NOAA Technical Memorandum NMFS-SEFSC-412

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

28 February - March 1, 1996
Hilton Head, South Carolina

Compilers:

Richard Byles
and
Yvonne Fernandez

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

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NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
D. James Baker, Administrator

NATIONAL MARINE FISHERIES SERVICE
Rolland A. Schmitten, Assistant Administrator for Fisheries

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Sea Turtle Program
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NEST CAGING AS A MANAGEMENT STRATEGY: DO THE BENEFITS OUTWEIGH THE COST ON URBAN BEACHES?

Stephanie L. Adamany[1], Michael Salmon[1], Blair E. Witherington[2]

[1]Department of Biological Sciences, Florida Atlantic University, Boca Raton, Florida 33431
[2]Florida Department of Environmental Protection, Tequesta Field Station, 19100 SE Federal Hwy., Tequesta, Florida 33469

Caging of sea turtle nests has been central to the City of Boca Raton's sea turtle conservation program as a method to deter terrestrial predators and reduce human disturbance. The cages are of the "self-release" type; mesh on the east side of the cage (facing the ocean) is large enough to allow hatchlings to escape. However, the juxtaposition of nest cages and artificial lighting behind the cages may pose serious threats to hatchlings. Three potential problems were addressed. (1) Do cages affect seafinding by loggerhead hatchlings on dark and illuminated urban beaches? (2) Can city lights cause hatchlings to be "cage-trapped" and if so, how changes in artificial light level ands and in natural illumination (lunar cycles and sunrise) affect the hatchlings? (3) Can darkening the cage environment at illuminated sites decrease cage trapping and improve hatchling orientation?

Cages did not affect orientation paths on artificially illuminated or dark beaches. Hatchlings did not experience any delay in cage escape on dark beaches, but a significant number were trapped inside the cages on artificially illuminated beaches. The highest incidence of trapping occurred on nights surrounding a new moon. Disoriented hatchlings exited cages either after city lighting was reduced (past midnight) or as natural levels of illumination increased shortly before sunrise. When cages were darkened, all turtles escaped but many still exhibited disorientation (i.e., failed to crawl toward the ocean).

Cages may be effective at preventing predation and disturbance, and appear to have no apparent negative effects on hatchling behavior at dark sites. At illuminated sites, cage trapping frequently occurs and could reduce survival. Potential harmful effects of trapping may be depleted energy stores (used while trying to escape) and higher predation rates by visually oriented predators when hatchlings leave cages at sunrise. A continued effort must be made to eliminate beach lighting at urban sites before caging can be an effective management tool.

SEA TURTLE NESTING ACTIVITY ON THE CAY SAL BANK, BAHAMAS

David S. Addison[1] and Beth Morford[2]

[1]5620 12th Avenue SW, Naples, Florida 33999
[2]Florida Department of Environmental Protection, Division of Marine Resources, Tequesta Field Station, Tequesta, Florida 33469

Sea turtle nesting activity in the Bahamas archipelago is not well documented (Karen Bjorndal, pers. comm). This is particularly true with respect to the widely scattered islands that dot the rim of the Cay Sal Bank (CSB), a shallow 4000 km² carbonate sand bank located between the Florida Keys and Cuba (Fig. 1). A survey to assess sea turtle nesting in this region was conducted in June 1995. Six islands were found to contain beaches that support nesting. The majority of the nesting occurs in two areas; the Cotton Cay/Middle Cay complex and Cay Sal (Fig 1). Substantially fewer activities were documented on the pocket beaches at Anguilla Cay, Water Cay and the Double Headed Shot Cays (Fig 1). During night surveys, loggerhead turtles (Caretta caretta) were the only species seen nesting. None of the 488 total crawls and nests evaluated appeared to have been made by green turtles (Chelonia mydas). Additional surveys could determine if green turtles and perhaps hawksbills (Etremochelys imbricata) may periodically nest in CSB. Ten nesting loggerheads were tagged; seven on Cay Sal and three on Middle Cay. This survey suggests the activity observed in CSB may be of some significance with respect to sea turtle nesting in the Bahamas.

METHODS

This survey was conducted from 12 to 17 June 1995. One day was spent surveying beaches in the northwestern edge of CSB. The Anguilla Cays were surveyed over 2 days and 1 night. The Cay Sal beach was surveyed over 4 days and 3 nights. All the beaches were examined on foot. A surveyor's wheel was used to measure lengths. The Cay Sal beach was divided into 152 m sectors to reference activity levels. Beach width (vegetation line to high tide line) were also measured at these reference points. No attempt was made to distinguish between nests and false crawls. After examining numerous body pits, it was concluded that there was too much room for error to accurately distinguish between nests and non-nesting events unless an emergence had occurred within the past 1 or 2 days. Independent counts were made on every beach. Counts that differed significantly were repeated. Night surveys began at about 2130 hrs and ended between 1200 and 0400 hrs. The purpose was to determine which species were present and to tag nesting turtles. Efforts were made to determine the cause of false crawls (Table 1). The location, tidal stage, and time of each event were recorded. Straight and curved carapace lengths and widths and head widths were measured (Table 2). Turtles were double tagged on the posterior margin of the left and right front flippers with inconel tags (Table 2). Morning surveys (ca 0900 hrs) were conducted to record activity that occurred after the night surveys ended.

RESULTS AND DISCUSSION

Six beaches are present on the northwestern rim of CSB. The easternmost large cay in the Double Headed Shot Cays (DHSC) contains three short beaches, all of which had crawls (Table 3). They are essentially pockets of sand bordered by a shoreline of limestone rock. The beaches on Water Cay are also pocket-shaped. Their higher elevation suggests that they are less likely to be overwashed than the beaches in the DHSC.

Three islands in the Anguilla Cays contain beaches that support sea turtle nesting. Anguilla Cay contains five pocket beaches on its western shoreline (Table 4). All are narrow and have low relief. Many crawls and body pits were in the low-growing woody vegetation that backs these beaches. The fact that they are somewhat protected from wave action probably reduces the chance of nests being flooded during storms.

Middle Cay, between Anguilla Cay and Cotton Cay contains 207 m of beach that faces Santaren Channel. It is wide with relatively high relief and is backed by low-growing vegetation. Nests here are probably less subject to flooding. A significant amount of sea turtle activity was observed (Table 4). Three nesting loggerheads were tagged on this beach (Table 2).

The southwestern shore of Cotton Cay contains six pocket beaches that are similar to those on Anguilla Cay. Pocket beaches #1, #2, and #3 were the only ones where crawls were seen (Table 4). Spring tides may have washed away evidence of activity on the other beaches. The beaches on the shore facing Santaren Channel all contained crawls (Table 4). All the beaches are backed by vegetated sand ridges that, in places, reach elevations of approximately 20 m. A total 184 activities were documented on these beaches (Table 1).

Cay Sal is roughly triangular in shape (Fig 2). The beach that fringes almost the entire island is 3.5 km long and varies in width from 1.0 m to 14.8 m (mean=6.7 m). Portions of this beach, particularly the northeast segment, are subject to overwash by spring tides. The initial survey documented 133 activities (Table 5). During additional surveys 37 more false crawls and 21 nests were documented. All occurred at night with one exception. This turtle was observed attempting to nest at 1150 hrs on 14 June. Seven loggerheads were tagged on Cay Sal. Loggerhead turtles were the only species observed nesting on Cay Sal and Middle Cay. None of the crawls on any of the beaches appeared to have been made by green turtles (Chelonia mydas).

The lack of comparative data on sea turtle nesting throughout the Bahamas archipelago makes the overall significance of CSB as a rookery area difficult to assess. On Cay Sal the mean number of nests each night was seven. Given a 90-day nesting season, a conservative estimate of activity might be between 500 and 600 nests (143-171 nests/km). The 191 total crawls counted on Cay Sal yields a density of 55 activities/km. Crawls counted on other beaches also provide a measure of activity. In the Anguilla Cays, 261 activities were observed on Cotton Cay and Middle Cay. The total 2 km of beach on the northeastern shore of Cotton Cay had a density of 92 activities/km. The 207 m beach on Middle Cay had a density of 217 activities/km. Extended surveys would help clarify the significance these beaches as rookery areas.

The activity on the beaches at Water Cay and the DHSC is also of interest. It is likely that the turtles that nest on these beaches are part of the population that nests in Florida; however, some turtles that nest in CSB may be from Cuban waters. Whether CSB beaches are specific destination points or are arrived at by chance as turtles migrate through the area on their way to nesting beaches in Florida is an interesting question. They may very well be a satellite of the Florida population. A comparison of mtDNA haplotypes from CSB turtles with the Florida population could provide an answer.

Although loggerheads accounted for all the observed activity, the question of whether or not hawksbills and/or green turtles occasionally nest in this region remains unanswered. The presence of hawksbills would be significant as the Cuban government has recently expressed interest in resuming the commercial harvest of this species from its territorial waters (Bowen, 1995). Green turtle nesting in Florida during 1995 was much lower (Barbara Schroeder, pers. comm.) than it was in 1994. Had this survey occurred during an "up year" for this species in Florida, perhaps green turtle activity would have been documented. Additional surveys over time might answer these questions.

ACKNOWLEDGMENTS

This field study was conducted under Bahamas Research Permit MAF/FIS/17. The authors express their sincere thanks to Keith Bishop of E.I.B. Bahamas, Ltd. and Todd Turrell of Turrell and Assoc., Inc. for underwriting the costs involved in carrying out this survey. We are also most grateful to Brian Schmitt, owner of the trawler Hippocampus, for generously giving of his time and hospitality during the cruise. Thanks also to Alan Bolten of the University of Florida for his advice and tags and to Bill Bourdier for preparing the graphics.

LITERATURE CITED

Bowen, B.W. 1995. Tracking marine turtles with genetic markers. BioSci. 45(8):528-534.

TABLE 3. Beaches on islands fringing northwestern rim of Cay Sal Bank, Bahamas, 12 June 1995

Location	Beach#	Beach Length (m)	# Activities
Double Headed Shot Cays	1	55	12
(eastern-most large cay	2	7	2
in this group of cays)	3	25	3
Total		87	17
Water Cay	1	25	3
(largest cay east of	2	9	1
Double Headed Shot Cays)	3	149	10
Total		183	14

Table 5. Sea turtle activity on 3.5 km long beach at Cay Sal, Bahamas, 12-14 June 1995.

Unidentified Activities[1]	False Crawls	Nests False	Total Activities	Activities/km
133	37	21	191	55

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[1] Crawls counted on 12 June, prior to start of night surveys.

TABLE 1. False crawls recorded on the island of Cay Sal, Bahamas.

False Crawl	Date	Time	Turtle Observed	Beach Location	Beach Index[1]	Tidal Stage	Moon Phase	Possible Cause of False Crawl
1	6/12	2325	yes	3,395	3	falling	waxing	saw observer while emerging?
2	6/13	0100	no	1,689	2	falling	waxing	unknown
3	6/13	0130	no	1,883	2	falling	waxing	unknown
4	6/13	0137	no	2,058	1	falling	waxing	unknown
5	6/13	0144	no	2,286	5	falling	waxing	unknown
6	6/13	0200	no	3,137	3	falling	waxing	unknown
7	6/13	0210	no	3,335	4	falling	waxing	lots of conch shells on beach
8	6/13	0300	no	1,237	5	falling	waxing	unknown
9	6/13	a.m.		1,241	4		waxing	unknown
10	6/13	a.m.			4		waxing	unknown
11	6/13	2200	yes	1,428	3	rising	full	missing left rear flipper,2 body pits, CL 97.7, CW72.0
12	6/13	2220	no	1,154	3	rising	full	unknown
13	6/13	2225	no	1,571	5	rising	full	crawled up against rock
14	6/13	2228	no	1,641	2	rising	full	unknown
15	6/13	2238	yes	1,787	5	rising	full	many big rocks on beach
16	6/13	2239	no	1,768	5	rising	full	unknown
17	6/13	2255	no	1,869	5	rising	full	unknown
18	6/13	2305	no	2,228	5	high	full	unknown
19	6/13	2335	no	2,278	4	falling	full	unknown
20	6/13	2335	no	2,187	4	falling	full	on top of false crawl 18
21	6/13	2345	yes	2,441	1	falling	full	barely emerged and aborted
22	6/13	2350	no	2,642	5	falling	full	hit scarp at dune, aborted
23	6/13	2400	no	3,047	4	falling	full	possibly driftwood on beach
24	6/14	0300	no	3,383	4	falling	full	lots of conch shell on beach
25	6/14	a.m.		1,671	4		full	crawled into rocks
26	6/14	a.m.		1,537	3		full	crawled into rocks
27	6/14	a.m.		826	3		full	big piece of driftwood in way
28	6/14	a.m.		1,164	5		full	unknown
29	6/14	a.m.		1,121	3		full	unknown
30	6/14	a.m.		1,262	2		full	unknown
31	6/14	a.m.		2,423	4		full	unknown
32	6/14	1150	yes	1,580	4		high	dug 3 egg chambers, hit rock every time, aborted
33	6/14	2230	no	1,835	4	rising	waning	crawled into rock, went around and back into water
34	6/14	2250	no	1,774	3	rising	waning	dug 2 body pits, 1 egg chamber, may have hit rock
35	6/14	a.m.		2,530	2		waning	unknown
36	6/14	a.m.		1,590	4		waning	probably rocks on beach
37	6/14	a.m.		1,528	3		waning	probably rocks on beach

[1] Beach Index: 1=w/in intertidal zone, 2=intertidal zone to high tide line, 3=middle beach, 4=w/in 3 m of vegetation line, 5=w/in vegetation.

