unfortunately moved to an area which was unpredictably lost to late season storm surge. Overall the 1992 season has shown some improvement in the beach, and fewer nests were moved by technicians. The Park staff will continue to do minimal shoreline clearing of dead material which could be hazardous to visitors, both human and sea turtles.

The accomplishments of the past 5 years of nocturnal research on hawksbills nesting at BUIS has been summarized in Table 1. Since 1988 the number of nights spent on the nesting beach has doubled, as have the number of hawksbill activities observed. This increased effort in time and personnel has greatly improved our ability to monitor the hawksbills and collect the necessary information needed to understand hawksbills and their unique nesting beach requirements at Buck Island Reef NM.

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Table 1. Annual Hawksbill Sea Turtle Project Results, Buck Island Reef NM, St. Croix, U.S. Virgin Islands, 1987 - 1992.

	NIGHTS ON BEACH	# HB ACT. PER YR	# HB ACT. OBS/YR	% NESTING BEACH DISTR.			AVERAGE CLUTCH SIZE		# OF HB-LINGS^	% HATCH SUCC
YEAR		JAN - DEC		NS	WB	SS/TB	n	x		x
1992	79	204	98	30	19	51	67	153.3	6842	71.5
1991	95	240	101	42	16	42	77	147.2	7281	66.2
1990	58	203	59	30	12	58	60	151.6	6041	81.4
1989	47	171	34	34	22	44	45	148.8	5700	83.7
1988	40	158	23	41	12	47	75	140.3	6800	80.9
1987	--	113	--	53	3	44	40	142.3	4793	83.5

^HB-LINGS = HATCHLINGS.

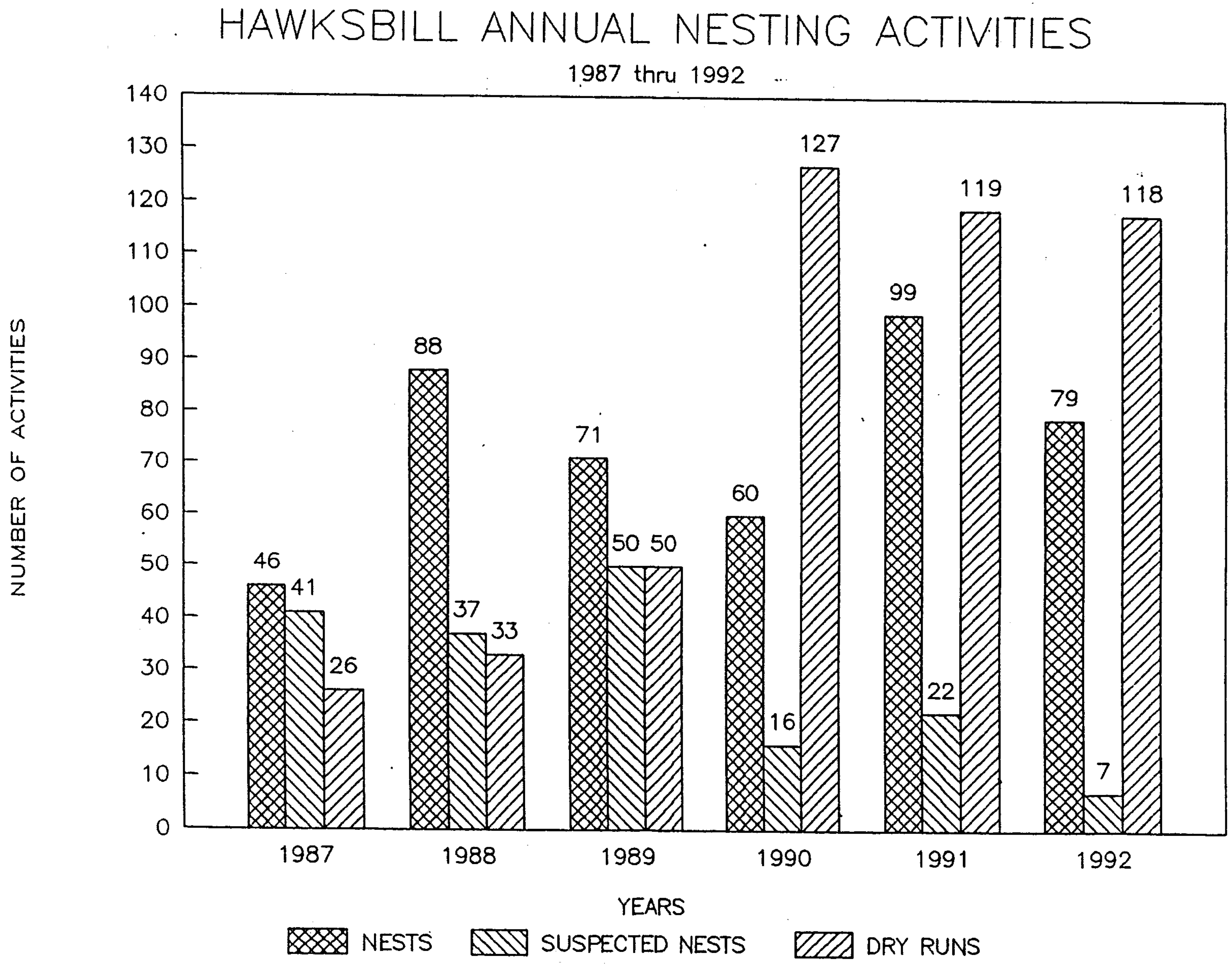

Figure 1. Annual Hawksbill Nesting Activities, Buck Island Reef NM, St. Croix, U.S. Virgin Islands, from 1987 - 1992.

A RADICAL COLOR CHANGE IN THE VENTRAL PIGMENTATION OF POST-HATCHLING GREEN TURTLES FROM JAPAN

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Extensive dark pigment seen in the plastron of post-hatchling green turtles has been reported at Hawaii and French Polynesia. This paper documents a similar color change seen in Japanese post-hatchling green turtles. Thirty green turtle hatchlings from Ogasawara Island (10 neonates randomly selected from each of three different clutches) and 18 turtles, each a few weeks old, from Okinawa Island (lineage unknown) were kept in captivity from summer 1992 through spring 1993. Photographs of the ventral surface of each turtle were taken at varying intervals. Size and weight of turtles were recorded. In the Ogasawara turtles, the extent of pigmentation varied both within and between clutches. The Okinawa turtles showed similar individual variation in pigmentation intensity, however, the darkest Okinawa individuals showed a narrower pigmented area than did the darkest Ogasawara turtles. In the Ogasawara neonates, pigmentation was already present at the inner ventral surface of their marginal scutes. In the darkest individuals, pigment spread onto the plastral scutes and ventral skin within a few days. In the lightest individual, most pigmentation was restricted to the marginal scutes and flipper skin. The pigment intensity reached its peak by 54-61 mm SCL. At 70-100 mm SCL, the newly forming portions of plastral scutes were unpigmented. As the turtles grew, the proportion of pigmentation on the ventral surface was gradually reduced. At the last stage, remnant pigment remained chiefly at the marginal scutes, but most of it disappeared by approximately 150 mm SCL.

EFFECTS OF HURRICANE ANDREW ON SEA TURTLE NESTING BEACHES OF SOUTH FLORIDA

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Because of the coincidence in time of hurricane season and sea turtle nesting season in the Caribbean and Atlantic basins, the possible impact of hurricanes on sea turtle populations is great. We assessed Hurricane Andrew's effect on 7 nesting beaches of South Florida, looking particularly at the causes and extent of mortality of the eggs and hatchlings.

The storm surge produced the greatest mortality through flooding of the nests. The greatest surge effect was felt on the beaches closest to the "eye" of the hurricane including Key Biscayne and Virginia Key. In both cases, egg mortality was 100%. In areas farther away from the eye, the surge was lower and mortality was correspondingly decreased. However, later mortalities were caused by changed beach topography in areas where sand was eroded from some nests and deposited on others. We suggest that post hurricane mortality in these cases could be reduced by quickly restoring the beach to its original topography. We determined that Hurricane Andrew affected turtle nests over a total of 90 miles of beaches on the east and west coast of Florida. Taking into account that most hurricanes have a much broader zone of influence, in addition to a high frequency of occurrence in this region, it can be concluded that hurricanes are causes of natural mortalities in sea turtles, particularly nests and hatchlings.

HYDRODYNAMIC DRAG CHARACTERISTICS OF JUVENILE *L. kempii, C. mydas,* AND *C. caretta*

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Drag is the primary force opposing forward motion in water. Sea turtles must consume energy to overcome this force during their daily activities. Our objective was to determine how the body form of juvenile sea turtles affects drag during swimming.

METHODS

Fifty nine turtles of three species (*L. kempii, C. mydas* and *C. caretta*) were measured and photographed to collect shape and data on epibiotic colonization. Analyses based on Reynold's number (Re) were performed to develop analytical models for each of the three species. Lift and drag characteristics were then calculated. This approach utilizes hydrodynamics to evaluate turtle activities. Similar types of studies have been performed, including research into sea turtle locomotion (Wyneken, 1988).

RESULTS AND DISCUSSION

Reynold's number (Re) for the turtles was calculated for swim speeds observed in long-distance tracking data (Morreale and Standora, 1992) and compared to the Re of other objects such as whales, tuna, aircraft, and automobiles (Vogel, 1981; Hoerner, 1958). The turtles compared dynamically with aircraft on the basis of Re, streamlined shape, and rigid outer skin. This enabled us to apply aircraft component test data (Abbott and Von Doenhoff, 1959; Hoerner, 1958) to analyze measurements of 59 juvenile sea turtles (Table 1). Although sea turtles do not look like conventional aircraft, they share similarities with the appearance of 'flying wings' such as the B-2 bomber (Fig. 1).

The turtles drag efficiency is influenced by design elements and by epibionts. For low drag, each turtle possesses laminar-type airfoil sections in cross-section and an elliptical shape from top view. An additional design benefit is body lift (Fig. 2). Flipper actions required for swimming affect stability and increase drag. The body lift forces counter these effects to minimize drag and, in process, add to propulsion. The influence on drag by epibionts is dependent on the amount of growth and position on the carapace (Fig. 3). The importance of drag efficiency is emphasized by the distances these turtles travel in late autumn with net movements > 700 km (Morreale and Standora, 1992). Considering the absence of feeding during the same period (Morreale, et al., 1992), it is probable that each turtle relies on body fat and low drag for swimming endurance.

Although the drag characteristics of these turtle's were not ideal (laminar), they were very low. Lift, which contributes to low drag, propulsion and stability, can be lost when flow becomes separated. Epibiota mounted on the forward carapace cause separated flow and a substantial increase in drag. Conversely, flow patterns over a swimming turtle minimize epibiotic colonization. The low epibiotic loads observed among these juvenile turtles enable them to maximize the efficiency of their shape and expend minimal energy during long-distance migrations.