TABLE 2. Loggerhead nesting activity on the islands of Cay Sal and Middle Cay, Bahamas.

Nest#	Date	Time	Turtle	Tag#	Measurements(cm)	Beach	Beach	Tidal	Moon
			Observed	Rt/Lt	SL SW CL CW Head Width	Location (m)	Index[1]	Stage	Phase
Middle Cay									
1	17 June	2200	yes	X6218 X6217	101.2/99.0		3	rising	waning
2	17 June	2210	yes	X6220 X6219	95.1/89.4		4	rising	waning
3	17 June	2220	yes	X6222 X6221	106.1/98.9		4	rising	waning
Cay Sal									
1	12 June	2145	no			523	2	rising	waxing
2	12 June	2207	yes	X6226/X6227	99.2/73.5/104.4/93.9/21.8	3,039	3	high	waxing
3	12 June	2350	yes	X6204	89.7/69.1/95.7/89.1/21.3	2,056	2	falling	waxing
4	13 June	0052	no			76	4	falling	waxing
5	13 June	morning				1,558	4		waxing
6	13 June	morning				2,993	3		waxing
7	13 June	2230	yes			1,731	3	rising	full
8	13 June	2306	yes	X6208/X6207	95.1/74.4/100.9/95.3/21.5	2,248	3	high	full
9	13 June	2358	yes	X6210/X6209	91.6/73.7/98.1/96.0/19.5	2,911	2	high	full
10	14 June	0010	yes	X6205/X6206	93.8/75.5/98.6/92.1	1,936	3	falling	full
11	14 June	morning				1,942	3		full
12	14 June	morning				1,905	3		full
13	14 June	morning				2,355	3		full
14	14 June	morning				2,238	3		full
15	14 June	2200	yes	X6214/X6212	92.9/71.7/101.2/95.3/20.9	1,537	3	rising	waning
16	14 June	2320	yes	X6216/X6215	83.1/63.0/89.8/78.1/17.7	101	4	rising	waning
17	14 June	2340	no			30	5	rising	waning
18	15 June	morning				2,387	3		waning
19	15 June	morning				1,760	4		waning
20	15 June	morning				1,623	3		waning
21	15 June	morning				630	4		waning

[1] Beach Index: 1=within intertidal zone, 2=intertidal zone to high tide line, 3=middle beach, 4=within 3 m of vegetation line, 5=within vegetation.

TABLE 4. Beaches on islands in Anguilla Cays, Bahamas, 16-17 June 1995.

Location	Beach#	Beach Length (m)	# Activities
Cotton Cay[1]			
Northeast Beaches	1	107	16
(southeast to northeast)	2	385	18(4)
	3	274	11(2)
	4	34	6
	5	168	1(3)
	6	76	6
	7	49	6
	8	81	8
	9	298	33
	10	529	52(1)
	Subtotal	2,001	174(184)
Southwest Beaches	1	93	10
(southwest to northwest)	2	61	3
	3	257	19
	4	31	0
	5	36	0
	6	15	0
	Subtotal		49332
	Total for Cotton Cay	2,494	206(216)
Middle Cay	1	207	45
Anguilla Cay	1	25	4
(southwest to northwest)	2	41	5
	3	137	14
	4	118	2
	5	84	11
	Total	405	36
Total for Anguilla Cays		3,106	287(297)

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[1] Numbers in parenthesis indicate new activities observed during a survey of all the beaches on Cotton Cay on 17 June. Beach #1 was not surveyed during the initial evaluation on 16 June.

[2] Activities/km=sum of old activities + new activities divided by distance.

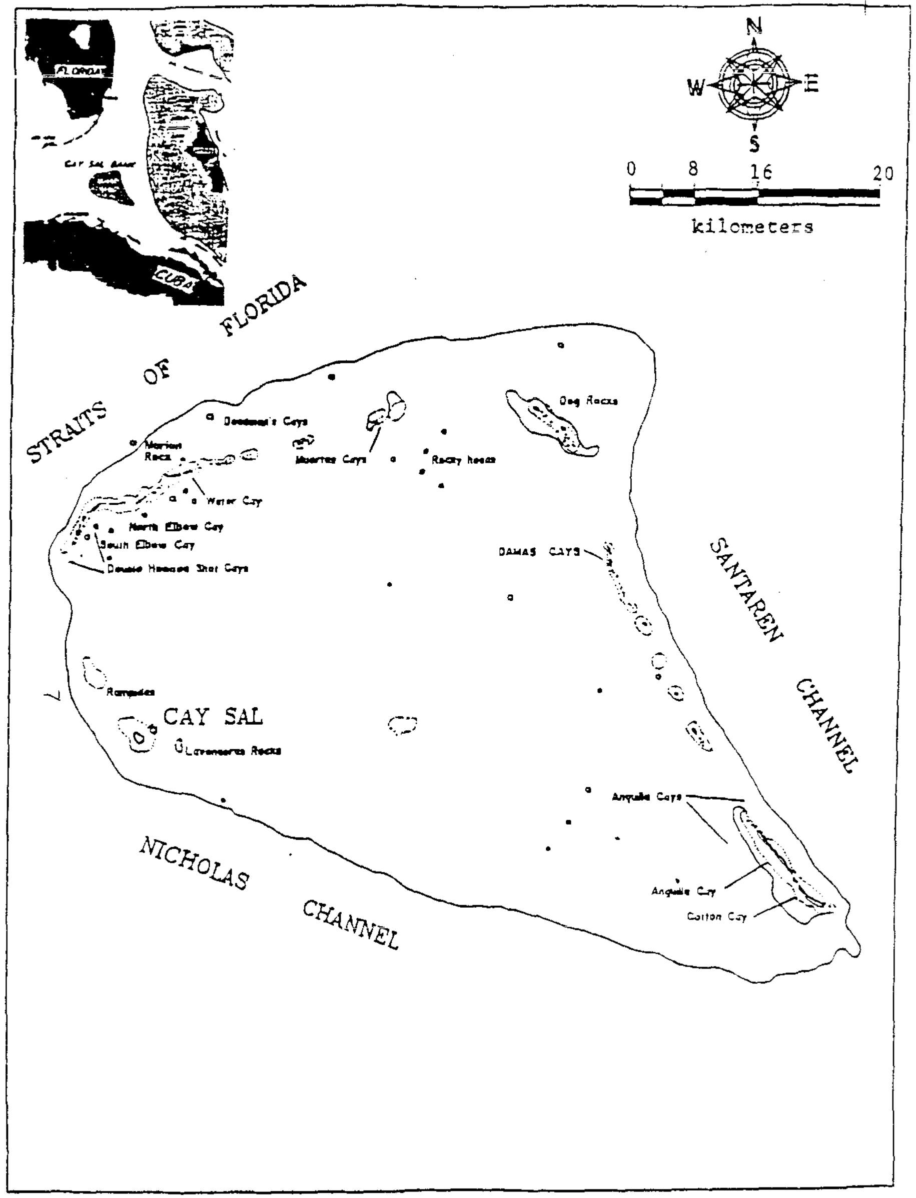
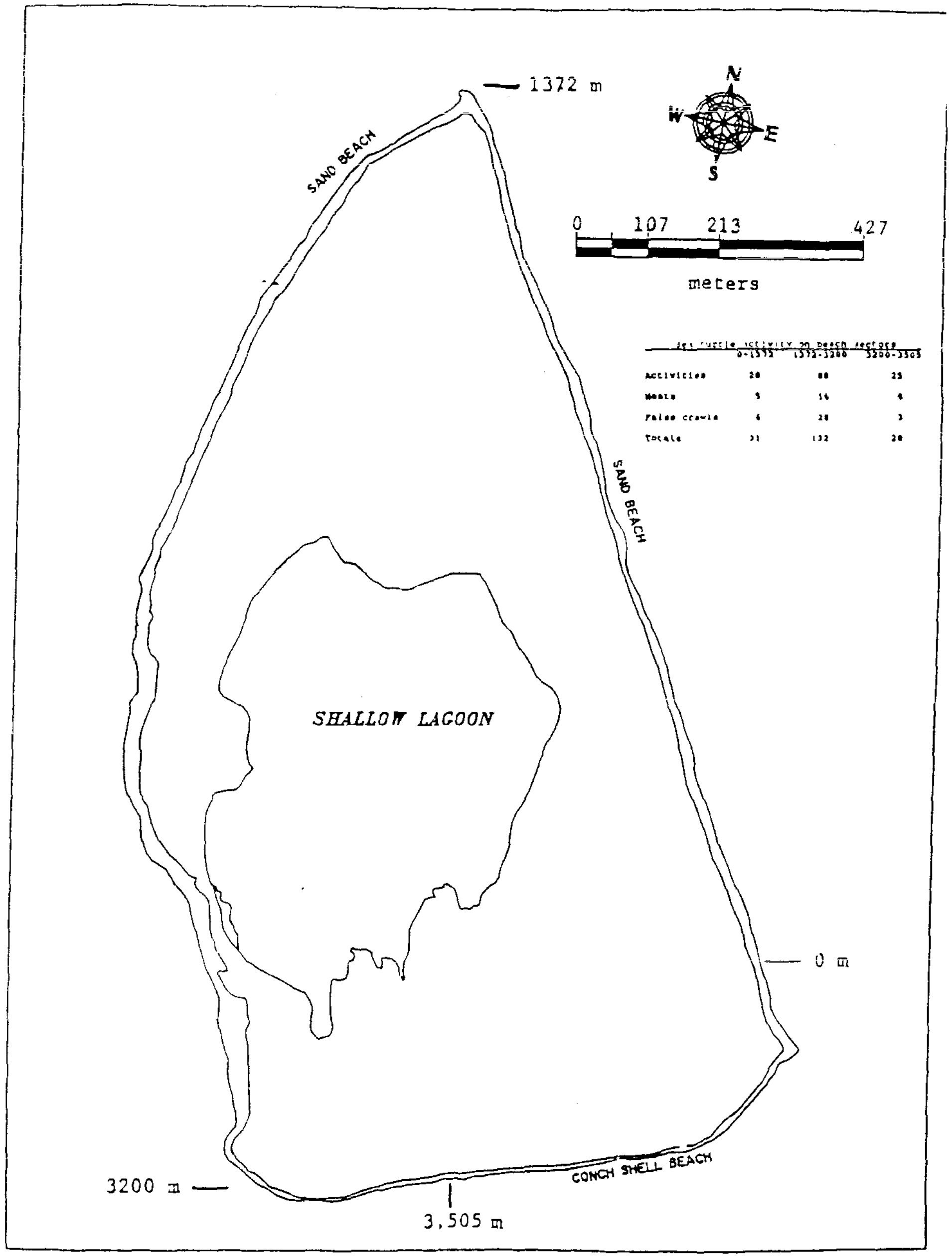


FIGURE 1. Islands and shoals of the Cay Sal Bank, Bahamas (Middle Cay not labeled)



Sea turtle activity on beach sectors

	0-1372	1372-3200	3200-3505
Activities	20	88	25
Nests	5	16	0
False crawls	6	28	3
Totals	31	132	28

FIGURE2. Cay Sal showing beach lengths were turtle activity was recorded.

INFLUENCE OF POSTHATCHING CAPTIVITY ON ACTIVITY AND ORIENTATION OF SEA TURTLE HATCHLINGS

Monika Albrecht

Abt. für Verhaltensphysiologie, Universität Tübingen, Beim Kupferhammer 8, 72070 Tübingen GERMANY

INTRODUCTION

It is a well known practice in many sea turtle conservation programmes to excavate natural nests on the beach and rebury the eggs in hatcheries for incubation. After hatching, sea turtles are placed into sea water tanks and released some days later. However, the time after hatching is a natural period of high and continuous swimming activity (Carr, 1962) that is necessary for the young turtles to swim out to sea and escape predators in coastal waters (Wyneken & Salmon, 1992).

I studied the influence of posthatching captivity on sea turtle hatchlings. An objective of this study was to find out for how many days hatchlings can be kept in captivity without influencing swimming and orientation behavior after release. The following questions are studied to find out the appropriate time for release: (1) For how many days after hatching do sea turtles show a high and continuous swimming activity? (2) For how many days are the swimming hatchlings oriented to sea? (3) For how many days are the animals oriented to the water while crawling down the beach after release?

MATERIALS AND METHODS

Experiments were carried out from March to May 1994 at the Sea Turtle Hatchery in Bentota on the west coast of Sri Lanka. Subjects were hatchlings of Pacific Green Turtles (Chelonia mydas japonica, THUNBERG 1787) and Olive Ridley Tutles (Lepidochelys olivacea, ESCHSCHOLTZ 1829).

My study included behavioral observations during the first 3 (L. olivacea) and 4 days (Chelonia mydas) after hatching. Clutches of around 70 to 110 animals were retained in a tank with a diameter of 1.30 m. Individual animals were watched for ten minutes each at different times of day and each swimming period was recorded. When the animal was swimming continuously against the wall of the tank the direction in degrees against north was read every 20 seconds. In addition hatchlings were released during the first 4 (L. olivacea) and 5 nights (Chelonia mydas) on the beach. Ten animals were placed simultaneously in the middle of a circle in the sand with r=3m. After all hatchlings had left the circle the directions of their tracks were measured at the periphery of the circle.

DATA ANALYSIS

Of each animal a total activity time was calculated. It was defined as the sum of all swimming periods. Activity times of every animal at different days were compared using the Kruskal-Wallis one-way analysis of variance by ranks. If there were significant differences between days, multiple comparison tests were used to identify the pairs involved. Of each swimming animal a mean vector was calculated and its directedness was tested with the Rayleigh test. Mean swimming directions of different days were compared using the Watson's U^2 test. Of each group of released animals a mean crawling vector was calculated. Vector lenghts and mean directions of different days after hatching were compared using the Kolmogorov-Smirnov two-sample test and the Hotelling two-sample test .

RESULTS

Activity decreased with time. Both species were active for less than half of the observation time on the third day (Fig.1, Fig.2). Multiple comparison tests indicated that decrease of activity is significant in both species between the first and second as well as between the second and third day ($p<0.05$), but not between the third and fourth day of Chelonia mydas.

The number of oriented hatchlings decreased with time in both species. Fewer L. olivacea than Chelonia mydas were oriented (Fig.3, Fig.5). Orientation of L. olivacea decreased from the first to the second day and ceased on the third day (Fig.5). Orientation of Chelonia mydas was similar during the first three days, however, decreased on the fourth day (Fig.3). Mean swimming directions of both species were always significantly directed towards the sea ($p<0.0001$). There was no significant difference between mean swimming directions on different days (Fig.4, Fig.6).

Right after emerging from the nest vector lengths were all higher than $a=0.80$ and differed significantly from those of the first and fourth night ($p<0.05$, Fig.7). Mean crawling directions were always significantly directed towards the sea ($p<0.0001$). Crawling directions right after hatching differed significantly from those of the fourth day ($p<0.05$, Fig.8). While all Chelonia mydas crawled to the water more L. olivacea refused to move with days elapsing (Fig.9).

DISCUSSION

Swimming activity, especially non-random swimming movements, decrease fast after hatching. This means that each day of captivity in a hatchery reduces the time period that undisturbed hatchlings spend after release to swim out to sea. If they are released later than in the night when they emerged from the nest, they will stop swimming before they are in the open ocean. If they are still near shore after they have lost motivation to swim, they get caught by predators or are drifted back to the beaches by currents.

Crawling orientation of hatchlings is much better right after hatching than on any other day. It seems as if the orientation capability deteriorates after they have been swimming in tanks. It is conceivable that turtles who spent some time in captivity cannot collect sufficient information about the nesting beach. They might not be able to return to the nesting beach as breeding adults. I suggest that hatchlings are not kept in captivity. They must be released right after emerging from the nest.

LITERATURE

Carr, A.F. (1962). Orientation problems in the high seas travel and terrestrial movements of marine turtles. Am. Sci. 50:359-374.

Wyneken, J. & Salmon, M. (1992). Copeia 1992 (2), pp. 478-484.

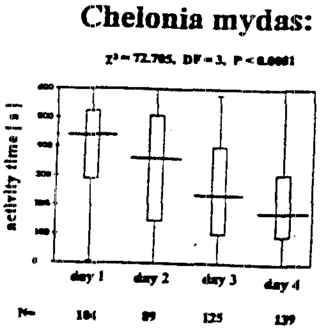


Fig. 1 : Total activity time of C. mydas during a ten minute observation period. (Range is indicated by two horizontal lines, median ± 1 quartile is indicated by a solid horizontal bar and a box)

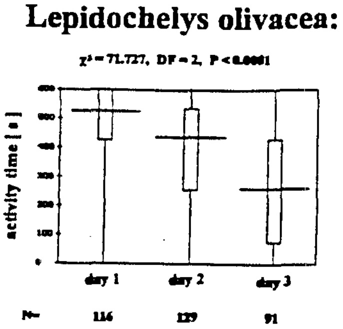


Fig. 2 : Total activity time of L. olivacea during a ten minute observation period. (Legend is the same as in Fig. 1).

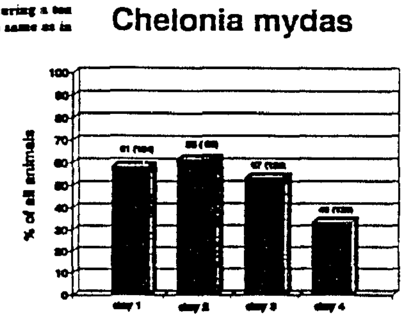


Fig. 3 : Number of C. mydas with non-random swimming movements. (Numbers in brackets indicate total sample size).

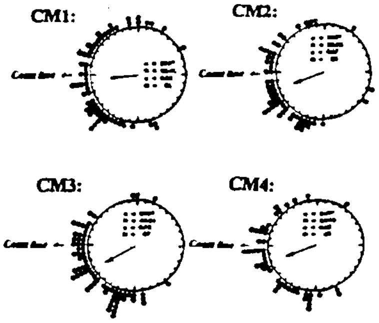


Fig. 4 : Mean directions of all C. mydas with non-random swimming movements and the mean vector (=centrifugal arrow) of the indicated directions. (Each dot represents the mean direction of one hatchling with non random swimming movements).

Lepidochelys olivacea

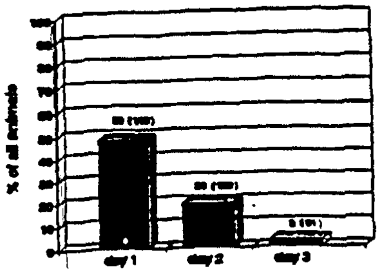


Fig. 5 : Number of *L. olivacea* with non-random swimming movements. (Legend is the same as in Fig. 3).

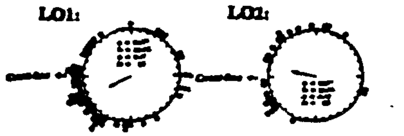


Fig. 6 : Mean directions of all *L. olivacea* with non-random swimming movements and the mean vector (centrifugal arrow) of the indicated directions. (Legend is the same as in Fig.4).

Chelonia mydas:

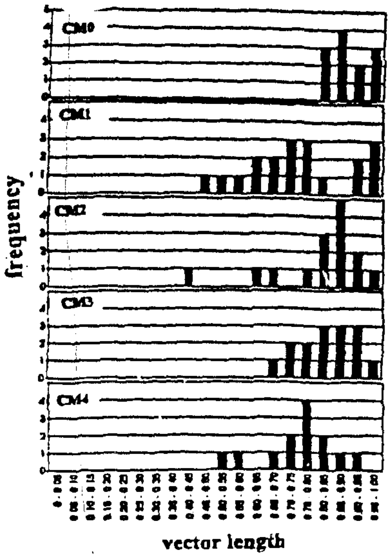


Fig. 7 : Vector lengths of released groups of *C. mydas* (Each group contains ten hatchlings).

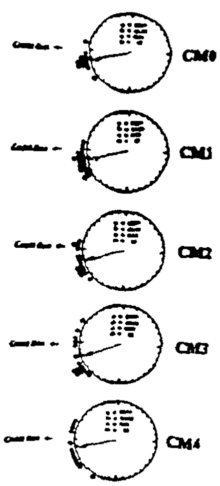


Fig. 8: Mean crawling directions of the released groups of *C. mydas*. (Each dot represents the mean direction of a group of ten hatchlings).

Lepidochelys olivacea

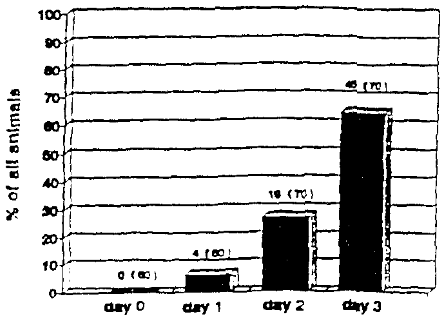


Fig. 9: Number of *L. olivacea* that were not moving after release (Numbers in brackets indicate total sample size).

PRELIMINARY RESULTS: EVALUATION AND TECHNOLOGY TRANSFER OF THE TURTLE EXCLUDER DEVICE (TED) IN THE PACIFIC SHRIMP FISHERY OF COSTA RICA

Randall M. Arauz[1], Isabel Naranjo [2], Raul Rojas [3], Roberto Vargas [2]

[1] Associate Researcher, School of Biology, University of Costa Rica
[2] TED Project, School of Biology, University of Costa Rica
[3] Consultant.

Arauz (1995) estimated that in Costa Rica the catch per unit of effort (CPUE) of sea turtles by shrimpers occurred at a rate of 0.0899, which makes the Central American eastern Pacific ocean the area in the world with the highest turtle catch rates recorded during commercial shrimping operations. The 55 commercial vessels in the national fleet are believed to catch approximately 20,000 turtles per year, with a mortality rate around 50%. Since 1990, in light of the high catch rates and the imminent embargo on shrimp imports promulgated by the U.S. from nations not requiring the use of TED's in their shrimp fleets, the University of Costa Rica initiated efforts to evaluate TED performance under commercial shrimping operations and then carry out an efficient technology transfer. Funds were finally secured in 1995, and were provided by the U.S. Agency for International Development (USAID-Costa Rica) and the National Commission for Scientific and Technological Research (CONICIT) of Costa Rica.

The project consists of three phases. Phase 1 was carried out in April 1995, and consisted of a Technology Transfer Workshop in Puntarenas, Costa Rica, for the local net makers and shrimpers, directed by the National Marine Fisheries Service and coordinated by the University of Costa Rica. Phase 2 initiated in May 1995 and will continue until June 1995, and has consisted of monthly trips on commercial vessels to evaluate TED performance. Phase 3 will consist of a second workshop in Puntarenas, where the shrimpers will be explained how the TED's performed and which are the modifications recommended to enhance trawling efficiency under our fishing conditions.

Objectives:

- ° Evaluate TED performance regarding shrimp retention.
- ° Evaluate TED performance regarding retention of commercialized by-catch.
- ° Evaluate TED performance regarding reduction of discarded by-catch.
- ° Evaluate TED performance regarding sea turtle exclusion.
- ° Determine modifications necessary to develop a TED adapted to our own fishing demands and conditions.
- ° Carry out an efficient technology transfer program and make it accessible to all of the Costa Rican shrimpers.

METHODOLOGY

Basically, the method has consisted of installing a Super Shooter TED (donated by the NMFS) on only one of the rigs of a commercial shrimp vessel, and the components of the catch are compared by means of a comparative t-student analysis to a control net to determine if any significant differences occur. However, before this can be done the nets must be calibrated, as they tend to perform differently depending on several factors. To do this, from 6 to 10 drags are carried out without the use of the TED. When the catch is hauled on board, care is taken to keep the catch from each net separate. Total shrimp catch by weight is recorded, as well as total commercialized by-catch for each net. Then, three subsamples of by-catch from each net are collected in 33 liter plastic boxes and weighed. The rest of the by-catch is discarded after being measured in 55 liter plastic boxes. Total weight of discarded by-catch may then be estimated by total volume. Following calibration, the TED is installed in any one of the nets, and the catch components of each net are sorted and weighed in the same way as during the calibration drags. When testing the TED, commercialized by-catch is also identified and measured.

As of December 1994, only three fishing excursion have produced enough data to come up with any results. During the only fishing excursion performed at depths of 40-50 fathoms for pink shrimp (Fig. 1) using a bottom shooting TED, a small yet significant loss of shrimp was detected (3.4%), although we detected a greater and significant loss of commercialized by-catch (35.19%) (6 drags). While fishing for white shrimp in shallow waters in the south Pacific shrimping grounds, the efficiency of the TED is severely impaired by logs that obstruct the TED, causing a still undetermined overall loss of total catch by weight (up to 40% in some drags). As observed in Fig 2, the average reduction of shrimp and commercialized by-catch was 19.37% and 24.2% respectively (4 drags) when using a bottom shooter. These figures contrast with Fig. 3, when a top shooter was tested, resulting in an apparent gain of shrimp and commercialized by-catch (14.5% and 20.5% respectively).

As for the turtles, Table 1 shows the fishing effort and very high sea turtle CPUE rates during the course of the study, which is consistent with previously released data by Arauz (1995).

DISCUSSION

For this second stage of the project, one TED was modified to 6 in. deflector bar distance (instead of 4 in), and 200 meshes of circumference are used in the extension web (instead of 150). Plans are currently underway to test TED's with larger frames. With a greater deflector bar distance we expect to retain larger fish. With 200 meshes circumference and a larger frame it is expected that the escape hole will be larger and more relaxed, and thus shoot the lots more easily.

The most important point is that TED's will probably have to undergo certain modifications in order to be accepted by the local fishermen, because of which their collaboration is essential. Fishing conditions are also different than in the U.S., as well as the use given to the by-catch. Furthermore, the age groups of turtles being threatened by shrimping activities also differs greatly, with only mature adults captured in Costa Rica.

LITERATURE

Arauz, R. M. 1995. A description of the Central American shrimp fisheries with estimates of incidental capture and mortality of sea turtles in Schroeder, B. A. and B.E. Witherington (Compilers). Proceedings of the Thirteenth Annual Syposium on Sea Turtle Biology and Conservation. NOAA Technical Memorandum NMFS-SEFSC-341, 281 pp.

REVIEW OF THE SEA TURTLE RESTORATION PROJECT'S ACTIVITIES THROUGHOUT CENTRAL AMERICA

Randall M. Arauz

Central American Director, Sea Turtle Restoration Project, Earth Island Institute, Costa Rica

During the last few years the Sea Turtle Restoration Project (STRP) has been involved with the conservation of sea turtles throughout Central America.