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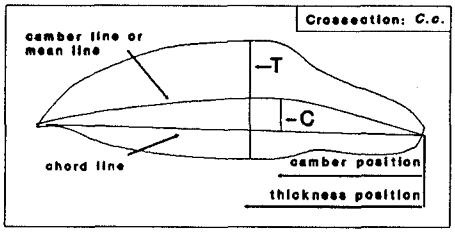
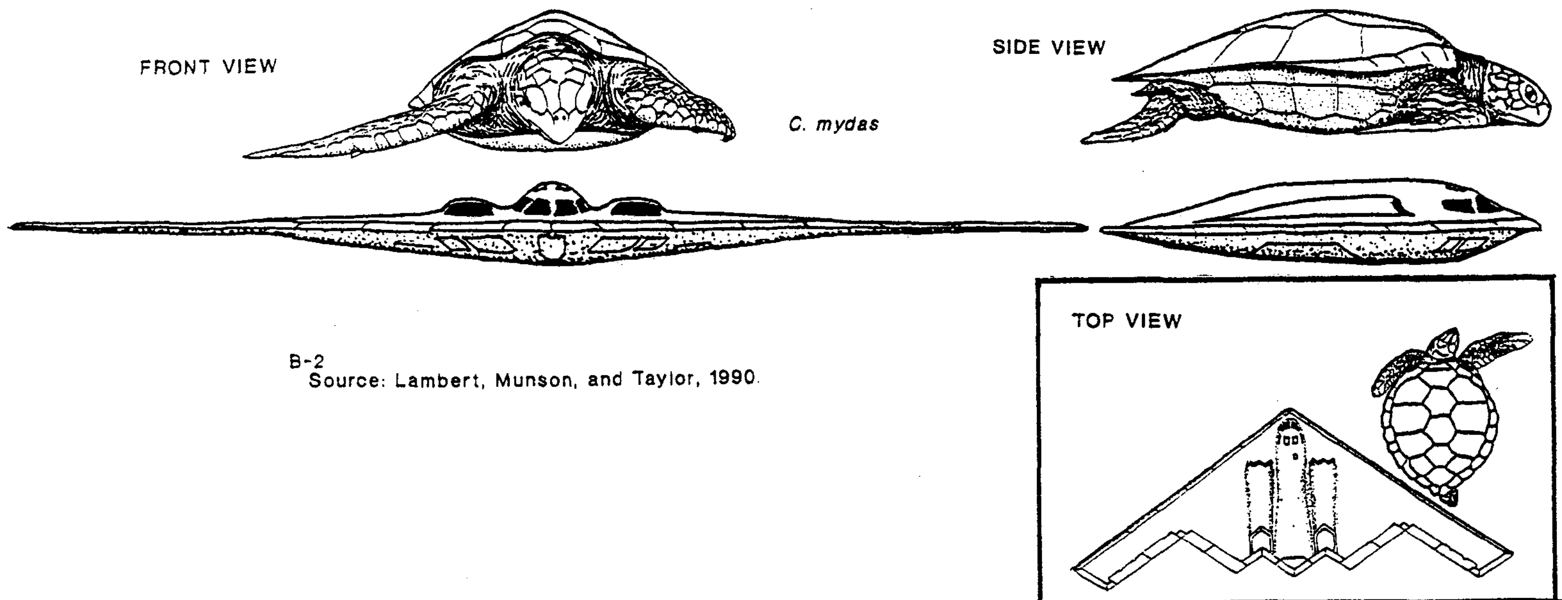


TABLE 1: MEASUREMENTS AND RESULTS

		Mean Measurements							Results	
		SCL		Maximum Thickness Mean		Maximum Camber Mean			Body Drag Coefficient	Body Lift Slope
SPECIES	N	Mean	Range	T%	Posit.	C %	Posit.		C_D	C_L/deg.
L. kempii	12	30.79	24.71-38.40	26.6	0.49	5.7	0.48	⇨	0.0059	0.042
C. mydas	12	30.65	26.33-38.80	28.6	0.47	6.7	0.43	⇨	0.0073	0.039
C. caretta	35	50.33	40.83-60.85	30.0	0.40	8.4	0.45	⇨	0.0074	0.039

FIGURE 1: SHAPE COMPARISON



Source: Lambert, Munson, and Taylor, 1990

FIGURE 2: EFFECTS OF ORIENTATION

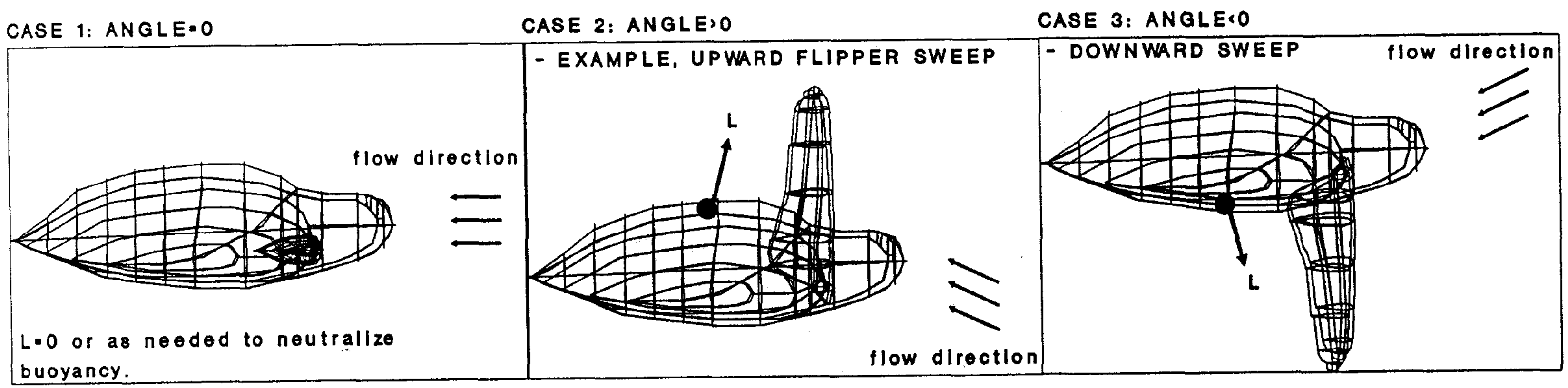
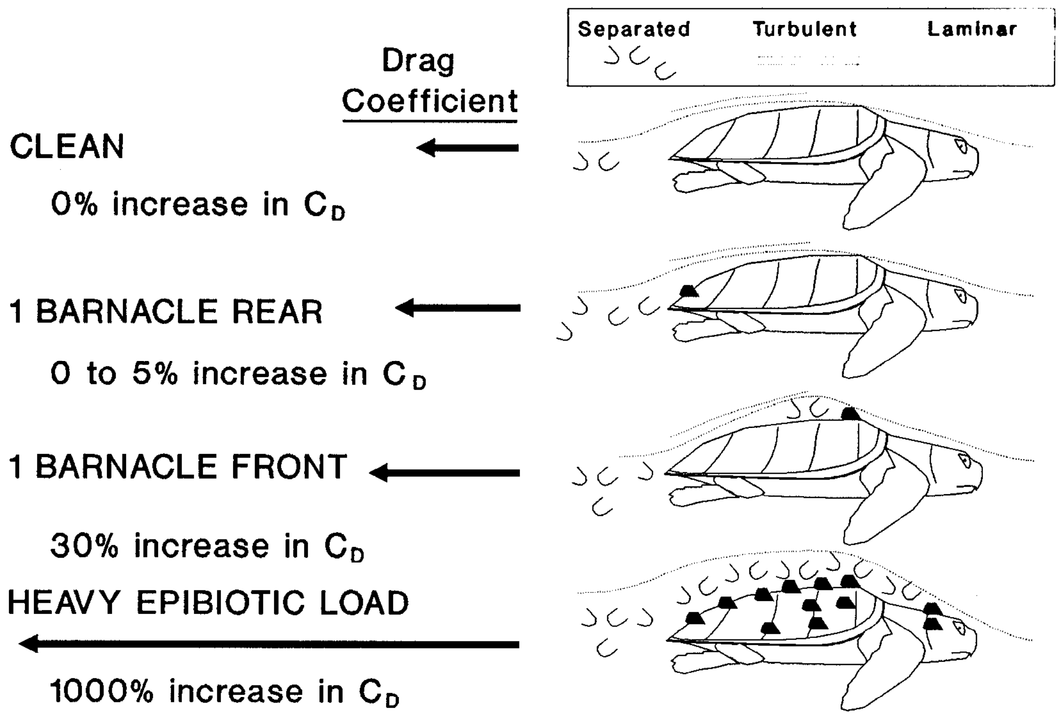


FIGURE 3: EPIBIOTIC EFFECTS



TAG RETENTION IN LEATHERBACK SEA TURTLES (*Dermochelys coriacea*) AT SANDY POINT, ST. CROIX, USVI

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The Leatherback Sea Turtle Research and Conservation Project in St. Croix, U.S. Virgin Islands, has experimented with a number of different flipper tags, including plastic, monel, titanium, and inconel tags. This project lends itself nicely to long-term tag retention studies, as about 35% of the turtles that nest each season are remigrants. Also, there is 100% beach coverage during the nesting season, ensuring that every turtle that nests is documented and tagged. Each turtle is double or triple-tagged, and as the turtles return in subsequent seasons, lost tags are documented and replaced with new ones. Since 1979, approximately 275 individuals have been tagged. The objective of this study is to compare retention rates of 1) different tag types and 2) different tag placements (i.e. front vs. rear flipper).

METHODS

We reviewed tagging data from 1979 - 1992 for monel, titanium and Reise-type plastic tags. We compared numbers of each tag type remaining at the end of each season, discarding all tags for which the turtle was not re-sighted after tag application. Monel tags were not applied to rear flippers before 1988, so we could not make direct comparisons on retention for rear monels for longer than four years.

In 1991 we began tagging with small inconel tags on the rear flippers in addition to the larger monels; the 1993 season should yield the first retention figures for those.

RESULTS AND DISCUSSION

Tag retention overall was highest in monel tags, with one lasting eight years. For both titanium and monel, rear tags had consistently higher retention. Plastic tags had very low retention, with none lasting over three years. Furthermore, in most cases the plastic tags left no discernable scar (Scott Eckert, pers. comm.) We have not documented any tag remaining on a turtle for longer than eight years.

Our figures indicate that while flipper tag retention, particularly on rear flippers, is fairly high for the first two or three years (85% and 67% respectively for monel and titanium rear flipper tags for two years), it is quite low after that (less than 12% overall for five years). Furthermore, this is likely an overestimate of tag retention, as some remigrants may have lost all their tags and could not be identified.

FURTHER STUDIES

In 1992, we began tagging turtles with PIT (passive inductive transponder) tags. These are small (6 mm in length), glass-encased microchips with magnetically coded numbers. The tags are injected into the shoulder muscle, and read with a small, battery-powered scanner. Tags are easy to inject and read in the field. They are especially suitable for work on a turtle nesting beach, as the turtle can be quickly and unobtrusively scanned for a tag at any time during nesting. Although it is too early to estimate tag retention, only one out of the 62 tags applied in 1993 had failed by the end of the season, and that one may have been lost during application.

GREEN TURTLES IN DEVELOPMENTAL HABITAT: AN UPDATE ON THE BERMUDA TURTLE PROJECT

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The Bermuda Turtle Project was initiated in 1968 by Dr. H. Clay Frick, trustee of the Caribbean Conservation Corporation (CCC). In January, 1992, the project became a joint effort of the CCC and the Bermuda Department of Agriculture, Fisheries and Parks. As of January 1993, a total of 1007 green turtles (*Chelonia mydas*) and 12 hawksbills (*Eretmochelys imbricata*) have been captured. The turtles are entrapped in a large (2000') net and retrieved by snorkelers. Exact coordinates of the netting sites are recorded by a Global Positioning System unit, which facilitates incorporation of these data into a Geographic Information System. The turtles are weighed and measured and are then double-tagged using a combination of plastic (Dalton), monel, inconel, or titanium tags. Blood samples have been taken from 380 turtles for sex determination, and 125 turtles have been laparoscoped so that maturity status of the gonad can be evaluated. The laparoscopic examinations also allow calibration of the testosterone assays used in sex determination. Blood samples have also been obtained to determine the genetic affinities of Bermudian turtles. Data on size distribution and maturity status indicate that the waters surrounding Bermuda serve as developmental habitat for the green turtle.

SEA TURTLE NESTING GEOGRAPHIC INFORMATION SYSTEM (GIS)

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The Florida Department of Environmental Protection (DEP) has integrated data on sea turtle nesting and on the physical morphology of nesting beaches into a computerized Geographic Information System (GIS). The Florida Marine Research Institute (FMRI) has developed and maintains an extensive database on sea turtle nesting. Likewise, in a number of their programs, DEP's Division of Beaches and Shores collects data on beach profile and other habitat qualities. Historically, the data-collection efforts of the two agencies have been made independently of one another. This project combines and consolidates these databases into a compatible GIS format.

In 1989, the Index Nesting Beach Survey program was initiated by the Florida Marine Research Institute and the U.S. Fish and Wildlife Service to standardize the methods for collecting data concerning 27 sea turtle nesting beaches in Florida. These beaches, comprising 358 kilometers, are where approximately 80% of nesting activity in the state occurs. They are systematically monitored by trained observers each year between 15 May and 31 August. Hutchinson Island, Index Nesting Beach #16, was selected to be a working prototype for the GIS project. The prototype will be applied to all Index Nesting Beaches, and eventually all statewide nesting data will be collected, formatted, and integrated via the GIS.

The boundaries for the nesting survey on this beach were determined using Global Positioning System. These readings were then plotted onto a computerized, historical-shoreline map. Land-use data were collected from aerial photographs and recent fly-over video tapes. Data were transferred to the map using Florida Department of Environmental Protection range monuments as reference points. Finally, fly-over video tapes and coastal-construction permit files were used to determine the types of armoring employed on the beach. Currently, efforts are underway to include beach-profile data in the system.

The inventory of sea turtle nesting-habitat information will allow the following:

1) assessment of the quality of turtle nesting-beach habitat
2) prediction of long-term habitat availability
3) identification of important nesting areas so that they can be protected.

MARINE TURTLE ACTIVITY AT THE ARCHIE CARR NWR IN 1992: A THIRD CONSECUTIVE YEAR OF ABOVE-AVERAGE LOGGERHEAD ACTIVITY AND THE BEST SEASON ON RECORD FOR THE FLORIDA GREEN TURTLE

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The Brevard County portion of the Archie Carr National Wildlife Refuge (ACNWR), long known as "Melbourne Beach", annually supports a large proportion of nesting for the Western Atlantic Loggerhead and the Florida green turtle. The UCF Marine Turtle Research Group has conducted season-long surveys of nest densities along this 21 km stretch of beach for eleven consecutive years.

Overall mean nesting densities of 607/km and 29/km were documented at the ACNWR for loggerheads and green turtles respectively during 1992. Loggerhead and green turtle spacial distributions (nests/km) during the 1992 season are illustrated in Figure 1; temporal distributions (nests/wk) for the both species are depicted in Figure 4. Nesting success rates (proportion of all emergences that resulted in a deposited clutch) was 53.8% for loggerheads and 49.1% for green turtles during 1992. Through the 1980's loggerhead nest totals varied only slightly around a mean of 9,400 (447/km), but in the first three years of this decade mean annual nest production (13,425; 640/km) exceeded that observed in the 1980's by 43% (Figure 2). Florida green turtle nest production adheres to a pattern of "highs" and "lows" alternating more or less biennially and nest counts have followed that pattern in recent years . Florida green turtle nesting activity rose sharply in 1992 to the highest level yet recorded at the Carr Refuge (Figure 3).

The greater levels of loggerhead and green turtle nesting during the past three years should provide enhancement for the Carr Refuge concept and spur the campaign to bring about acquisition of lands by all government and non-governmental organizations committed to wildlife conservation.

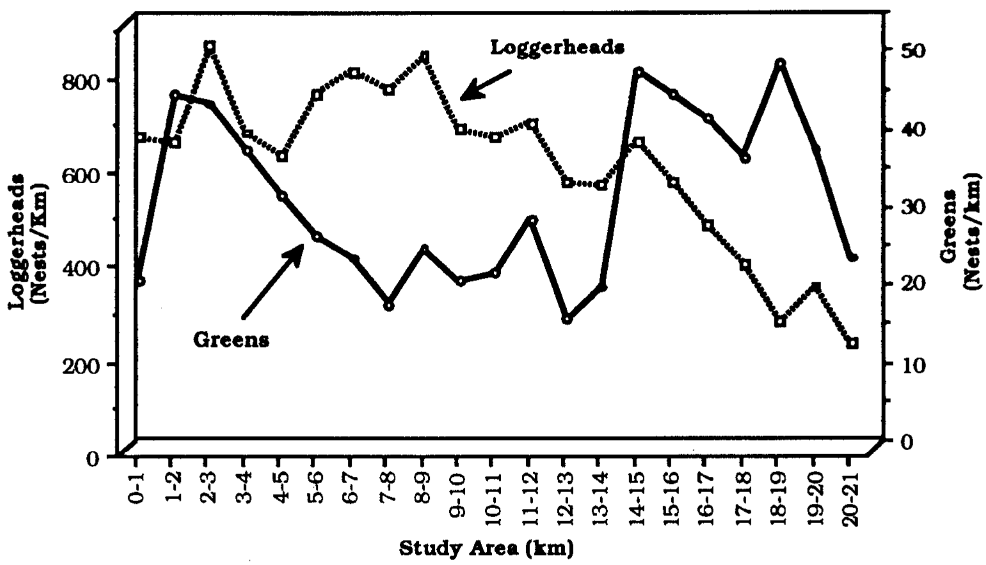

Figure 1. The spacial distribution (nests/km) for both loggerhead and green turtles in the Brevard County portion of the Carr Refuge during 1992.

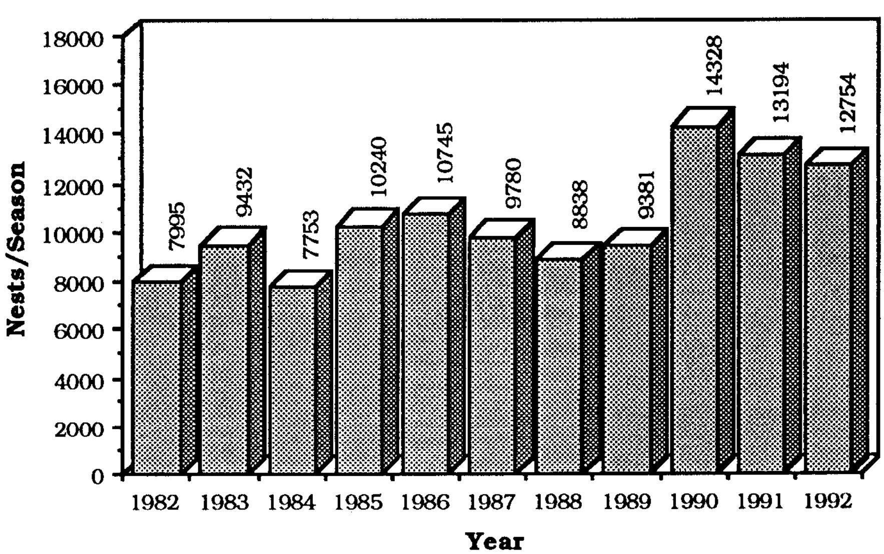

Figure 2. Loggerhead nest totals per season within the Brevard County portion of the Archie Carr NWR, 1982 through 1992.

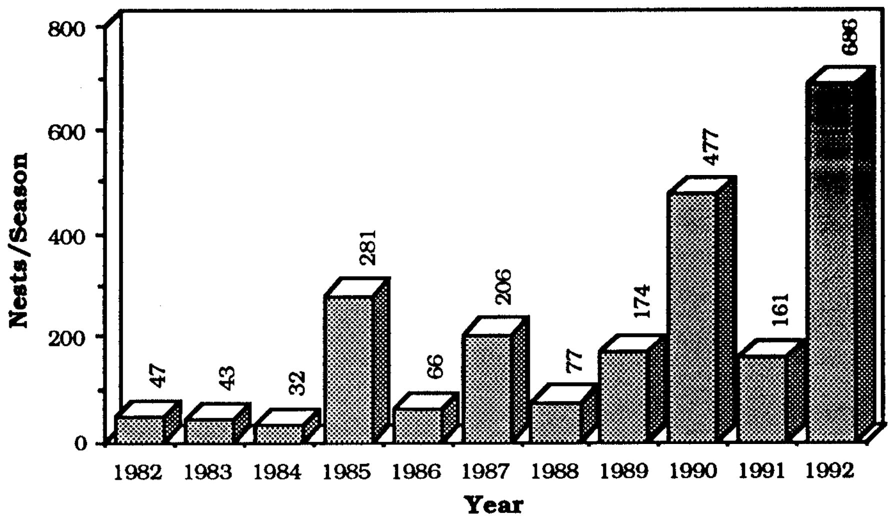

Figure 3. Green turtle nest totals per season within the Brevard County portion of the Archie Carr NWR, 1982 through 1992.

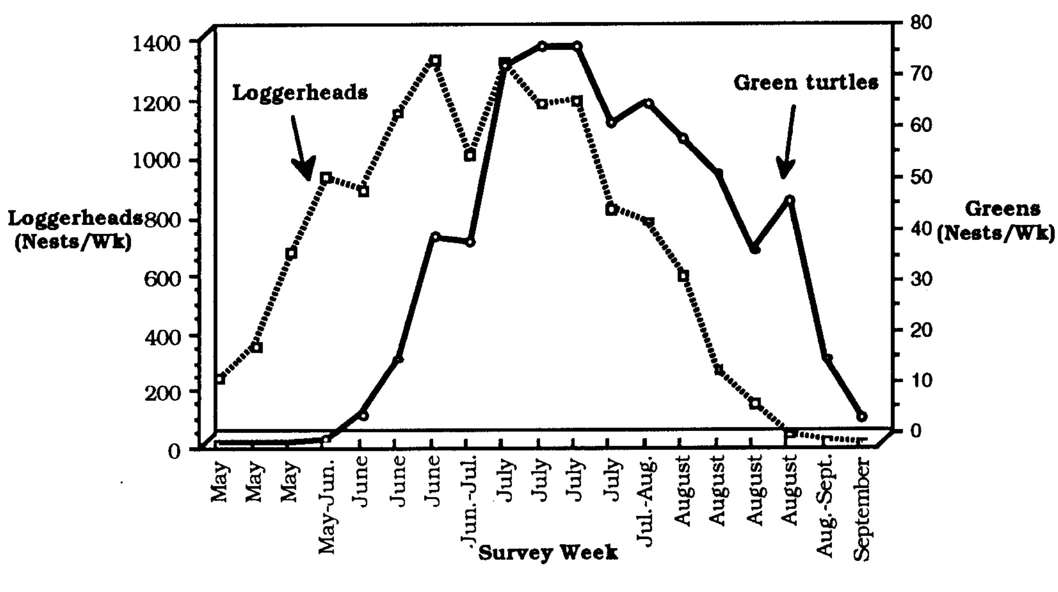

Figure 4. Temporal distribution (nests/week) for both loggerhead and green turtles in the Brevard County portion of the Carr Refuge during 1992.

SEASONAL DISTRIBUTION OF SEA TURTLE SURFACINGS IN CAPE LOOKOUT BIGHT, NORTH CAROLINA

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After several years of recognizing what appeared to be a "hotspot" for sea turtle surface behavior near the western shore of Cape Lookout Bight, we initiated a series of boat based vigils to investigate the annual presence and seasonal variations in numbers of surfacings. During 20-minute vigils conducted on an average of 1.3 per week from February 1992 through February 1993. We recorded date, time, sea state, and number of sightings by one observer. Off effort sightings at the same site were also recorded. The average number of sightings per vigil were 1.21. The seasonal breakdown was 1.45 sightings per vigil in the spring, 2.20 in the summer, 0.56 in the fall, and no sightings in the winter. Off effort sightings, although not quantified, show the year-round presence of sea turtles in Cape Lookout Bight. This method, if continued here and applied to other areas, might help identify critical habitat for sea turtles.

INTRODUCTION

Cape Lookout Bight is a semi-enclosed body of water located in the central coastal area of North Carolina. It is bound by two islands of Cape Lookout National Seashore: Shackleford Banks and the southern end of South Core Banks. Barden Inlet provides tidal exchange through Cape Lookout Bight between the Atlantic Ocean and the inland sounds, bays, and rivers.

Five species of sea turtles are known to occur in the coastal waters of North Carolina: the loggerhead (*Caretta caretta*), the green (*Chelonia mydas*), the leatherback (*Dermochelys coriacea*), the hawksbill (*Eretmochelys imbricata*), and the Kemp's ridleys (*Lepidochelys kempi*) (Epperly et al., 1990). It is only the loggerhead that is known to nest predictably on the beaches adjacent to the study area.

This study area was selected because of its proximity to loggerhead nesting beaches, the relative convenience of conducting year-round observations, and our incidental sightings which suggest that sea turtles surfaced here at a rate more frequently than adjacent waters. This study seeks to document the seasonal presence and variations in sea turtle surface activity and inspire similar studies to help define critical habitat areas for sea turtles.

METHODS

We established a site near the western edge of Cape Lookout Bight approximately 20 meters from shore (see site map) by mooring a buoy at which we anchored our observation boat (various motor boats ranging from 5 to 12 meters in length). Boat based 20-minute vigils were conducted opportunistically by one observer when the sea state was Beaufort 3 or less. We made an effort to keep the observer's head at a consistent height (approximately 2.5 meters) above the water.

We recorded date, time of vigil, sea state, tidal state, boat used, number of sightings during vigil, species ID when possible, number of off-effort sightings in the area. The observer scanned the water for approximately 180 degrees with his/her back to the shore. Each time a sea turtle came to the surface counted as one sighting.

We analyzed the data to show the average number of vigils and sightings per season (as defined by solstices and equinoxes) and the number of off-effort sightings.

RESULTS

In a one year period 70 vigils were conducted with a total of 85 sightings. The seasonal breakdown was 32 sightings in 22 vigils in the spring, 44 sightings in 20 vigils in the summer, 9 sightings in 16 vigils in the fall, and zero sightings in 12 vigils in the winter. The average number of sightings per vigil in spring, summer, fall, and winter were 1.45, 2.20, 0.56, 0.00 respectively (Figure 1). The peak sighting frequency recorded was 22 on July 2, 1992. We recorded off effort sightings in all seasons.