Nicaragua - Since 1992, the STRP has financed the Central American University of Central America in Managua to carry out biological research on the olive ridley sea turtle population that nests in Playa La Flor Wildlife Refuge, Rivas, Nicaragua. Additionally, the Ministry of the Environment is funded to reinforce protection of the nesting beach with 10 additional rangers during the nesting season. In 1993, STRP financed the construction of a research facility on the site to lodge rangers and biologists. Currently, the STRP is attempting to implement an Action Plan to involve the local communities in the conservation of the area, which is being carried out in collaboration with the Ministry of the Environment and the University of Central America.

Playa La Flor, however, is threatened by an imminent tourist development planned by the owner of the property. Unfortunately, the property is not legally protected, and the authorities can only negotiate with him, not enforce any regulations. Aware that this situation jeopardizes the long term protection of La Flor, the University of Central America in collaboration with the STRP is preparing a campaign to have the government declare the area as a Wildlife Refuge through a Presidential decree. This would enable the authorities to enforce regulations and protect the beach from the hazards irresponsible tourism may bring.

Guatemala - Four short training lectures were dictated to local biologists and conservationists who manage the 21 government run hatcheries throughout the Pacific coast. The Guatemalan conservation program was evaluated and recommendations were made to the Government so as to improve their work. For instance, all hatcheries are provided with thatched palm roofs and walls. Moreover, hatchlings are excessively manipulated. A workshop is currently being organized by STRP, the Association for the Rescue of Guatemalan Wildlife (ARCAS) and the General Forestry Department (DIGEBOS), to train locals and update them with the latest scientific turtle knowledge. The existing gap of basic scientific research will be filled in by the Columbus Zoo, which has offered to fund a graduate student and cover the expenses of a Guatemalan student to carry out the research.

<u>Costa Rica</u> - Three different communities recently organized in conservation organizations have sought STRP assistance to help improve their conservation programs, Islita, Ostional and Punta Banco. Islita and Punta Banco are two Pacific coastal communities that do not have previous experience with sea turtles. However, their interest is born from the booming tourism industry, and sea turtles are always an attraction to the ecotourist. Plans are currently underway to provide technical assistance on hatchery operation tp each community, and funds are being sought to contract a biologist on each site to monitor the nesting populations and carry out environmental education tasks.

In Ostional, plans are underway to orchestrate a national and international campaign to guarantee the protection of the Ostional Wildlife Refuge, where a unique turtle egg harvesting program takes place. The area is currently threatened by several situations, mainly: (a) lack of popular knowledge of the Ostional project, and thus support; (b) lack of government control on the turtle egg harvest, which fosters poaching; and (c) lack of government support to control the national marketing of turtle eggs and the growth of the tourism industry in the area. Currently, all the responsibilities of administrating and handling the Refuge lies only on the Development Association of Ostional, and they have their own technical and financial limitations. The campaign will be focused to educate the general Costa Rican public on the Ostional project, and why their support is important. This will be followed by an international campaign to support the Costa Rican's through letters to political personalities. The objective of the campaign will be to obtain the political support necessary to enforce regulations and effectively protect the nesting beach and the sea turtles from poachers and uncontrolled tourist development. Finally, plans are currently underway to design a TED program in Pacific Central America. This project will include funds to finance local universities or professionals in each country to carry out TED research. The main goal is to train TED teams in every country so that they can have their own local expert evaluating and determining TED modifications that work best under their particular fishing conditions.

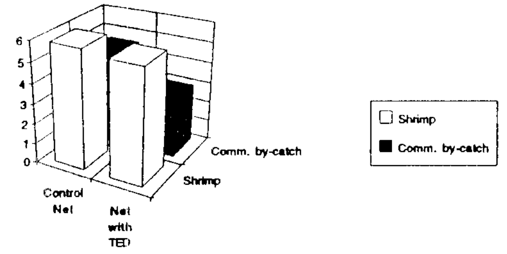


Fig. 1. Mean CPUE rates "Karla G."
(3.4% shrimp reduction, and 35.19% commerc. by-catch reduction. N = 6)
Shrimp (t = 4.118, p = 0.009)/comm.by-catch (t = 0.866, p = 0.014)

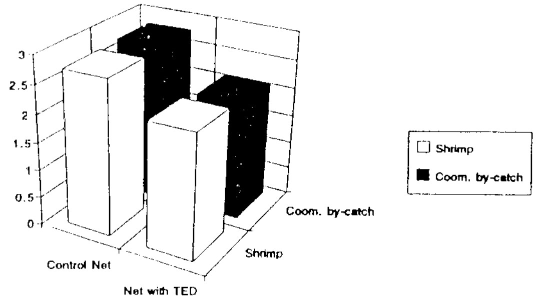


Fig. 2. Mean CPUE rates "Nautlius"
(19.37% shrimp reduction, and 24.21% commerc. by-catch reduction, n = 6)
Shrimp (t = 1.114, p = 0.339)/comm.by-catch (t = 0.840,p = 0.489)

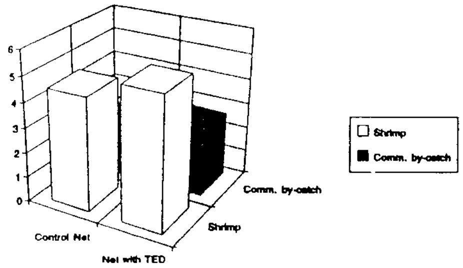


Fig. 3. Mean CPUE rates "Rio Grande"
(increase of 14.5% shrimp catch, and 20.5% increase in commerc. by-catch, n = 4)
Shrimp (t = -1.088, p = 0.349)/comm.by-catch (t = 0.789, p = 0.494)

Table 1. CPUE Sea Turtles
(# indiv/hr)

Vessel	dates	hours dragging	#turtles	CPUE
1- "Karla G"	14/5 - 26/5	89.05	13	0.1460
2- "Mari Pia"	23/6 - 28/6	52.15	6	0.1151
3- "Picaroto"	23/7 - 26/7	39.25	3	0.0760
4- "Nautilius"	22/8 - 02/9	177.10	67	0.3783
5- "Edjorka"	3/10 - 15/10	140.15	7	0.0500
6- "Rio Grande"	7/11 - 16/11	127.8	2	0.0156
7- "Maria Aur"	3/1 - 11/1	138.43	7	0.0506

CPUE rate for turtles in the Gulf of Mexico = 0.007

PRELIMINARY STUDY OF GHOST CRAB (Ocypode quadrata) ACTIVITY ON LOGGERHEAD TURTLE (Caretta caretta) NESTS AT BALD HEAD ISLAND, NORTH CAROLINA

Denise M. Barnes and David Webster

Department of Biological Sciences and Center for Marine Science Research, University of North Carolina at Wilmington, Wilmington, NC 28403-3297

ABSTRACT

The activity of ghost crabs (Ocypode quadrata) at the nests of loggerhead turtles (Caretta caretta) was studied on the beaches of Bald Head Island, North Carolina. Nests were monitored from July 14 through August 15, 1995 (excluding 5 days, when data were unavailable). Monitoring periods were sub-divided into seven intervals: the first and second weeks after nests were laid; the week surrounding and including the assumed midpoint, as well as the weeks preceding and following the week of the midpoint; the next to last week and the week prior to emergence. Ghost crab activity during each sub-interval were compared throughout the incubation period. Of 88 nests, it was determined that 24.4% of the nests were disturbed by ghost crabs during the week prior to hatchling emergence, which was the week showing most ghost crab activity. The weeks including and preceding the midpoint had the lowest ghost crab activities, with 0% of the nests disturbed.

INTRODUCTION

Although many studies have shown that overall, ghost crabs (Ocypode quadrata) do not significantly affect the nests of sea turtles, they appear to be the major predator throughout the incubation period at this study site. This investigation was conducted to discern when ghost crabs were digging into the loggerhead turtle (Caretta caretta) nests, and whether there was one particular time in which most of the digging occurred.

METHODS

Eighty-eight loggerhead nests were monitored for ghost crab activity for 28 nights during the period from July 14 to August 15, 1995. The number of ghost crab (Ocypode quadrata) burrows within 0.5 m of each nest was tallied each evening. Observed burrows were filled with sand and checked again the same night for subsequent disturbance. Burrow data were standardized using the following procedure. The number of burrows for each nest during the monitoring period was used to calculate the expected number of burrows had the nest been monitored throughout the entire incubation period. In addition, data for all nests were placed into one of seven time intervals, each 1 week in length, as follows: first week after nest laid, second week after nest laid, week surrounding and including assumed midpoint, week preceding the week of the midpoint, week following the week of the midpoint, next to last week, and week prior to and including emergence.

CONCLUSIONS

1. Most loggerhead sea turtle nests do not have ghost crab burrows.
2. Ghost crab burrowing activities increase during the week prior to hatchling emergence.

ACKNOWLEDGMENTS

I would like to thank the following for their input to this study: Bald Head Island Conservancy, Bald Head Island, North Carolina, Department of Biological Sciences and the Center for Marine Science Research, University of North Carolina at Wilmington.

Figure 1 Thirty-three of 88 nests were disturbed by ghost crabs during the study period. The majority (65.2%) of loggerhead nests monitored during this investigation had no ghost crab burrows during the incubation period. Approximately one-fourth of all nests had only one burrow during incubation. Some nests were repeatedly disturbed, with as many as 14 burrows during the incubation period.

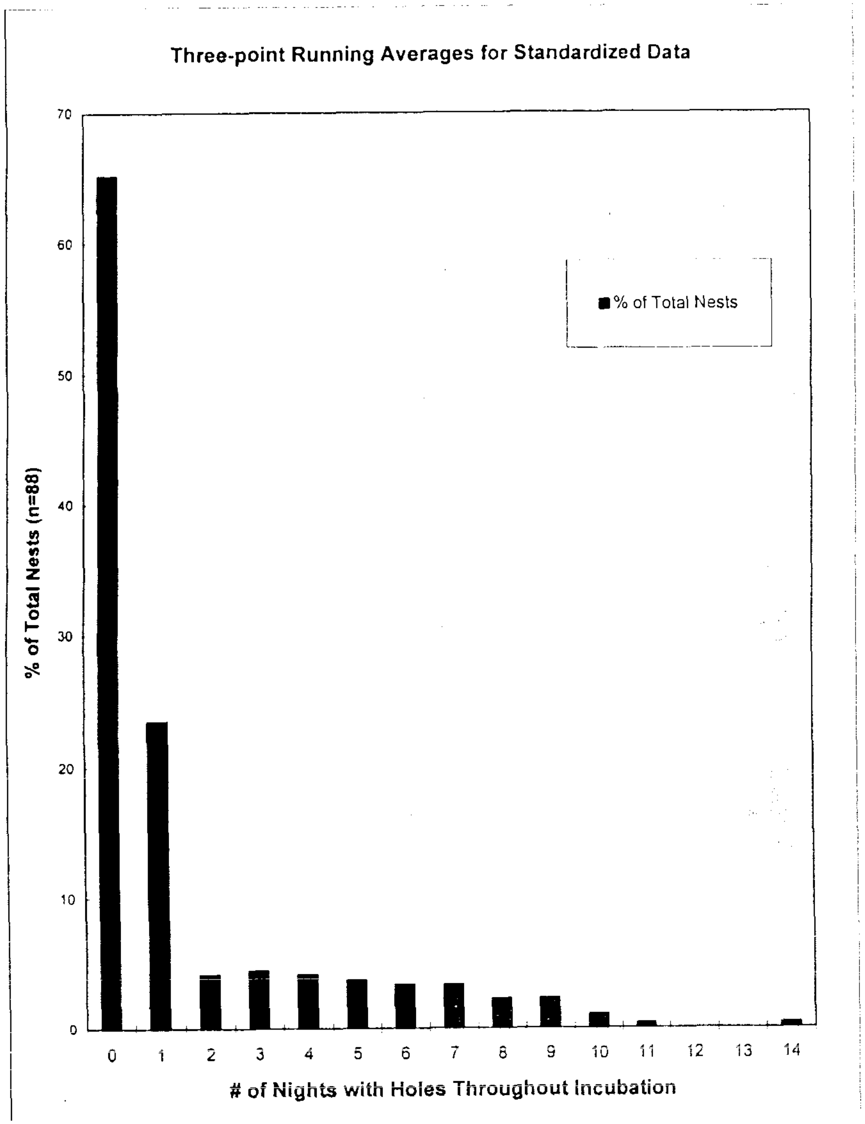
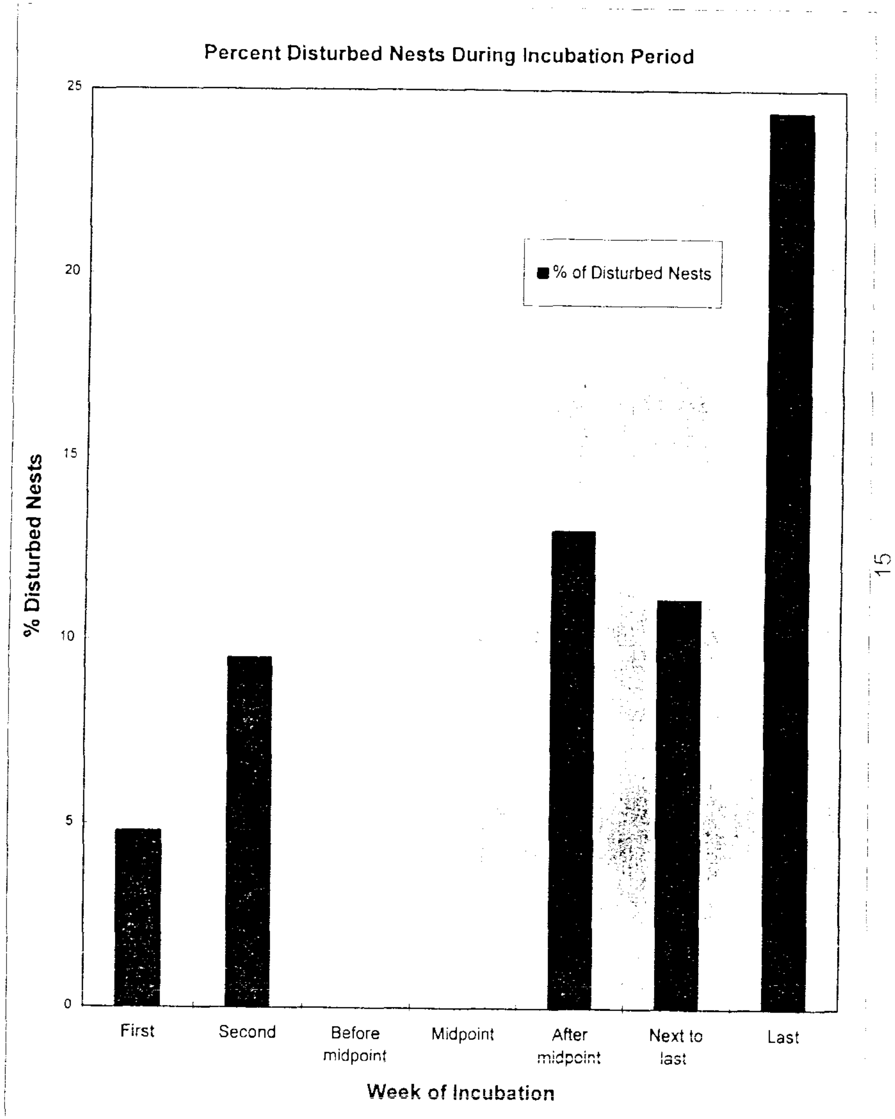