DISCUSSION

The results indicate a summer peak in sea turtle surface activity. The next highest level of surface activity occurred in the spring. These data vary according to the corresponding levels of beach nesting behavior on adjacent South Core Banks. Although our vigil data suggest that sea turtles may be absent from our study area in the winter, off-effort sightings indicate otherwise.

It may be significant that our study site is adjacent to a loggerhead nesting beach (South Core Banks), has abundant food resources as evidenced by the intense fishing activities that occur there, is sheltered from the prevailing summer winds and rough seas, and is located above a steep drop-off from approximately 1 meter to 8 meters deep over a surface distance of approximately ten meters.

Typically, the sea turtles observed came to the surface for two to five seconds before they submerged again. When a turtle stayed at the surface for longer periods it was almost always identified as a leatherback which tended to raft for 10-20 seconds before sounding. The only exception was a sighting on October 13, 1992 when two pairs of turtles were observed coming to the surface with mud on and trailing off their carapaces. In both cases the turtles were facing but not quite touching each other and stayed at the surface for 20-30 seconds while apparently taking several breaths.

With this study we have begun to collect baseline data with which to compare future data here and hopefully data from similar studies elsewhere. Identifying the timing and location of critical sea turtle habitat at sea is a pressing research need. It is worth noting that we make no attempt to estimate the number of sea turtles in the study area, only to estimate the relative abundance of surfacings. The potential of this research lies in its long term ability to identify critical marine turtle habitat at sea and to correlate our findings with data from aerial surveys, strandings, and nesting beach surveys.

ACKNOWLEDGEMENTS

Thanks to Therese Conant of the North Carolina Non-Game Endangered Wildlife Program for her help with graphics and her enthusiasm for our work and sea turtle research and conservation. We recognize the interns, volunteers, and program participants from the North Carolina Maritime Museum and the School for Field Studies for their interest and willingness to stay on board while we conducted vigils.

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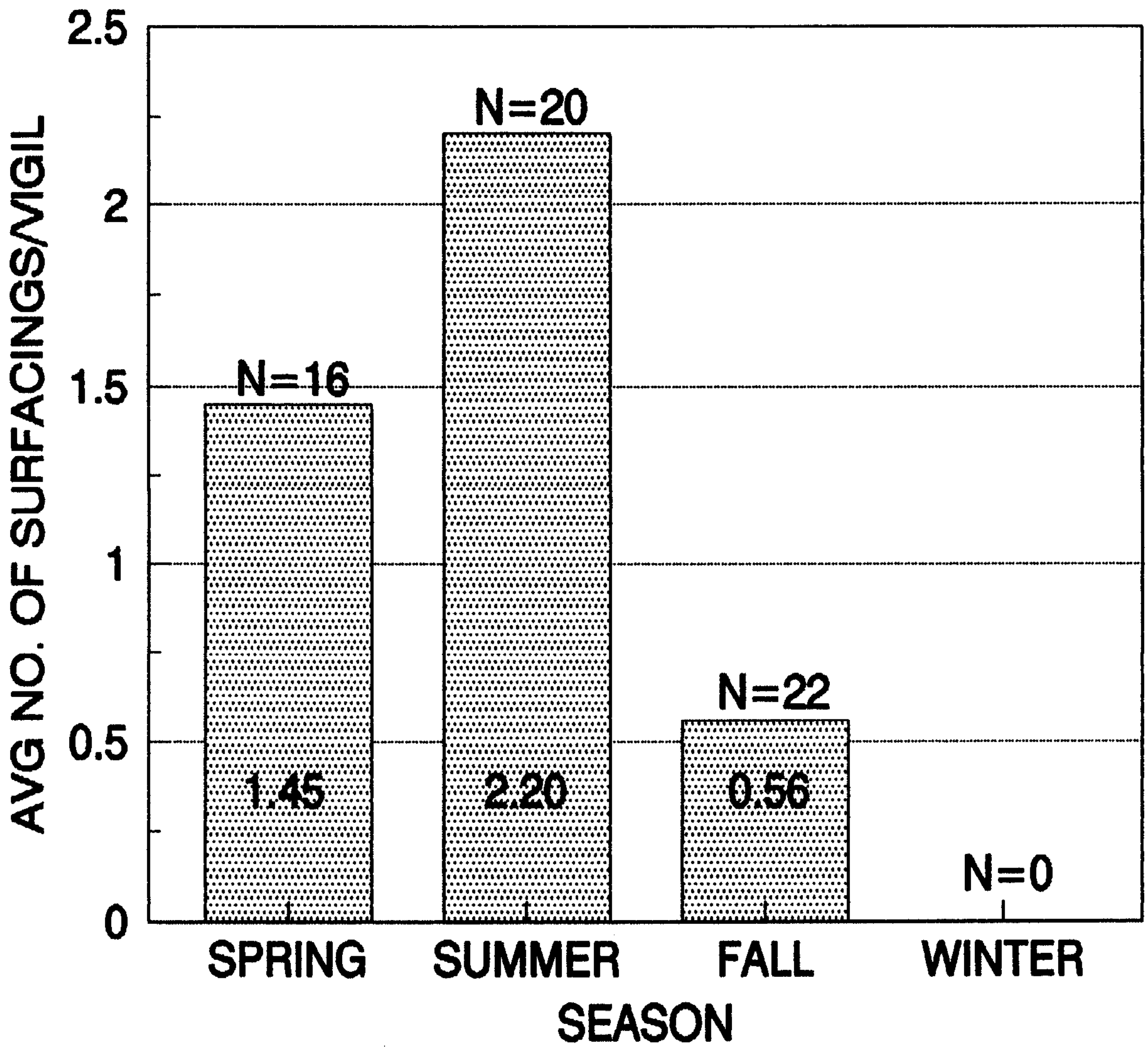

Figure 1. Average number of sea turtle surfacings per 20 minute vigil in Cape Lookout Bight North Carolina, February 1992 through February 1993.

A JUVENILE BLACK TURTLE (*Chelonia mydas agassizi*) FOUND SICK IN PLAYON DE MEXIQUILLO, MICHOACAN, MEXICO

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INTRODUCTION

The coast of Michoacan is considered an important nesting site for sea turtles. The main nesting beaches for black turtles (*Chelonia mydas agassizi*) are located in the north part of the state, while the most important ones for leatherbacks (*Dermochelys coriacea*) are found in the south; olive ridleys (*Lepidochelys olivacea*) nest along the whole shore of this state. Likewise, it is possible to find turtles in the ocean adjacent to the coastline. During offshore trips in Playón de Mexiquillo adult sea turtles of the three species are often observed. Turtles are usually found mating, swimming, or resting, diving when they feel threatened (pers. obs.); in most of the occasions turtles are adult males and females. Also it is possible to spot from certain cliffs along the rocky shore juvenile hawksbill turtles (*Eretmochelys imbricata*). The presence of juveniles or subadults of the rest of the species has not been documented for this area. This is the first documented report of an encounter with a subadult black turtle offshore Playón de Mexiquillo.

GENERAL PHYSICAL CONDITION

During an offshore trip in front of Playón de Mexiquillo on November 15, 1992 we observed a white floating object which was later identified as a sea turtle floating upside down, with head and flippers underwater. It was alive, but couldn't submerge or swim due to an evident weakness. It's carapace and plastron were covered by algae and large barnacles, and the neck and flippers were very skinny. We counted 63 large barnacles adhered to the plastron, more than 60 on the carapace and 5 on the head. Barnacles left scars of 3.8 X 3.1 cm in average when removed. The largest barnacle removed left a scar of 4.3 X 3.0 cm. The turtle also had a number of barnacle-like organisms encrusted in the front flippers' skin; these organisms have not been identified yet due mainly to the difficulty of extracting them intact. When extracted, they left a pit of 3 mm depth in the flesh.

The carapace and plastron were also cleaned of algae. The carapace showed zones where pieces of scutes fell off, leaving the bare bone exposed. The plastron was extremely soft at touch, and showed an evident bloating of the abdominal region, mainly in the femoral scutes zone. It was clear that the animal spent several days in that condition.

DESCRIPTION OF THE TURTLE

STD. CURVE CARAPACE LENGTH......... 56.2 cm
CARAPACE WIDTH .... 52.0 cm
SCUTES: CENTRAL 5
LATERAL4 pairs
MARGINAL12 pairs
POST-OCULAR4 pairs
PREFRONTAL1 pair

TREATMENT

The turtle was taken to "El Farito" turtle camp for treatment. The gas trapped in the abdominal region, which caused the bloating, was extracted using a syringe, and antibiotics (Gentamicina) were administered (2.2 cc each 3 days). Since it refused to eat, it was fed through a gastric catheter, with codfish liver oil as a vitamin supplement.

Everyday the carapace and plastron were scrubbed and cleaned to prevent algae growths, and feeding through the plastic catheter continued, although the turtle didn't seem to retain any food, spitting it immediately. The turtle remained in a critical condition until its death, 18 days after its capture.

NECROPSY

Necropsy showed a general advanced undernourishment, the gut and muscle masses were very diminished. The lungs were collapsed, and the aspect that most attracted our attention was the distal region of the digestive tract, which was completely stuffed with a fibrous wood-like vegetal material, which apparently obstructed the cloaca and preventing normal functioning of the digestive tract. This interpretation is sustained by the fact that the turtle defecated only on one occasion after receiving a dose of castor oil, excreting a fragment of such fibrous material. No other intestinal contents were found, except some fragments of plastic in the esophagus and some of the codfish liver oil given to the turtle soon before its death.

DISCUSSION

Genus *Chelonia* presents some taxonomic difficulties. Some authors have defined a number of subspecies for species *mydas* (Caldwell, 1962; Hirth, 1971: Casas-Andreu and Gomez-Aguirre, 1980; Anon. 1982). The subspecies are: *Ch. m. mydas, Ch. m. agassizi, Ch. m. carrinegra, Ch. m. japonica.* Other authors recognize the species *Ch. agassizi* as separate from *Ch. mydas* (Bocourt, 1868; Villanueva, 1981; Pritchard et al, 1982; Alvarado y Figueroa 1986; Márquez, 1990), being *Ch. mydas* the Atlantic, Gulf of Mexico and Caribbean green turtle and *Ch. agassizi* the East Pacific black turtle. Caldwell (1962) described turtles found in the Gulf of California, identifying them as *Ch. m. carrinegra* and having great difficulties to distinguish them from the *Ch. m. agassizi* found in the south (mainly in Michoacan coastline); he based the difference exclusively on carapace coloration. Since there are lots of uncertainties in sea turtle taxonomy, and being descriptions referring to number of scutes fundamentally in carapace and head, curvature of carapace, general turtle's size and to non-quantitative aspects as coloration ("brownish-greenish" or "yellowish"), we have determined our specimen as *Ch. mydas agassizi*, differing only in the number of marginal scutes.

The black turtle is distributed from Ecuador to the Gulf of California, being the largest population in the northern hemisphere the one found in Michoacan, specifically in 18 beaches along 80 km in the north part of Michoacan's shore (Villanueva, 1981; Alvarado, 1986). Although it is believed a migratory species due to it's seasonal reproduction and the distance between feeding and breeding zones, there exist some data on the presence of subadults in the area (Anon., 1982) and unpublished personal observations of one juvenile (in El Tamarindillo, Mich.) and one subadult (in Maruata, Mich.), as well as one juvenile stranded in a gill net in front of Playón de Mexiquillo, and the present report.

Márquez and Doi (1973) estimate that this species achieves sexual maturity at a carapace length of 55-65 cm, although for Hirth (1971) the adult black turtles have a carapace length of more than 80 cm. After necropsy was done on our 52 cm carapace length organism, we found that the gonads were of very small size (immature?). Even then we decided to use Hirth's scale, so we consider our specimen as a subadult black turtle, whose sex has not been determined yet. Something interesting to note was the abundance and large size of barnacles adhered to the caparace and plastron. More studies would be needed on barnacle growth cycle that can yield useful information about the turtle's age.

We think that the cause of the turtle's death was an intestinal paralysis due to an obstruction caused by the fibrous material found in the last third of the intestinal tract, material highly compacted and dehydrated. The digestive process malfunction probably caused a fermentation in the food ingested, producing gases that accumulated and deprived the turtle of diving to search for food. If the turtle couldn't dive to feed normally, it had to consume floating material from the surroundings, like the pieces of plastic found in the esophagus, accelerating the undernourishment and subsequent death.