Figure 2 Most ghost crab activity occurred during the week of emergence, with 24.4% of the nests disturbed. Across the remaining weekly intervals, an average of 6.4% of the nests were disturbed each week.



LOGGERHEAD TURTLE NESTING TRENDS ON TOPSAIL ISLAND, NORTH CAROLINA : 1990-1995

Jean Beasley [1], Howard Malpass [1], and Gilbert S. Grant [2]

[1] Topsail Turtle Project, P.O. Box 2663, Surf City, NC 28445
[2] Department of Biological Sciences, University of North Carolina, Wilmington, NC 28403

Loggerhead turtles (Caretta caretta) nest along the east coast of the U.S. from Florida to North Carolina, and occasionally as far north as New Jersey (Ernst et al. 1994). Little has been published on the nesting biology of this species near the northern edge of its range. Schwartz (1989, 1995) and Grant et al. (1995) presented some North Carolina loggerhead turtle nesting data from the beaches of Topsail Island, Camp Lejeune, and Cape Lookout National Seashore. In this paper we present nesting data obtained during six seasons (1990-1995) from Topsail Island, North Carolina.

Volunteers with the Topsail Turtle Project reported nesting activities as they occurred along the entire 42km length of Topsail Island. Each nest was marked, roped off, and posted with a sign. Nests with eggs below the high tide line or in areas subject to significant negative human impact (walkways, large light sources, volleyball courts, etc.) were moved to safer environments on the beach. Relocated eggs were removed and transported in a careful manner to minimize rotational and thermal stresses to the developing embryo (Limpus et al. 1979). Near the end of the incubation period, nest sitters were in attendance at nests subject to human and light interference. Nest analyses were performed 3+ days after emergence. Eggs and eggshells were counted to determine clutch size, number hatched, percent emergence, and the number of live and dead hatchlings remaining in the nests. The Mann-Whitney two-tailed test was used to test for significance between two populations and the acceptance level was 0.05.

The numbers of nesting activities varied from 104 in 1993 to 194 in 1991. About one-half of all activities were false crawls (Fig. 1). Most nests and false crawls were initiated between 1 June and 31 July (Fig. 2,3). A higher proportion of false crawls were documented near the beginning (15-31 May) and end (1-31 August) of the nesting season (Fig. 3). Incubation periods (all nests) varied between and within years (Fig. 4, Table 1); eggs laid in June and early July required shorter incubation periods. Incubation periods in 1991, 1992, and 1994 were significantly longer than those of 1990, 1993, and 1995. Relocated nests experienced shorter incubation periods than did natural nests in all years (Table 2). Mean clutch size ranged from 119 eggs in 1995 to 131 eggs in 1990 (Table 1). Emergence rates of nests ranged from 87 to 91% for nests followed throughout the incubation period. Nests washed out during storms were not included in these figures. Complete nest losses due to storm washout events included 3 nests (1990), 9 nests (1991), 8 nests (1992), 7 nests (1993), 2 nests (1994), and 8 nests (1995). Emergence rates ranged from 79 to 87.5% when total egg loss due to storm washout was included in the analysis.

Year-to-year variation in the numbers of nesting activities is probably due in part to different cohorts of turtles. Only a small percentage of turtles nesting on Topsail have been tagged. It is unclear as to why a higher percentage of activities were false crawls in 1992 (Figure 1). Relatively more false crawls occurred early and late in the season, suggesting that it might be related to the physiological state of the turtle rather than to human activities or the condition of the beach. Eggs laid early and late in the nesting season were exposed to longer incubation periods, probably resulting in larger percentages of male hatchlings. The 1991, 1992, and 1994 nesting seasons were cooler and wetter, again resulting in longer incubation periods. Higher tides and excessive rainfall indirectly lower the sand temperature and thus would prolong incubation (Kraemer and Bell 1980). Incubation periods of eggs laid between 15 June and 15 July 1995 were unusually short (most 46-56 days), due to unusually hot and dry weather during this time. It is tempting to speculate that more female hatchlings were produced during this time. Relocated nests were placed higher on the beach and consequently experienced higher temperatures. Relocated nests had significantly shorter incubation periods during all years studied.

ACKNOWLEDGMENTS

We thank the many volunteers of the Topsail Turtle Project for aid in gathering the data and protecting the turtles.

LITERATURE CITED

Ernst, C.H., J.E. Lovich, and R.W. Barbour. 1994. Turtles of the United States and Canada. Smithsonian Institution Press, Was4hington, DC.

Grant, G.S., J. Beasley, and K. Beasley. 1995. Nesting success of loggerhead turtles on Topsail Island, North Carolina, pp. 188-191. In Richardson, J.I. and T.H. Richardson (compilers). Proceedings of the Twelfth Ann. Workshop on Sea Turtle Biology and Conservation. NOAA Tech. Memor. NMFS-SEFSC-361.

Kraemer, J.E. and R. Bell. 1980. Rain-induced mortality of eggs and hatchlings of loggerhead sea turtles (Caretta caretta) on the Georgia coast. Herpetologica 36:72-77.

Limpus, C.J., V. Baker, and J.D. Miller. 1979. Movement induced mortality of loggerhead eggs. Herpetologica 35:335-338.

Schwartz, F.J. 1989. Biology and ecology of sea turtles frequenting North Carolina, pp. 307-331. In George, R.Y. and A.W. Hulbert (eds.) North Carolina Coastal Oceanography Symposium. NOAA-NURP Rept. 89-2.

Schwartz, F.J. 1995. Analyses of 12 years of seasonal and spatial nesting patterns by loggerhead turtles Caretta caretta on Onslow Beach, Camp Lejeune, North Carolina, pp. 234-239. In Richardson, J.I. and T.H. Richardson (Compilers). Proceedings of the Twelfth Ann. Workshop on Sea Turtle Biology and Conservation. NOAA Tech. Memor. NMFS-SEFSC-361, 274 pp.?

Table 1. Summary of nesting parameters of loggerhead turtles on Topsail Island, NC, during 1990-1995 nesting seasons. Data presented as mean + standard deviation. Sample size in parentheses with year.

	1990(80)	1991(94)	1992(83)	1993(58)	1994(102)	1995(84)
Lay Date	180.2+21.7	183.9+20.2	186.1+20.9	185.7+16.9	181.6+22.0	176.2+20.4
Hatch D.	239.2+21.2	246.4+22.2	251.0+22.8	242.9+17.6	245.4+23.3	232.9+17.5
Incub. Per.	58.9+3.8	62.5+4.0	64.9+6.3	57.1+3.6	63.8+5.7	56.7+6.2
# Eggs	131.3+24.2	124.9+22.0	127.6+25.2	123.7+21.1	127.6+26.8	119.1+25.9
Emerged	115.4+24.2	114.3+23.4	110.9+28.3	109.7+23.4	114.0+29.1	104.8+28.0
%Emerged	87.8+11.7	91.2+9.9	86.7+15.5	88.9+13.0	89.2+12.1	87.5+15.3

Table 2. Incubation periods of loggerhead turtle nests on Topsail Island, NC, 1990-1995. Data presented as mean + standard deviation (sample size). All are significantly different (Mann-Whitney, $P < 0.05$).

Year	Natural Nests	Relocated Nests
1990	59.7 + 3.6 (57)	56.9 + 3.5 (22)
1991	63.0 + 3.8 (86)	58.0 + 3.5 (8)
1992	65.2 + 6.3 (76)	62.0 + 6.0 (7)
1993	58.0 + 3.5 (40)	55.1 + 3.4 (17)
1994	64.9 + 5.5 (74)	61.0 + 5.1 (28)
1995	58.3 + 5.9 (54)	53.9 + 5.9 (30)

Table 1. Summary of nesting parameters of loggerhead turtles on Topsail Island, NC, during 1990-1995 nesting seasons. Data presented as mean ± standard deviation. Sample size in parentheses with year.

	1990(80)	1991(94)	1992(83)	1993(58)	1994(102)	1995(84)
Lay Date	180.2±21.7	183.9±20.2	186.1±20.9	185.7±16.9	181.6±22.0	176.2±20.4
Hatch D.	239.2±21.2	246.4±22.2	251.0±22.8	242.9±17.6	245.4±23.3	232.9±17.5
Inc.Per.	58.9±3.8	62.5±4.0	64.9±6.3	57.1±3.6	63.8±5.7	56.7±6.2
# Eggs	131.3±24.2	124.9±22.0	127.6±25.2	123.7±21.1	127.6±26.8	119.1±25.9
Emerged	115.4±24.2	114.3±23.4	110.9±28.3	109.7±23.4	114.0±29.1	104.8±28.0
%Emerged	87.8±11.7	91.2±9.9	86.7±15.5	88.9±13.0	89.2±12.1	87.5±15.3

Table 2. Incubation periods of loggerhead turtle nests on Topsail Island, NC, 1990-1995. Data presented as mean ± standard deviation (sample size). All are significantly different (Mann-Whitney, $P < 0.05$).

Year	Natural Nests	Relocated Nests
1990	59.7 ± 3.6 (57)	56.9 ± 3.5 (22)
1991	63.0 ± 3.8 (86)	58.0 ± 3.5 (8)
1992	65.2 ± 6.3 (76)	62.0 ± 6.0 (7)
1993	58.0 ± 3.5 (40)	55.1 ± 3.4 (17)
1994	64.9 ± 5.5 (74)	61.0 ± 5.1 (28)
1995	58.3 ± 5.9 (54)	53.9 ± 5.9 (30)

Figure 4. Loggerhead turtle incubation periods 1990-1995 on Topsail Island, NC.

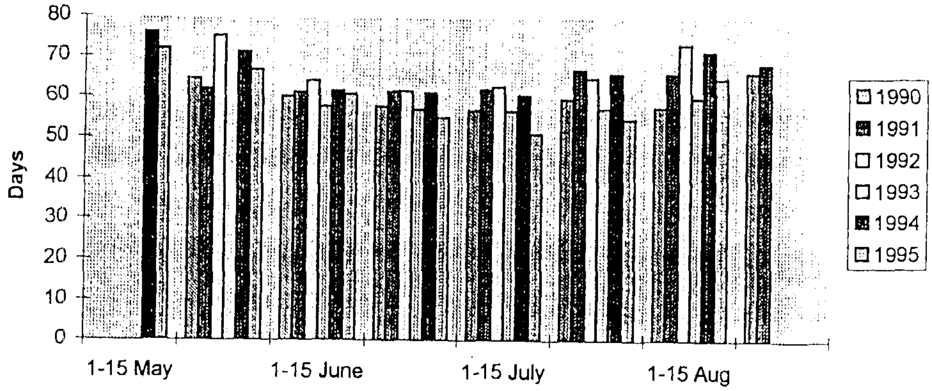


Figure 1. Loggerhead nesting activities on Topsail Island, NC.

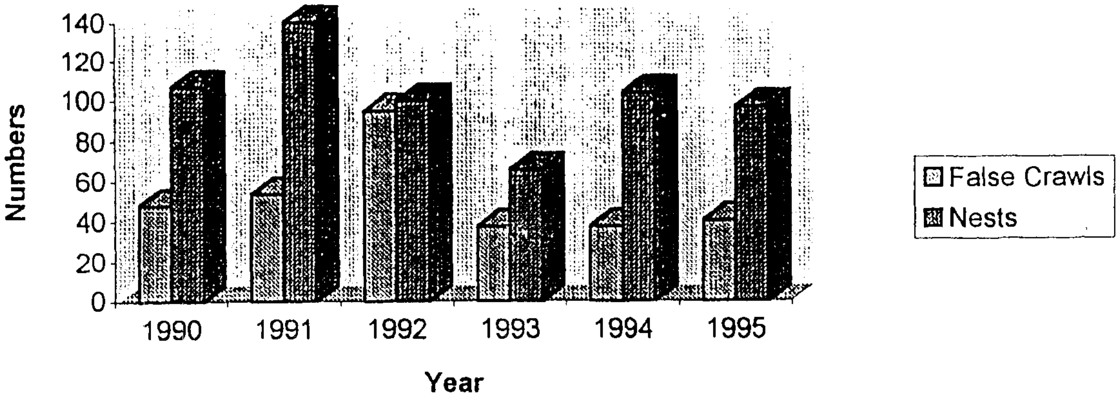


Figure 2. Loggerhead turtle nests by two-week intervals on Topsail Island,NC.

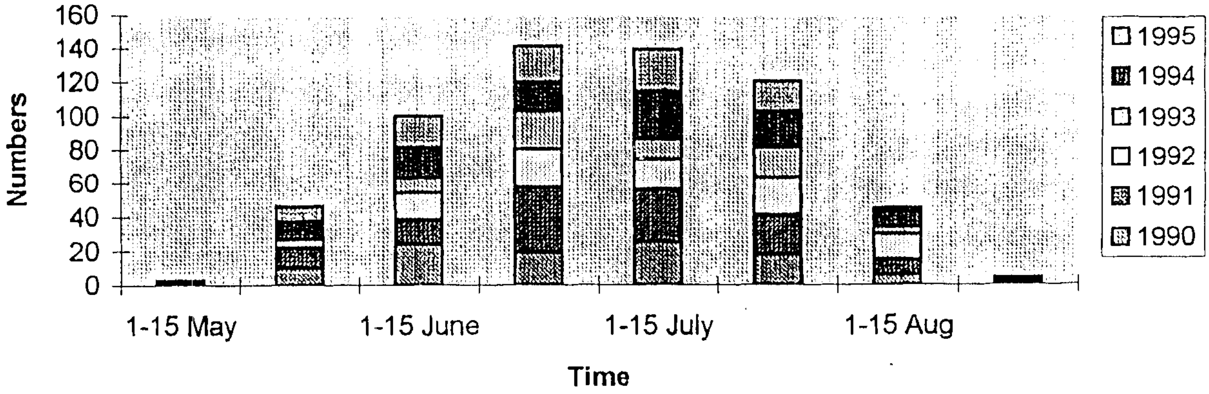
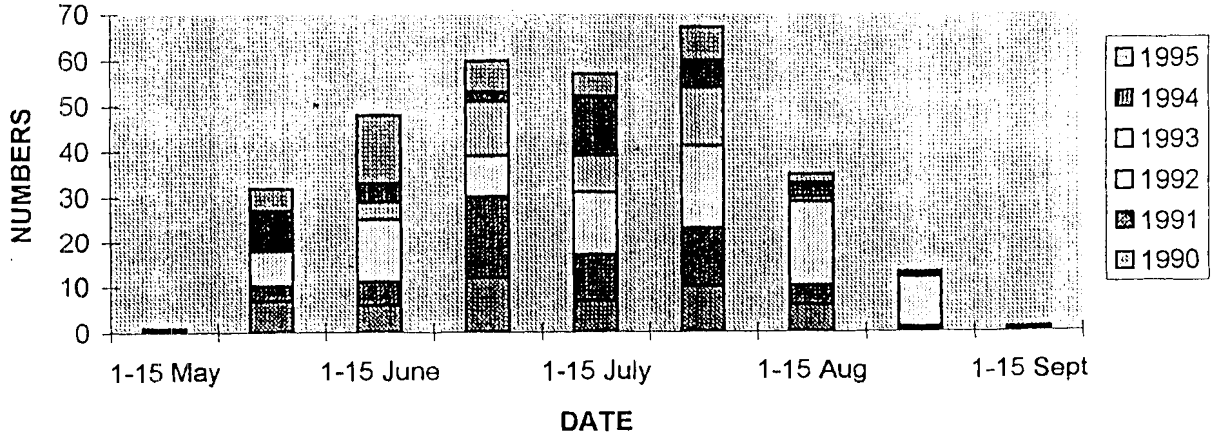


Figure 3. Loggerhead turtle false crawls by two-week intervals on Topsail Island.



TRACKING REHABILITATED SEA TURTLES IN THE MEDITERRANEAN SEA

Flegra Bentivegna[1], Valentina Cianciulli[1], Lisa M. Davis[2], and Angela Paglialonga[1]

[1]Stazione Zoologica, 'Anton Dohrn' Villa Comunale 80121 Naples, Italy
[2]Emory University Dept. of Anatomy and Cell Biology, Atlanta, GA 30322

INTRODUCTION

In 1983 the Naples Aquarium of the Anton Dohrn Zoological Station (Stazione Zoologica) started a program whereby wounded loggerhead sea turtles, Caretta caretta, from the Gulf of Naples are recovered, rehabilitated, and released. These turtles are commonly victims of maritime traffic, pollution, or are wounded by nets, fishing hooks, or plastic bags (Bentivegna et al. 1992;1993). Every year since 1983, the rehabilitated sea turtles have been released without any type of tracking device. We know that Caretta caretta do not come to the Gulf of Naples to reproduce, but probably to graze (Bentivegna et al. 1994). It is likely that they come from the Mediterranean basin where there are numerous egg deposition sites (Venizelos, 1991). To verify this hypothesis we started tracking a loggerhead in October 1995 using satellite telemetry. This research follows the first attempt to track a loggerhead in the Mediterranean Sea by satellite which was carried out by Hayes et al. (1991) where a single turtle was followed for 58 days in the area of Cephalonia, Greece to examine inter-nesting movements.

METHODS

Our program began on October 1, 1995 and will continue through the end of March 1996. The turtle we are tracking has a curved carapace length of 73 cm, width of 63 cm, and weighs 43.7 kg. She is equipped with a Telonics platform transmitter terminal (PTT) model ST-6 with salt water switch (12.5 cm long x 5.2 cm wide x 3.9 cm high, weighing 325 g). Satellite transmissions are monitored using the ARGOS tracking system utilizing NOAA satellites that guarantee complete coverage of the Earth's surface. Each satellite is equipped with a data collection and location system (DCLS) which receives and records signals from the PTT when visible during an overpass. Everyday we receive the location of the loggerhead, the surface water temperature, dive time, and average dive time.

RESULTS AND DISCUSSION

Immediately after the release, the turtle turned southeast and swam continuously for 2 months (October-November). Maintaining an average speed of 1 km per hour, she arrived at the coast of Peloponnesus and continued to the island of Crete. These preliminary observations seem to confirm that most loggerhead turtles which are found in the mid-southern to southern regions of the Tyrrenian Sea come from the eastern basin of the Mediterranean Sea. Tagged female C. caretta nesting in Greece (Margaritoulis, 1988) have been shown to disperse over a wide area of the central Mediterranean extending west to Sardinia. At the present time, satellite tracking shows that our turtle is making short-range movements, tending to remain between Crete and northeast Libya. It is likely that in light of the winter season, C. caretta remain in an area where the average surface temperatures (16-18C) are higher than in other areas of the Mediterranean due to an isolated yearly isotherm averaging 20C (Tortonese, 1951). This research is still in progress and new data will be forthcoming.

LITERATURE

Bentivegna, F., P. Cirino & A. Toscano, 1992. Sea Turtles in the Naples Aquarium: conservation policy. European Union of Aquarium Curators, Naples 10-16 October 1992.

Bentivegna, F., P. Cirino & A. Toscano, 1993. Care and treatment of loggerhead sea turtles from the Gulf of Naples, Italy. Marine Turtle Newsletter 61: 6-7.

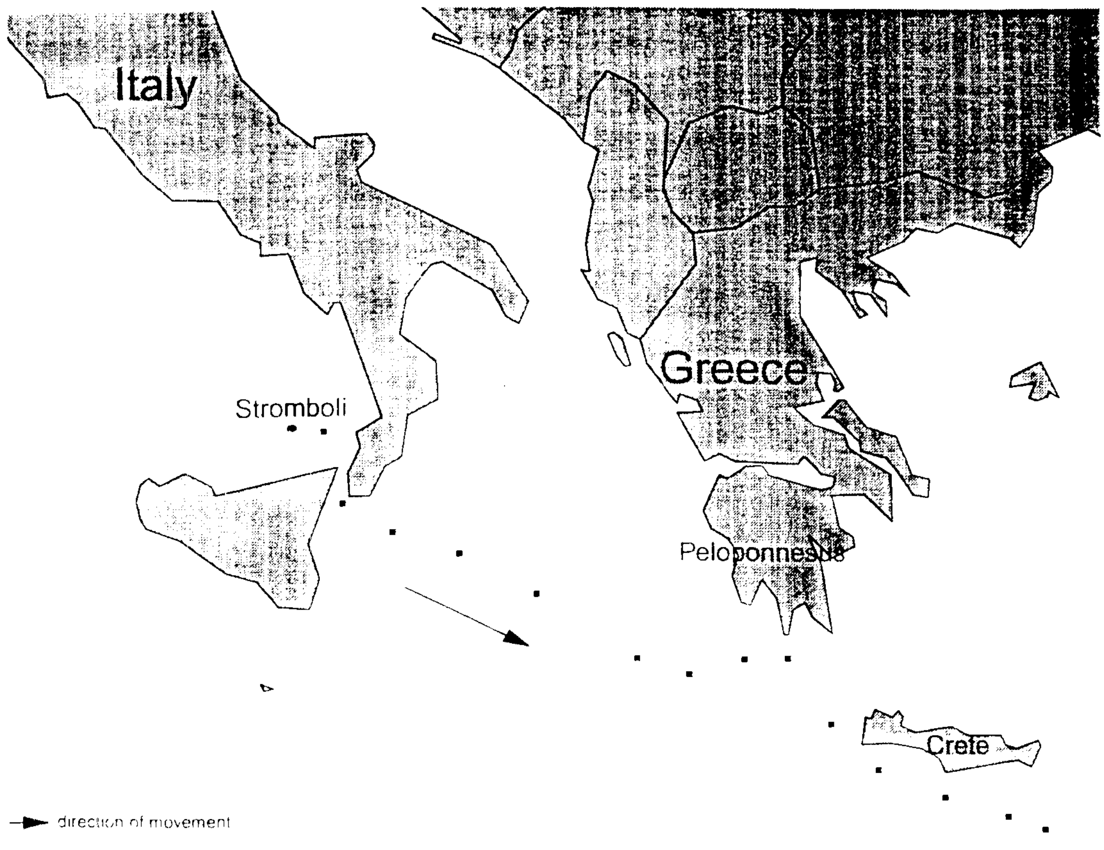
Bentivegna, F., P. Cirino & A. Toscano, 1994. Threats to Caretta caretta in the Gulf of Naples. Proceedings of the 14th Annual Symposium on Sea Turtle Biology and Conservation. 1-5 March 1994. Hilton Head, South Carolina.

Hayes G. C., P. I. Webb, J. P. Hayes, I. G. Priede & J. French, 1991. Satellite tracking of a loggerhead sea turtle (Caretta caretta) in the Mediterranean. J. Mar. Biol. Assoc. U.K., 71: 743-746.

Margaritoulis, D., 1988. Post-nesting movements of Loggerhead Sea Turtles tagged in Greece. Rapports et Proces-Verbaux des Reunions. Condenses des travaux presentes lors du XXXI Congres-Assemblee Pleniere Athenes (Grece). Volume 31(2): 284, VIII3. C.I.E.S.M., Monaco.

Tortonese, E., 1951. I caratteri biologici del Mediterraneo orientale e i problemi. Attual. Zool., 7: 207-251.

Map: Point-by-point route of navigation of tracked loggerhead.



LEATHERBACKS (Dermochelys Coriacea) ON ST. CROIX, U.S. VIRGIN ISLANDS: 1981 TO 1995

Ralf H. Boulon, Jr.[1], Peter H. Dutton[2], and Donna L. McDonald[1]

[1]Department of Planning and Natural Resources, Division of Fish and Wildlife, 6291 Estate Nazareth 101, St. Thomas, USVI 00802-1104 USA
[2]NOAA-NMFS-SWFSC, P.O. Box 271, La Jolla, CA 92038

From 1981 to 1995, saturation tagging and consistent night patrols have provided information on every leatherback turtle (Dermochelys coriacea) nesting at Sandy Point National Wildlife Refuge, St. Croix, U.S.V.I.. Data are obtained on adult lengths and weights, seasonal number of nests per female, internesting interval, clutch size, incubation period, and hatch success. A total of 358 individual leatherbacks has been tagged since 1979, with 18 to 55 females per season. Annual remigration rates averaged 34.1%, and the most common remigration interval was 2 years. Fifty-eight percent of all turtles nesting on Sandy Point were only documented during one season. Of the remainder, most were documented for two seasons, although two turtles have nested in seven seasons. A small number of turtles (< 12) encountered on Sandy Point were originally tagged on other beaches on St. Croix and on nearby islands. Several turtles originally tagged on Sandy Point were later observed to nest in Vieques, Culebra, and Anguilla, British West Indies. One turtle stranded in New Jersey, and another was caught by a fisherman in Mexico. Nearly half of the nests on Sandy Point were relocated to prevent loss due to predictable annual cycles of sand erosion and redeposition. Project efforts have reduced nest loss due to erosion to less than 5%, and eliminated poaching of nests. We estimate that approximately 130,200 hatchlings emerged at Sandy Point from 1982 to 1995, possibly double the number that would have been produced without these efforts. This may be reflected in the increased numbers of nesting females since 1991, and this trend may provide clues as to age of maturity for this species.