ACKNOWLEDGMENTS

We wish to thank the Foundation for Field Research for supporting us with supplies and material, Carl for being our photographer and without whom this poster would not have such nice pictures; the National Geographic Magazine photographers who paid for the offshore trip in which we found Nashonal; Vicente, for providing his veterinarian skills when we most needed them; and Pancho, Lety, Cristo, Crisis, Tanga and Mony, our dedicated Field Staff, for taking care of "Nashonal" while it lived and for helping us with the necropsy.

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LONG DISTANCE DISPERSAL AND REMIGRATION OF ADULT GREEN TURTLES IN THE OGASAWARA ISLANDS, JAPAN

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A tagging program for adult green turtles in the Ogasawara Islands, Japan has been conducted since 1973. Up to 1992, we have released 678 turtles (635 females and 43 males) bearing plastic tags. A total of 70 recoveries (65 females and 5 males) have been made from long distance localities, chiefly from the southern part of the Japanese Archipelago. Most of the recoveries were made after short periods: 85.7% within one year, 47.1% within two months. Remigration to the Ogasawara Islands was recorded for 81 individuals (79 females and 2 males). Remigration intervals range from 2 to 9 years with a mode of 4 years. Ten females were recorded over 3 nesting seasons and 2 females over 4 nesting seasons. Four females were recaptured at the southern part of the main islands of Japan before they remigrated to the Ogasawara Islands. The main islands of Japan are considered to be the feeding ground of the green turtle population nesting at the Ogasawara Islands.

RADIO AND SONIC TRACKING OF SEA TURTLES IN SOUTH TEXAS

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In the summers of 1991 and 1992 cooperative studies were undertaken by the National Marine Fisheries Service (NMFS) Galveston Laboratory and Texas A&M University at Galveston (TAMUG) Institute of Marine Life Sciences and the U.S. Army Corps of Engineers Galveston and New Orleans Districts, in order to determine the movement, diving patterns, and feeding ecology of sea turtles near dredged channels of the lower Laguna Madre in south Texas (Figure 1). Numerous sightings of sea turtles reported by NMFS personnel and by the general public through a sea turtle sighting campaign led to the hypothesis that the jetties and associated channel of Brazos Santiago Pass could be important developmental habitats for sea turtles (Williams and Manzella, 1992). Unfortunately, turtles in these areas could potentially be impacted by dredging activities in the channels. On the Atlantic coast of the United Sates there have been documented injuries and mortalities of sea turtles from the use of hopper dredges (Dickerson et al, 1991).

Sea turtles for the study were captured primarily using turtle entanglement nets and hand-held cast nets. From April 1991 to December 1992, a total of 47 sea turtles were captured within the lower Laguna Madre (D. Costa, TAMUG, personal communication, January 1993). Of these, 23 green turtles (*Chelonia mydas*), 2 loggerheads (*Caretta caretta*), and 1 Kemp's ridley (*Lepidochelys kempi*) were captured within the bay. Twenty-one green turtles were caught at Brazos Santiago Pass. NMFS has tracked three green turtles and one loggerhead within the bay and eleven green turtles at the pass using radio and sonic telemetry. Radio tags with ranges of approximately 13 - 16 km were attached along the neural scutes using fiberglass cloth and resin. Each turtle was assigned a unique frequency in the 164-165 MHz range. Sonic transmitters with maximum ranges of 1.0 km were attached along the posterior marginal scutes.

Turtles were held a minimum of 24 hours before release so that fecal samples could be collected. Each turtle was released in the area of its capture. The turtles were tracked for approximately 9-10 hours per day with observation hours varying throughout the study in order to encompass both daylight and dark hours. A five element Yagi antenna and Telonics TR2/TS1 receiver/scanner were used to monitor radio signals. The location of the turtle could be determined by rotating the antenna toward the direction of the loudest signal. Because radio signals do not transmit through salt water, signals were only received when the transmitter antenna broke the surface of the water, thereby making it possible to monitor the turtles' diving patterns. A directional hydrophone was used to receive signals from the sonic transmitter and to pinpoint the turtle's location. The bearings were confirmed by visual observations of the turtle.

LORAN or Global Positioning System units were used to record latitude and longitude of sonic contacts and visual observations for all turtles in open water. Markers were placed at 50 yard increments along the jetties in order to record exact turtle positions at that location. General notes on turtle behavior were recorded throughout the study. Additional sightings of non-radio tagged turtles made during the study were also noted. Surface and submergence times were analyzed by hour of day in order to examine changes in behavior over a 24 hour period. Movements over four periods comprising dawn, day, dusk and night were analyzed in order to determine if habitat preference varied by time of day. Location data were used to calculate home ranges (Renaud et al, 1993).

Location data generated by the tracking studies were also used to select sites for habitat characterization. A variety of methods were used by TAMUG to characterize the habitat and to identify potential food items. Hydrological monitoring consisted of surface and bottom measurements of temperature, salinity and conductivity. SCUBA surveys consisted of visual observations, quantitative transects, sample quadrates and core samples. Trawl surveys were also conducted at each sampling station (Landry et al, 1992).

Results from the studies indicate that sea turtles within the bay frequent the Brownsville Ship Channel and Intracoastal Waterway, but impacts from dredging would be minimal because these channels are not maintained by hopper dredges (Renaud et al, 1992). Hopper dredges are used to maintain Brazos Santiago Pass, however, the turtles tracked near the jetties rarely ventured into the channel. Also, green turtles captured at Brazos Santiago Pass are significantly smaller than those captured within the bay. Only one radio tracked turtle moved between the two habitats (Renaud et al, 1993).

Since 1988, the NMFS Galveston Laboratory has tracked 27 sea turtles using radio and sonic telemetry and 16 turtles using satellite telemetry. The data collected has greatly increased our knowledge of sea turtle behavior in both the inshore and offshore environment. In 1993 studies incorporating radio, sonic and satellite telemetry of Kemp's ridley sea turtles will be initiated along the upper Texas coast near Sabine Pass. Further studies of this nature will help us to better protect endangered sea turtles and their habitat.

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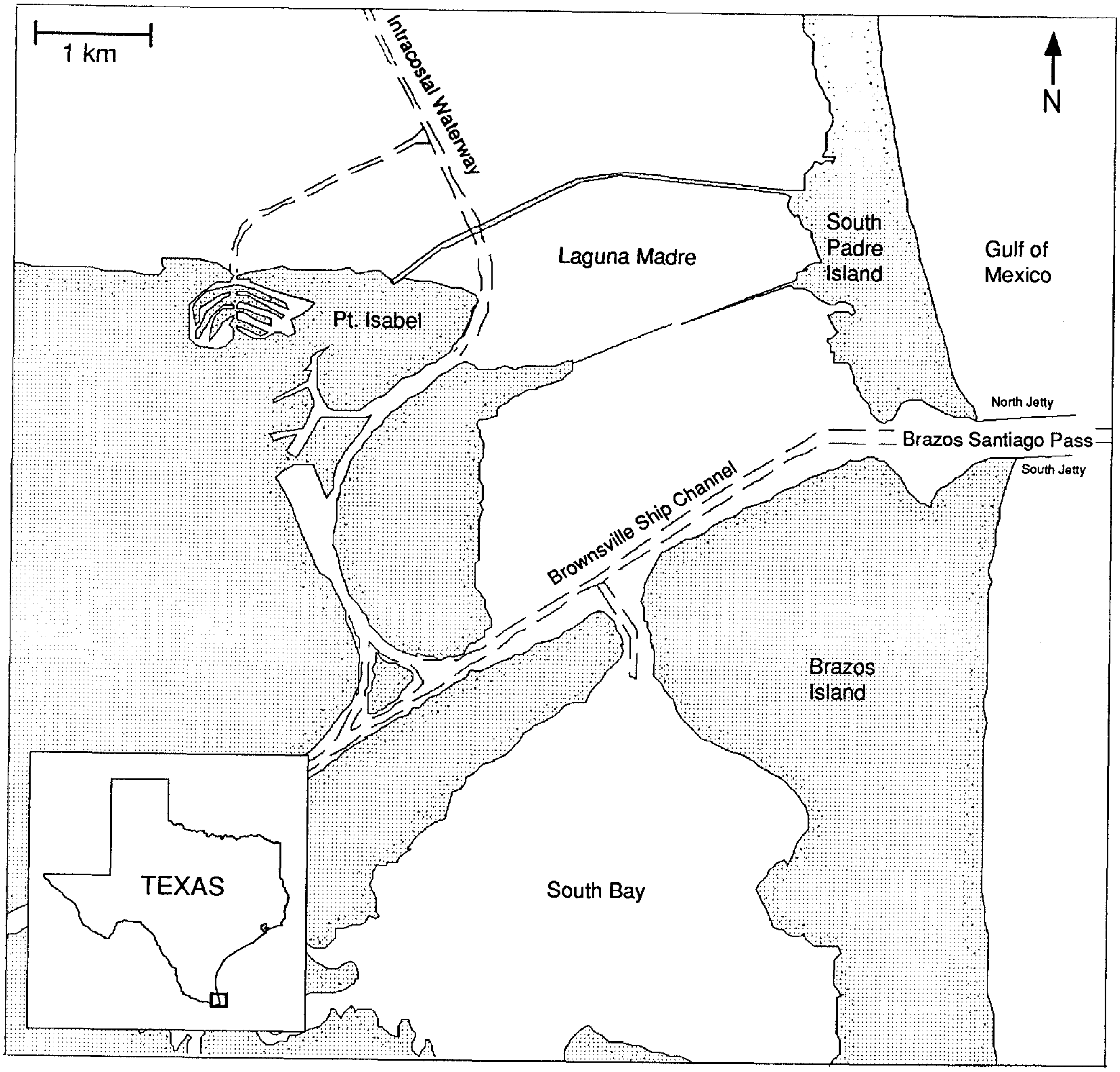

Figure 1. Study site for radio and sonic tracking of 14 *Chelonia mydas* and 1 *Caretta caretta* by National Marine Fisheries Service Galveston Laboratory in 1991 and 1992.

MARINE TURTLE NESTING AT PATRICK AIR FORCE BASE, FLORIDA IN 1992

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Since 1987, the UCF Marine Turtle Research Group has been conducting surveys at Patrick Air Force Base (PAFB) to monitor loggerhead and green turtle nesting activity. This 7 kilometer stretch of beach in central Brevard County, Florida is among the best of the "second order" loggerhead nesting beaches on the western rim of the Atlantic, and likewise is proving to be an important beach for the Florida green turtle. The hallmark of this nesting ground is unusually high hatching and emerging rates.

Surveys were conducted 7 days a week from 7 May 1992 through 31 August 1992. This season proved to be the third consecutive "high" year for loggerheads at PAFB (Figure 1). There has been a remarkably constant relationship among the sectional nest totals over the six year period (Figure 2). A representative sample of nests was marked for the purpose of assessing reproductive success. Hatching success and emerging success for the 58 inventoried loggerhead nests are given in Figure 3. Hatching success is defined as the fraction of yolked eggs that hatched and emerging success as the fraction of yolked eggs that resulted in hatchlings that escaped the nest. At PAFB, these high reproductive success rates are generally attributed to the lack of raccoon predation that is so prevalent on nearby beaches.

Although the overall number pales in comparison to the loggerhead count, there was more nesting by the Florida green turtle at PAFB in 1992 than in any previous study year (Figure 4). While only 17 nests were inventoried in 1992, it appears that the attributes of this beach that promote reproductive success for loggerheads also operate for green turtles (Figure 5). In conclusion, with high nesting activity as well as high reproductive success, PAFB is recognized as one of the essential links in the chain of East Florida beaches that constitute the primary nesting ground for Western Atlantic loggerheads and Florida green turtles.

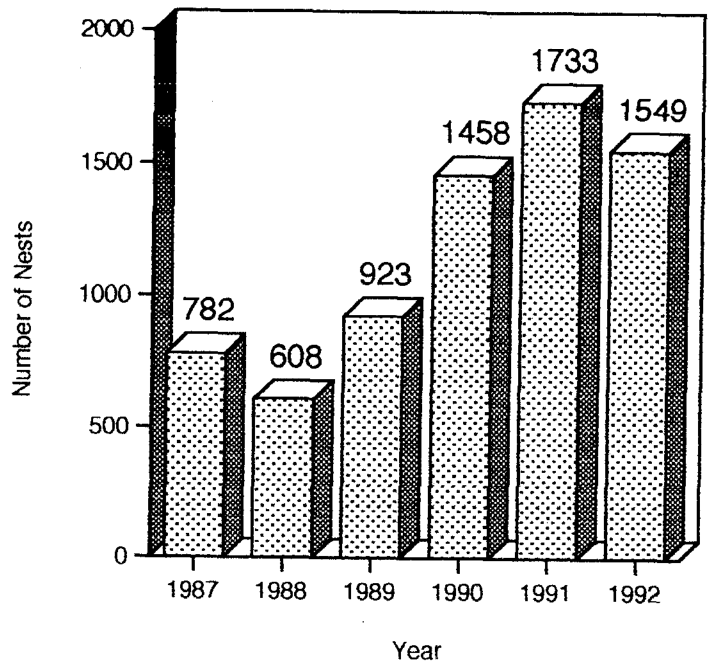

Figure 1. Loggerhead nest totals per year at PAFB, 1987-1992.

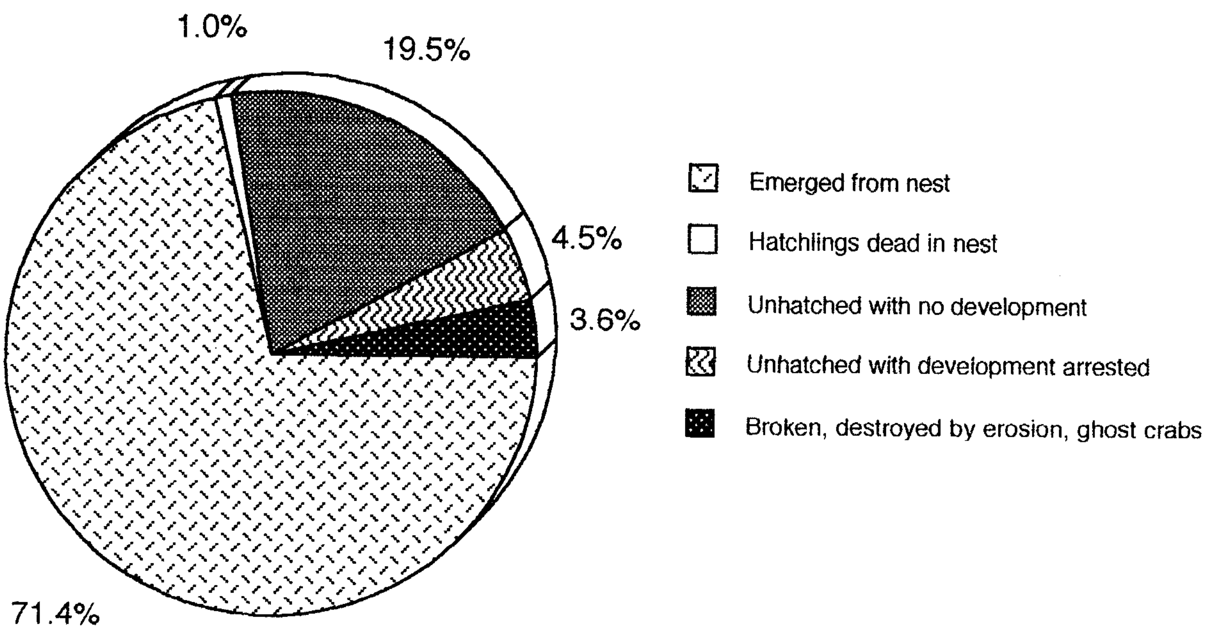

Figure 3. Descripive fates of eggs from clutches of marked loggerhead nests at PAFB, 1992.

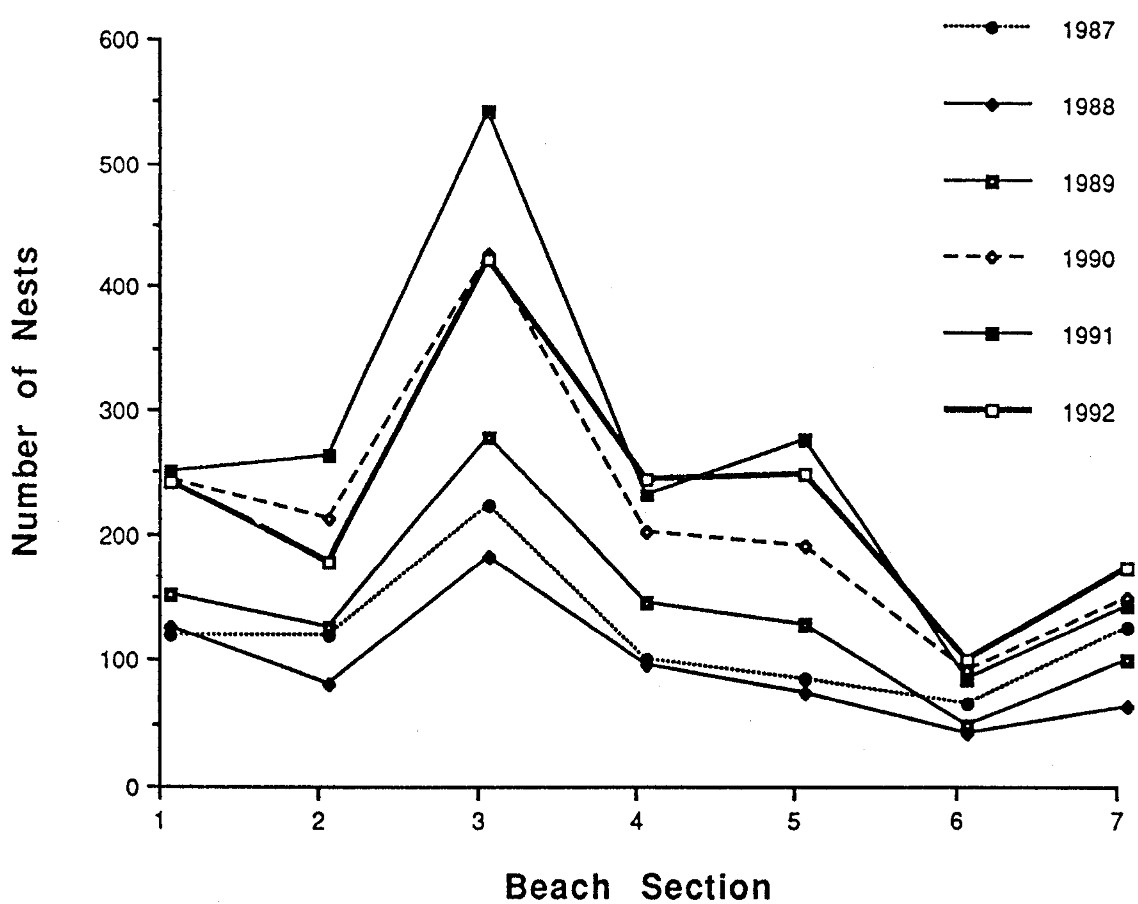

Figure 2. Loggerhead nest totals by location at PAFB, 1987-1992.

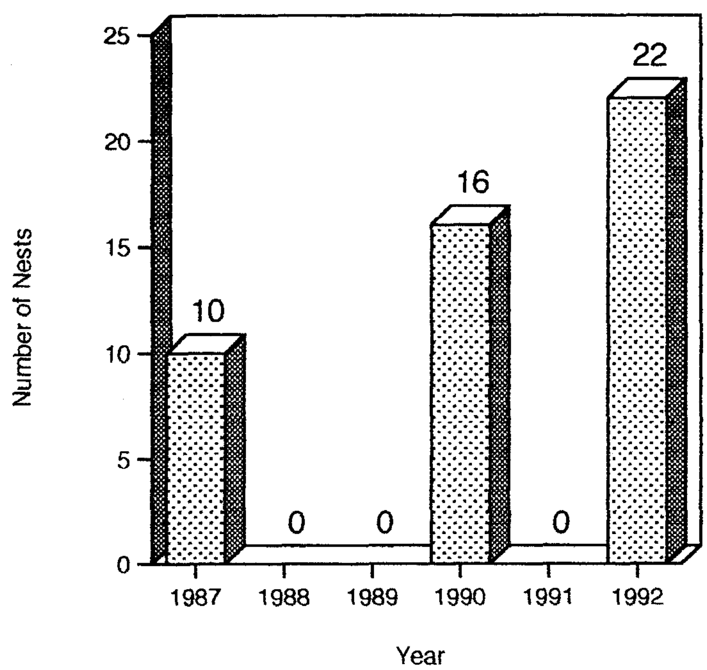

Figure 4. Green turtle nest totals per year at PAFB, 1987-1992.

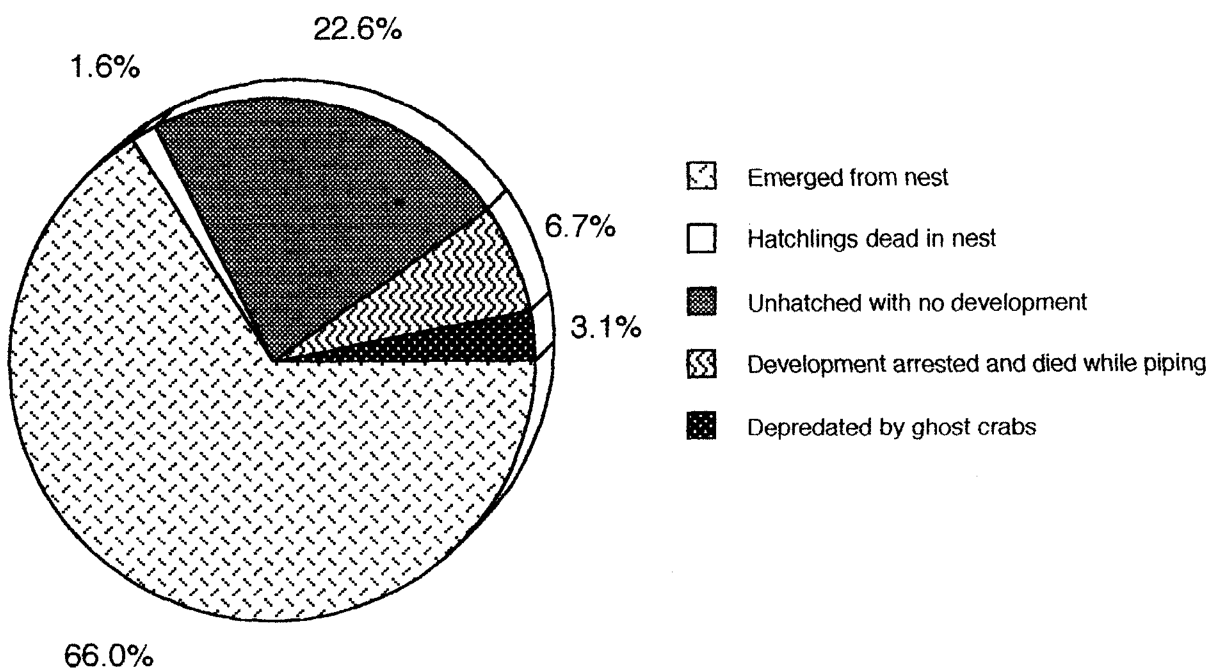

Figure 5. Descriptive fates of eggs from clutches of marked green turtle nests at PAFB, 1992.

LIVING TAGS IN THREE SPECIES OF SEA TURTLE HATCHLINGS IN THE MEXICAN CARIBBEAN

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INTRODUCTION

Among the worldwide interests in the programs of sea turtle conservation are: to increase the survival rates (at the different stages of development), to find out where they go during their first year of age or lost year, to determine at which age they reach sexual maturity and to know how they manage to return to a determined beach to breed. In order to obtain data on these aspects of their biology, several techniques have been implemented, one of these techniques is that of "graft-marking" or "living tag", which has produced very good results (Hendrickson and Hendrickson 1981; 1986). Using Hendricksons' technique, a tagging program was initiated in 1990 in the state of Quintana Roo, with hatchlings of green turtle, *Chelonia mydas* and loggerhead, *Caretta caretta*. Both species are the most abundant in this area. In 1993 the hawksbill turtle, *Eretmochelys imbricata* was also added to the study.

RESULTS

Besides the living tag, eleven turtles (8 loggerheads and 3 greens) were tagged with Monel metal tags at the moment of releasing (between 11 and 16 months of age). Presently, 33 of the hawksbill hatchlings tagged with the Hendricksons' technique in September of 1993 are kept in tanks at Xcacel.

MATERIALS AND METHODS

Biopsy punch and tissue glue for veterinary use are needed. With the biopsy punch a piece of tissue was removed at a specific lateral or costal scute to indicate the year tagged, the ventral tag remains the same to indicate the beach where the animal was tagged. The hatchlings were tagged 8 - 20 days after emergence and released after three days.