VARIABLE NEST DAMAGE AND DIFFERING RESPONSE PATTERNS BY ADULT FEMALE HAWKSBILL SEA TURTLES (Eretmochelys imbricata) IMPACTED BY TWO HURRICANES STRIKING A NESTING BEACH IN ANTIGUA, WEST INDIES

Amy L Brown[1], Heather Mayers[2], and Jim I Richardson[3]

[1]PO Box 774164, Steamboat Springs, Colorado 80477
[2]797 Orange Street, New Haven, Connecticut 06511
[3]University of Georgia, Institute of Ecology, Athens, Georgia 30602

INTRODUCTION

Since 1987, the Jumby Bay Hawksbill Project has been studying the nesting behavior and ecology of hawksbill sea turtles on Pasture Bay Beach, Long Island (a 300 acre, privately- owned island, 2 km off the northeast coast of Antigua, West Indies). Pasture Bay Beach faces east and northeast toward the prevailing tradewinds. It is made up of natural Aragonite sand with a series of seagrape "islands" and a portion of original beach forest remaining after extensive vegetation removal in the 1970's. Exotic dune grass and young, native seagrapes were planted in recent years in a significant effort to retard beach erosion.

Hurricanes are occasional, but regular, violent events affecting beach configuration and nesting sea turtles in the Caribbean. Because of the threat of physical harm to themselves and their nests on exposed beaches, it would not be surprising if the turtles possess adaptive responses to occasional hurricanes. These responses might be expressed as behavioral changes in normal nesting rhythms. Hurricane Hugo in 1989 and Hurricane Luis in 1995 provided an opportunity to look for such behavioral responses.

METHODS

A yearly, 5-month, intensive tagging program, running 15 June - 15 November, has been in progress since 1987. Information on weather condition, water temperature, rainfall and beach condition are gathered on a nightly basis, along with all turtle activity on the research site including false crawls, nests laid and nest hatches. Every nest laid on Pasture Bay beach is marked with a cord for location and an identification number to distinguish it from all other nests.

Approximately 20-40 nesting females use Pasture Bay beach each year during the 150-day patrol season, although some nesting occurs on all months of the year. On average, 20% of all recorded females nesting in a single year are untagged, first-time seen nesters.

All information gathered on the effect of Hurricane Hugo and Hurricane Luis is incidental or contained in normal data collection.

RESULTS AND DISCUSSION

Hurricane Hugo: Hurricane Hugo was an enormous storm. The eye of the storm passed 38 miles SW of the island. The winds struck from behind the nesting beach. Damage to nests on the beach at the time of the storm was virtually nonexistent. Possibly three nests close to the water's edge were lost as a result of tidal surge. A normal hatching event was recorded on the first night after the passing of the storm. Damage to the beach forest from storm surf was minimized by a thick root mat armoring the forward edge of the erosion bluff.

Isolated trees were left with exposed roots, but this would never have occurred if the beach forest had not been cleared in the past. In fact, wind blown sand was deposited lightly on top of leaf litter beneath clumps of seagrape, possibly providing additional protection for incubating clutches of eggs. In retrospect, Hurricane Hugo may have improved the Pasture Bay nesting beach.

It was observed following the 1989 nesting season that adult female hawksbill known to be in the vicinity of the nesting beach at the time of the hurricane displayed a significant increase in their inter-nesting interval (fig. 1). For example, turtles involved in the 14-day wait period between nesting events while Hugo passed Antigua required approximately two days longer (±14 days) prior to and following the hurricane date (fig. 2). We hypothesized from this observation that Antigua hawksbills found shelter during the storm at some significant depth below water for several days, effectively shutting down their metabolic activity during this extended period of submergence, including the process by which the eggs are fertilized and provided with shells for deposition on the beach.

Hurricane Luis: The night of September 3/4, 1995 hawksbill turtle PPN047 laid the last recorded pre-hurricane nest. The following day, damaging winds struck from NNW to W, a frontal blow to the seagrape and mixed shrub communities that are most heavily used by nesting turtles. Based on the direction of their fall, it was determined that seagrape clumps were uprooted early in the storm. Mixed shrub communities, normally a dense cover growing to the water's edge, were completely removed for a distance of 5-8 m, leaving the fore edge of the beach exposed. Sand in this area was relocated by wind and waves and deposited as a berm 10-20 m from the water's edge.

An estimated 47 nests (roughly 7000 eggs) were on the beach in various stages of development when Luis struck. Nearly all were lost because of the violent reconfiguration of the beach. Nesting is normally clustered beneath "islands" of seagrape close to the water's edge or in a band of mixed woody shrubs and trees within 10 m of the high tide line. Heavy surf and a tidal surge attacked the dune previously sheltered beneath the seagrapes, and all nests were either washed out or drowned in this area.

Beginning ten 10 m from the water's edge, sand was piled to an approximate depth of 60 cm on top of pre-hurricane nesting areas, beneath impenetrable tangles of uprooted trees and woody shrubs. Hatchlings, if not drowned as embryos during the storm, were probably entombed by the overburden of sand and brush in these areas. Perhaps 10 nests on the beach during the hurricane managed to produce a limited number of hatchlings for the season, but the nest sites could not be located for analysis beneath the entangled brush and debris. Fifty-six nests (estimated 8,400 eggs) were recorded from 11 September to 15 November following Hurricane Luis. With an average hatching success in excess of 80% estimated for the nests laid on the research site, perhaps 7,000 hatchlings were produced in 1985 from Pasture Bay in spite of the hurricane. Accurate hatchling production figures were not available because we were required to close the season on 15 November, approximately 2 months after the storm and just as the first post-Luis nests might have been expected to emerge.

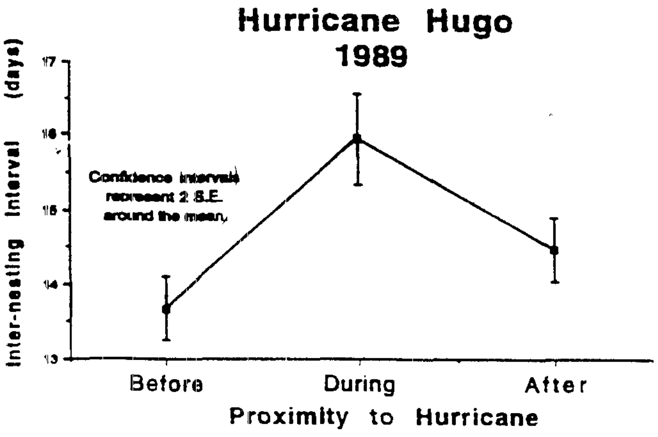
Only a single "regular" turtle failed to appear for predicted nesting visits following the hurricane. Other turtles crawled to overturned trees and were denied access beneath the vegetation (their usual nesting areas) because of impenetrable walls of interlaced roots and branches. As a result, turtles nested wherever they struck root walls, thus placing nests in areas of full sun and exposed beach. They also nested beneath chairs and other resort beach paraphernalia. The effect on sex ratios was not measured.

Hurricane Luis provided the ideal opportunity to see if the Pasture Bay hawksbills again delayed the egg preparation period (inter-nesting interval) by several days during violent weather (fig. 3). Analyzing the results (fig. 1), there was no significant difference in the inter-nesting interval completed before, during, and after Luis passed Antigua, even though this 1995 hurricane was more violent than Hugo in 1989.

We can speculate to one slim possibility for the results. If the nesting females move to the south of mainland Antigua, staying close to the coastline during the inter-nesting interval, they will find deeper water here in this area of the coast. Hurricane Hugo, the weaker of the two storms, struck from the south, causing a significant swell to the deep water. Hurricane Luis struck from the north, allowing the deep water of the south coast to fall within the lee of the storm. As such, the turbulence in this area in 1995 would have been significantly less than in 1989. Perhaps sufficient to allow the waiting turtles to remain physiologically active during the passing of Luis.

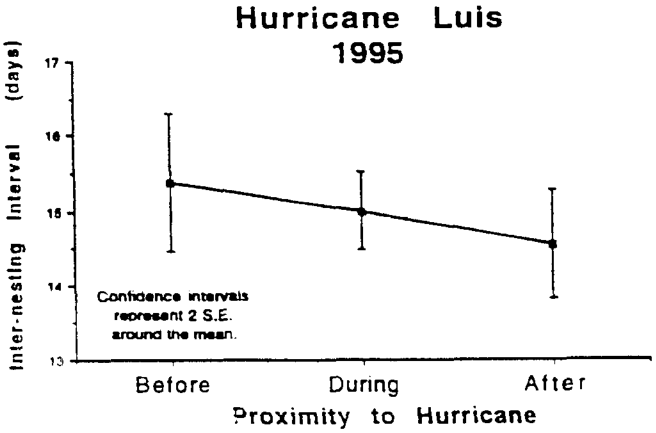
CONCLUSION

We were unable to prove our hypothesis because the data did not result in a significant difference. The storms did not travel in the same exact path and this could have made an impact on the results. We have speculated what may have happened based on the information we collected. We feel this is an interesting approach and one that no one has ever studied before. We hope this will lead to more questions and challenge others to explore.



Hurricane Hugo 1989

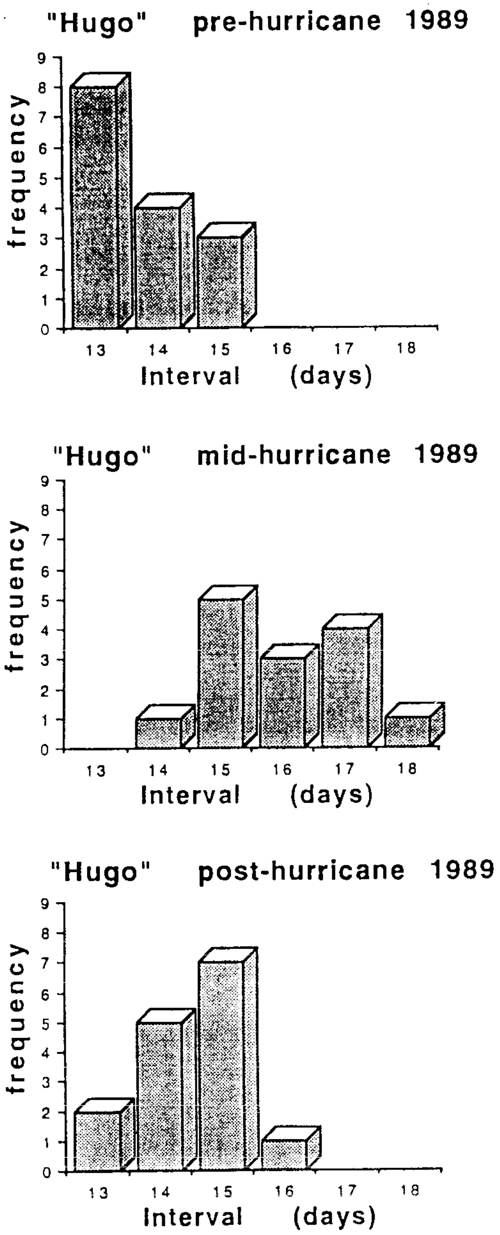
Confidence intervals represent 2 S.E. around the mean.



Hurricane Luis 1995

Confidence intervals represent 2 S.E. around the mean.