DISCUSSION

In spite of the great interest that the tagging of hatchlings has in the studies of sea turtles, we only managed to tag a few specimens, due to the lack of logistic support and funding. We expect to tag in the future, many more loggerheads and greens at Xcacel, where our hatching program is located. We do not now plan, to tag any more hawksbills, because these breed up north in Holbox Island. In addition, this activity seems to sensitize national and foreign tourists that visit the beach about the sea turtle's importance.

ACKNOWLEDGEMENTS

To all the friends of Xcacel who have been so cooperative during field work, particularly to Ms. Pat Quatlebaum and her son Gordon for their help in the caretaking and maintenance of the hatchlings. Promotora Xcaret S.A. for taking care of the hatchlings food.

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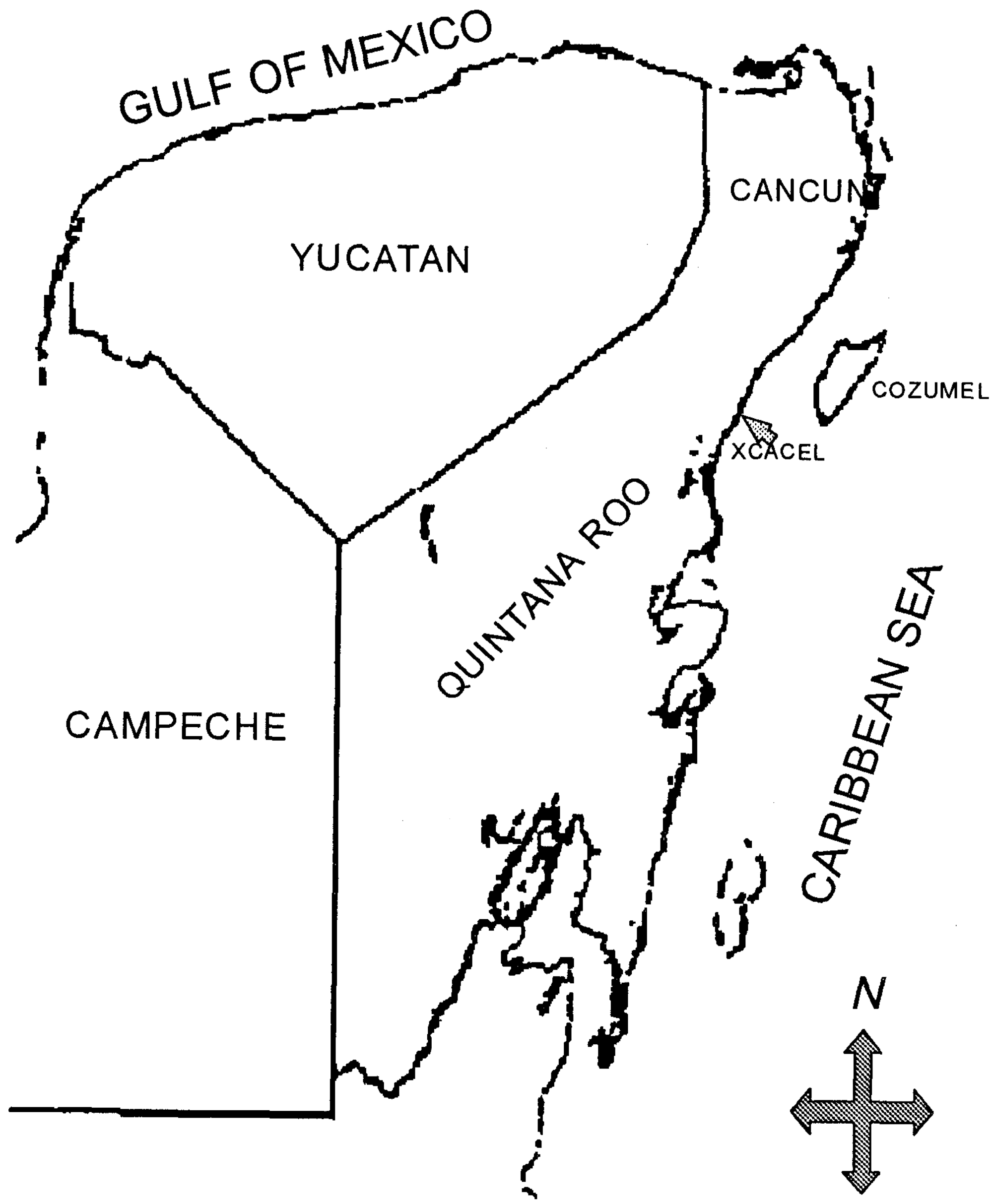
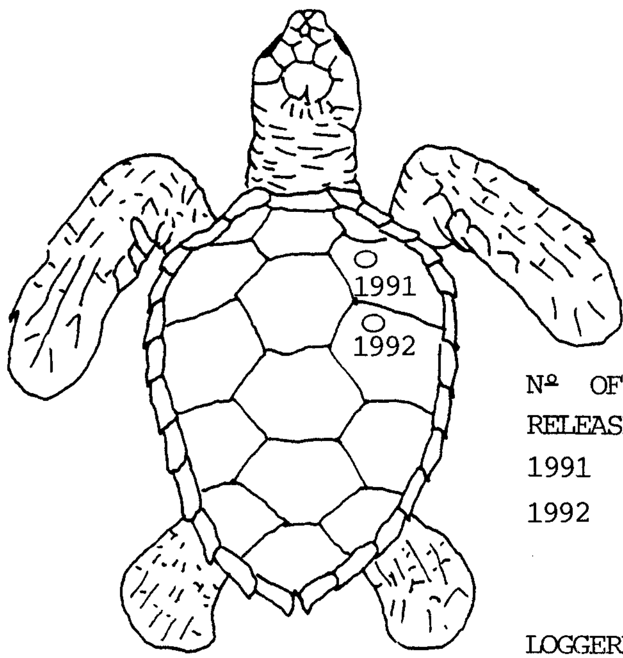
Hendrickson, J.R. and L.P. Hendrickson. 1981. Experimental evaluation of graft-marking procedure for sea turtles. Final Report.,U.S. Fish and Wildlife Service. 16 pp.

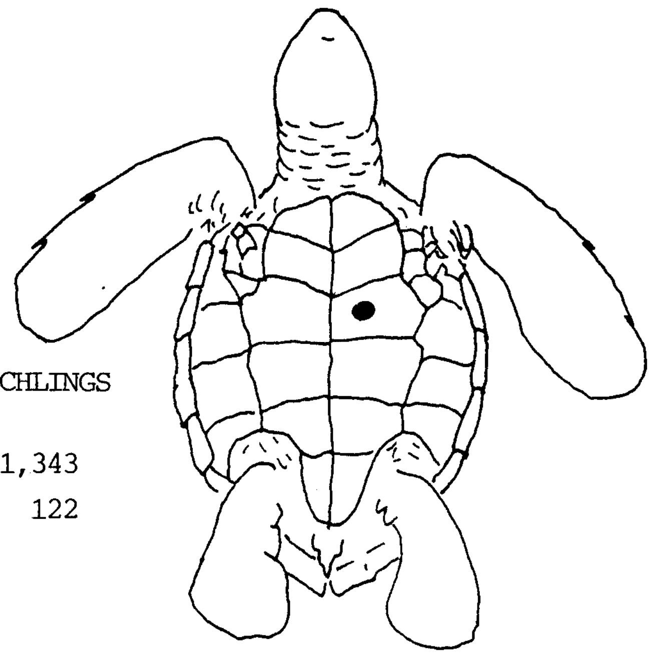
STUDY ZONE


GULF OF MEXICO
YUCATAN
CANCUN
COZUMEL
XCACEL
QUINTANA ROO
CARIBBEAN SEA
CAMPECHE
N

YEAR OF TAGGING

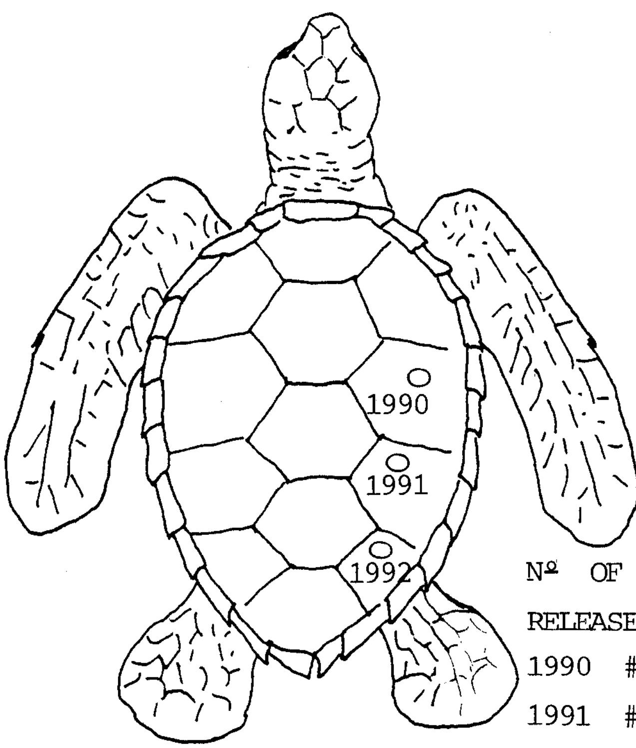
BEACH OF TAGGING
AND RELEASING (XCACEL)

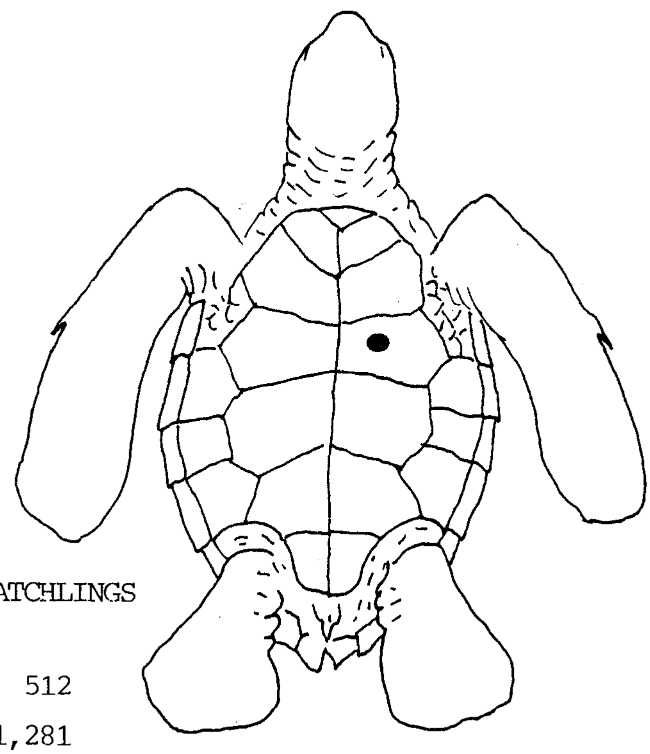




Nº OF HATCHLINGS
RELEASED
1991 # 1,343
1992 # 122

LOGGERHEAD





Nº OF HATCHLINGS
RELEASED
1990 # 512
1991 # 1,281
1992 # 482

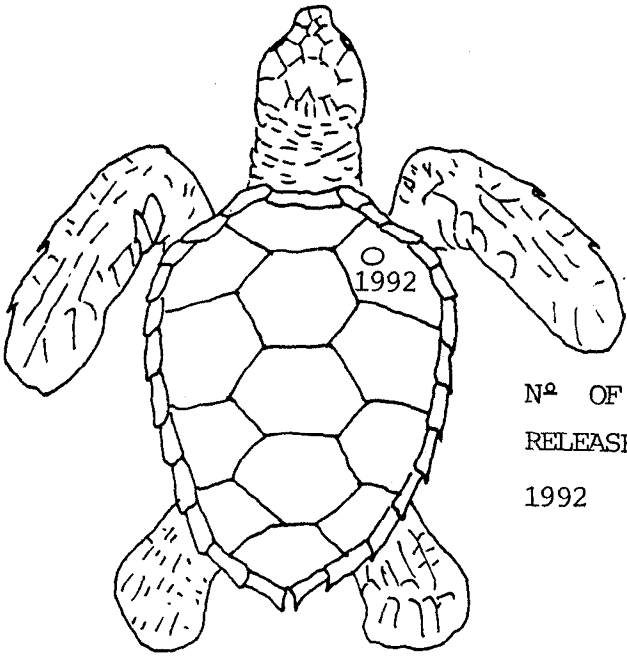
GREEN TURTLE

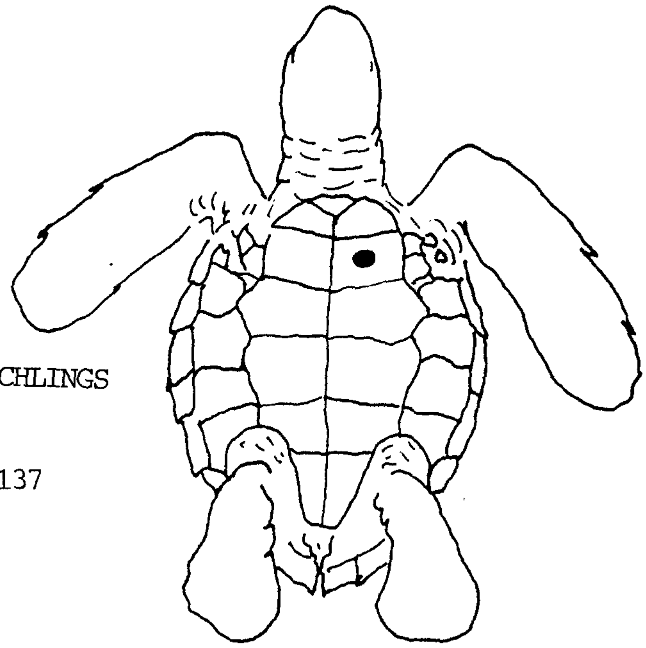
DORSAL VIEW

VENTRAL VIEW

YEAR OF TAGGING

BEACH OF TAGGING
AND RELEASING (XCACEL)





Nº OF HATCHLINGS
RELEASED
1992 # 137

HAWKSBILL

DORSAL VIEW

VENTRAL VIEW

MARINE TURTLE CONSERVATION ON THE CENTRAL COAST OF QUINTANA ROO AND ISLA COZUMEL

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There are four species of sea turtles that nest on the coast of Quintana Roo: hawksbill, *Eretmochelys imbricata*; loggerhead, *Caretta caretta*; green, *Chelonia mydas* and leatherback, *Dermochelys coriacea*. The first three once had great economic importance, thus offering a relatively large base of regional information. There is a lack of knowledge on distribution of the leatherback, as there are only reports of sporadic nestings throughout the coast of Quintana Roo. Kemp's ridley *Lepidochelys kempi* have also been found in coastal waters in the northern part of the state. Over twenty-five years ago sea turtle conservation started in the region. In the last decade more institutions have joined the sea turtle conservation effort. One of the institutions to have joined the effort is Centro de Investigaciones de Quintana Roo (CIQRO), during the past six years the sea turtle populations on the central coast of Quintana Roo has been studied systematically. On Cozumel island since 1987 the eastern nesting beaches have been included in a municipal reserve. In 1990 the Sea Turtle Protection Committee of Cozumel Island was formed to monitor and protect the beaches with the help of residents of the island.

METHODS

The field work and research that is coordinated by CIQRO'S personnel covers more than 100 km of the central continental coast and 20 km on Cozumel island. Beach patrols are used from May to October. On the more important beaches nightly patrols are used. On the less productive beaches monitoring is limited to once a week to count the nests and after eclosion of the hatchling the nest is checked.

RESULTS AND DISCUSSION

The central part of the state contains around twenty-five percent of the nesting beaches of the state. There are three very important sites for the greens and loggerheads: Xcacel, Aventuras, and Kanzul beaches. The first two beaches are in the Cancun-Tulum tourist corridor and are threatened by resort development. Kanzul is the most important beach in the Sian Ka'an Biosphere Reserve, however, electrical service for future development was installed last year.

Every year an internal evaluation is conducted to improve our techniques. Factors such as natural predation, poaching, and inundation of nests by sea water are considered. We have changed our techniques since the start of the project to minimize the manipulation necessary with the nesting female. The persistency of the programs including physical and human resources, coordination with other institutions, protection of habit, intensive tagging and measuring to evaluate the reproductive potential are necessary to expand the knowledge of sea turtles. We are gathering and constructing a base of biological data that will permit a definition of distinctive characteristic of the populations of sea turtles nesting in Quintana Roo.

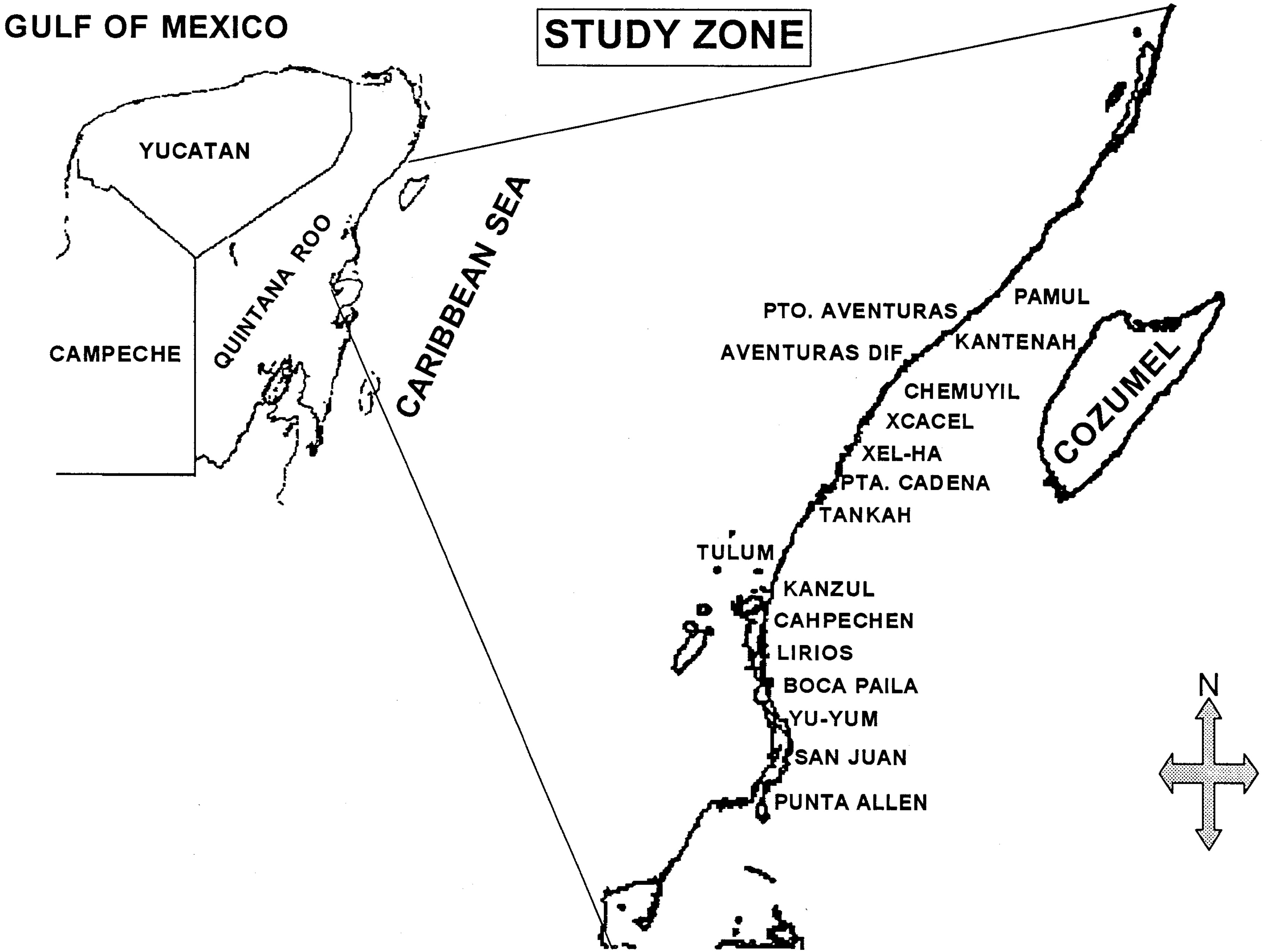
GULF OF MEXICO
STUDY ZONE
YUCATAN
CAMPECHE
QUINTANA ROO
CARIBBEAN SEA
PAMUL
PTO. AVENTURAS
KANTENAH
AVENTURAS DIF
COZUMEL
CHEMUYIL
XCACEL
XEL-HA
PTA. CADENA
TANKAH
TULUM
KANZUL
CAHPECHEN
LIRIOS
BOCA PAILA
YU-YUM
SAN JUAN
PUNTA ALLEN
N

FIGURE 2 SEA TURTLE NESTS RECORDED ON CENTRAL COAST OF QUINTANA ROO, (1987-92)

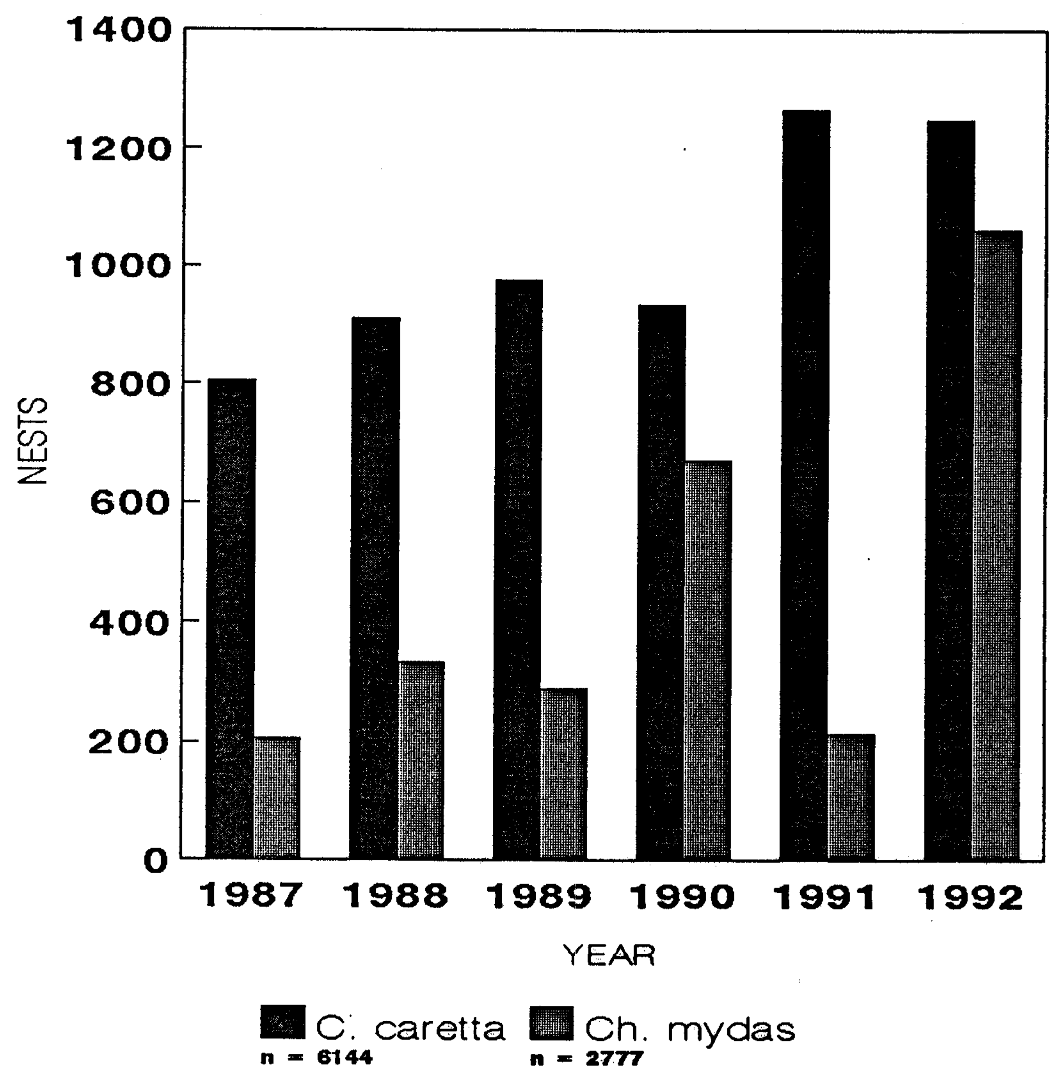

FIGURE 3 SEA TURTLE NESTS RECORDED ON COZUMEL ISLAND, 1990-92