FIGURE 2

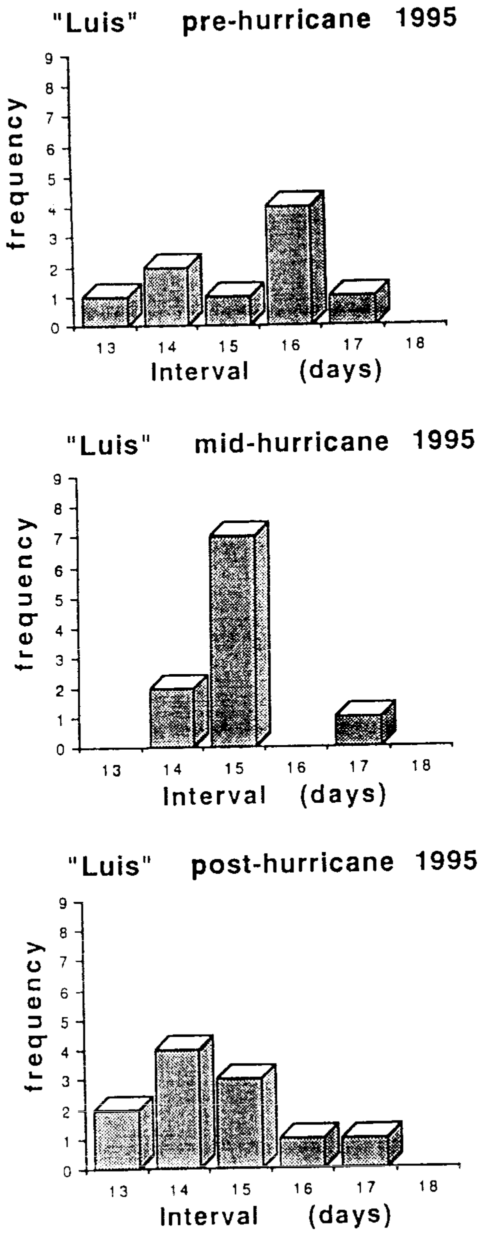


"Hugo" pre-hurricane 1989

"Hugo" mid-hurricane 1989

"Hugo" post-hurricane 1989

FIGURE 3



"Luis" pre-hurricane 1995

"Luis" mid-hurricane 1995

"Luis" post-hurricane 1995

TURTLES & TOURISTS: ASSESSING ECOTOURISM POTENTIAL AT OSTIONAL, COSTA RICA

Lisa M. Campbell

Department of Geography, University of Cambridge, Downing Place, Cambridge CB2 3EN, UK

INTRODUCTION

Ecotourism is tourism undertaken for the primary purpose of viewing wildlife and natural areas. It is an appealing concept to wildlife conservationists for two reasons: (1) it can provide economic incentives for communities to leave local resources in a natural state; and (2) it can reduce dependence on existing more consumptive forms of resource use. The idea is particularly appealing in rural developing areas where 'preservationists' have long been accused of being anti-development, and of ignoring the legitimate economic needs of local populations. Within the turtle community, the majority of ecotourism research to date has focused on the impacts of tourism development and activities on turtles (e.g., Campbell 1994; Johnson et al 1994). The purpose of this research was to consider the socio-economic implications of turtle based ecotourism development, and what they might mean for long-term conservation.

METHODS

This research was conducted in Ostional, Costa Rica, from October 1994 - March 1995, and from July 1995 - September 1995. The purpose was three-fold: (1) to measure current levels of tourism to Ostional, and to estimate the economic value; (2) to assess community perceptions of the growing tourism industry; and (3) to assess the ability of tourism to reduce dependence on the primary current resource use, the legalized olive ridley sea turtle egg harvest. The primary research method was a survey conducted at 76 (of 90) households. In-depth interviews were conducted with 22 individuals.

RESULTS AND DISCUSSION

Current Levels of Tourism in Ostional - Overnight tourism in Ostional was measured from January to August 1995 (data for Sept. to Dec. to be added). Total person nights for the period was 626, and monthly variation corresponded to local impressions of the tourist season. National tourism is high during January/February, the Costa Rican dry season. International tourism begins to increase during June, July, and August, corresponding with the North American and European summer holidays. However, most international tourists come to view turtles, and further data should reveal an increase in international tourism during the major nesting months of September and October. The value of overnight tourism during the study period was 630,500 colones.

Local impressions are that tourism is increasing annually, and is reflected in the construction of tourist services from year to year. Pre-1994 there was only 1 set of cabinas. Since 1994, the original sets capacity has been doubled, 2 further sets of cabinas have been built, a local soda (café) opened, and 2 foreign-owned restaurants have been constructed. Money earned by cabina operators is substantial and both operators now identify tourism as their most important source of income. For the period January - May 1995, the egg harvest and tourism were worth 60,000 colones and 262,000 colones respectively for one cabina owner, and 40,000 colones and 368,500 colones respectively for the other.

Local Perceptions of Tourism Opportunities and Benefits - Whether or not local people will benefit from or control tourism development will be influenced by perceived tourism opportunities, and individual desire and ability to participate in them. When asked to identify potential opportunities, 32% of respondents could not identify any opportunities, 27% identified only 1, and 22% identified 2. Potential jobs identified included guiding (by 45% of respondents), cooking (32%), providing accommodation (24%), making crafts (11%), and providing information (8%). For all identified tourism opportunities, more people could identify them than were willing to work in them. For example, only 9% of respondents said they would work as a guide, as opposed to 45% who identified it as an opportunity. 37% of respondents said there was no tourism job they would do, and 37% said they would work in "anything."

When asked to identify impediments to working in tourism, most people (64%) identified only 1. Family responsibilities (24%), lack of time (21%) and lack of training (20%) were seen as the biggest impediments. Only 11% and 5% of respondents identified monetary or legal impediments respectively, 2 very real restrictions on tourism development in Ostional, given a minimal and unreliable cash income base, and legal restrictions on land ownership and development within a National Wildlife Refuge.

Perceptions of tourism impacts will also influence tourism development. If locals see tourism as beneficial they will be more likely to support and even participate in tourism development. Respondents were asked to evaluate the impacts of tourism on the turtles, the economy, and the community. Overall, opinions on tourism were positive or neutral (meaning good and bad), and generally uncritical. Twenty-one percent of people identified negative impacts of tourism on turtles. This figure later contrasts with only 5% of respondents who independently suggest an increase in tourism could hurt the turtles. Twenty-four percent of respondents suggest tourists spend money in Ostional. This is equal to the number of respondents who later identify money and work as the best thing about tourism. Very few respondents could identify specific reasons that they thought tourism was good for the community. The small percentage of respondents suggesting tourism had negative social impacts (8%) contrasts with 17% of respondents who later identified social problems as the worst aspect of tourism.

Reducing Dependence on the Egg Harvest Project - Ostional Village is highly dependant on the egg harvest project, with 69% of households identifying it as the primary source of income. Thus, ecotourism could provide needed diversification to the Ostional economy. Furthermore, most people in Ostional would like to see tourism increase, although the high number of respondents supporting an increase (72%) contrasts with 12% of respondents who independently identify tourism as a form of future development they would like to see.

While most of the community supports an increase in tourism, the scope to benefit from further development may be limited. While tourism is increasing, existing cabinas were never fully occupied, and the third set will add five rooms to the accommodation pool. Building cabinas is also financially beyond the reach of most of the community. Thus, it is not immediately evident that more cabinas are necessary, nor that local people can invest in them. There does appear some scope for investment in dining facilities. This niche, however, is quickly being filled by foreigners, with two foreign owned restaurants opened since July 1995.

There are also limited prospects for guiding. While guiding has been organized in the village, and was recognized as a potential tourism opportunity, it was non-operational during the study period. While locals believed this was due to a lack of organization, guiding was also problematic due to the nature of the beach itself. Because most turtle seeking tourists come during arribadas, it is difficult to convince them of the need for a guide. Turtles are easily found, and difficult to frighten.

Results from the survey show that locals fear tourism in Ostional could threaten the turtles, and the egg harvest project. When asked about current conflicts between the egg harvest project and tourism, 63% thought there was no conflict, and 20% of respondents suggested tourism pose threats to the project (tourists not liking it, Costa Rican tourists wanting to take eggs, and tourist construction). When asked about future conflict, however, only 24% suggest there will be no conflict, while 45% feel tourism will pose threats as it increases. Given that 69% of people depend on the egg harvest and only 4% identify tourism as a primary source of income, the number of people supporting an increase in tourism while simultaneously believing an increase could threaten the egg harvest project is surprising. Development possibilities in Ostional are limited, however, and tourism is growing with little effort on behalf of the community. Thus, it is a realistic and even attractive option now. The optimistic feelings about tourism could change if the predicted conflicts manifest themselves.

LITERATURE CITED

Campbell, C.L. 1994. "The effects of flash photography on nesting behavior of green turtles (Chelonia mydas) at Tortuguero, Costa Rica" in Proceedings of the 14th Annual Symposium on Sea Turtle Biology and Conservation, K.A. Bjorndal, A.B. Bolten, D.A. Johnson, P.J. Eliazar [compilers], NOAA Technical Memorandum NMFS-SEFSC-351.

Johnson, S.A., K.A. Bjorndal, & A.B. Bolten, 1994. "Influence of organized turtle watches on loggerhead nesting behavior and hatchling production in Florida" in Proceedings of the 14th Annual Symposium on Sea Turtle Biology and Conservation, K.A. Bjorndal, A.B. Bolten, D.A. Johnson, P.J. Eliazar [compilers], NOAA Technical Memorandum NMFS-SEFSC-351.

CAPTURE OF JUVENILE KEMP'S RIDLEYS IN THE NEARSHORE WATERS OF APALACHEE BAY, FLORIDA

Cathi L. Campbell

Southeastern Biological Science Center, National Biological Service, 7920 NW 71st Street, Gainesville, FL 32653

INTRODUCTION

The Kemp's ridley sea turtle (Lepidochelys kempii) is the most endangered of the seven extant marine turtle species (Ross et al. 1989). Lack of knowledge about early life stages of the Kemp's ridley sea turtle currently hinders recovery efforts for this federally-listed species. In the species recovery plan for the Kemp's ridley [U.S. Fish and Wildlife Service and National Marine Fisheries Service (NMFS), 1992], the recovery team identified in-water, live capture studies as a Priority I Task for recovery of the species to determine seasonal use of nearshore habitat by juveniles and subadults. Juvenile and subadult Kemp's ridleys are known to use the shallow nearshore waters of the northwest and central west coast of Florida (Ogren 1989, Rudloe et al. 1991, Schmid and Ogren 1991). In the nearshore waters of Cedar Key, Florida, Schmid and Ogren (1991) have been conducting a long-term study of wild subadult Kemp's ridleys. This is one of few studies that has characterized the population of Kemp's ridleys using developmental habitat in the region. The current study was undertaken as part of a collaborative effort between the Southeast Fisheries Science Center, NMFS, Panama City, Florida, and Southeastern Biological Science Center, NBS, Gainesville, Florida, to establish sampling methods for development of population indices for monitoring Kemp's ridleys in the Florida Panhandle.

The objectives of this study were to: (1) identify potential capture sites by sighting turtles as they surfaced, interviewing local fisherman, and net sampling; (2) determine size distribution and relative abundance of Kemp's ridleys; and (3) identify movement patterns through mark-recaptures of Kemp's ridleys in Apalachee Bay and adjacent bays.

MATERIALS AND METHODS

Netting was conducted primarily from mid-August through October 1995. Data from 26-27 June 1995 are also included in this study because the same area was sampled for fish species diversity and abundance using identical sampling methods. A total of five sites were sampled using mesh entanglement nets: Dickerson Bay, Levy Bay, near Fiddler's Point (entrance to Dickerson/Levy Bays), adjacent to Whetstone Point, and adjacent to the lighthouse in St. Marks National Wildlife Refuge (SMNWR). Other sites were attempted but aborted due to strong tidal currents. Nets used in sampling measured 45-60 m in total length with 10-25 cm bar length. Nets were set most often across narrow channels and shallow grass beds in 0.5-2.7 m water depth. Substrate data were collected from these sites whenever possible.

Turtles were checked for evidence of previous tagging, e.g., living, flipper, and PIT (Passive Integrated Transponder) tags. If flipper tags were not present, inconel flipper tags (National Band and Tag Co., supplied by NMFS, Miami) were placed on the trailing proximal edge of both anterior flippers. If a PIT tag was not detected by scanning the anterior flippers and shoulder region then one was placed subcutaneously in the dorsal left anterior flipper. Measurements including straight and curved carapace lengths and widths, plastron lengths, and mass were collected.

RESULTS

Twenty-one sightings of Kemp's ridleys were recorded in the sites where netting was conducted. We did not count multiple sightings of the same individual when this could be determined by observing surfacing patterns. Most of the sightings (76.2%) occurred at Fiddler's Point. No turtles were sighted in Levy Bay or Dickerson Bay. Turtles were observed foraging nearshore or traveling in or near channels.

Approximately 143 hours were spent netting. The majority (65.2%) of netting was conducted at Fiddler's Point (32.7%) and Levy Bay (32.5%) followed by Dickerson Bay (20.4%), Lighthouse at SMNWR (7.4%), and Whetstone Point (7.0%). A total of six turtle net captures occurred for an overall capture rate of 0.042 turtles/h. All six captures occurred at Fiddler's Point and Levy Bay with capture rates of 0.086 turtles/h and 0.043 turtles/h, respectively. No turtles were captured at Dickerson Bay, SMNWR Lighthouse, or Whetstone Point (although sampling effort was relatively low at the last two sites).

Four captures occurred at Fiddler's Point (including one recapture) and two occurred in Levy Bay. L. kempii was the only species of marine turtle captured. Turtles ranged in size from 29.3 - 8.8 cm maximum straight carapace length and weighed 4.5 - 8.6 kg. Turtles were captured in shallow waters from 1 - 2 m in depth over either a seagrass or sand/mud substrate. Of the five individuals captured, three were headstarted turtles, and all were captured at the Fiddler's Point site. The headstart turtles were identified from either PIT, flipper or living tags. They were from the 1991, 1992 and 1993 year classes and therefore ranged from approximately 2 - 4 years of age (C.W. Caillouet pers. com.). The remaining two turtles, captured in Levy Bay, are presumably wild because there was no evidence of previous tagging.

DISCUSSION

Carapace lengths of Kemp's ridleys captured in this study (29.3-38.8 cm) are within the size range of turtles captured in this same area by Rudloe et al. (1991). However, compared to Rudloe et al. (1991), we captured a proportionally higher number of headstarted ridleys (60% compared to 15%) of longer carapace lengths, 29.3 - 38.8 cm compared to 24.1 - 29.7 cm. However, these differences may be the result of small sample sizes and not reflective of the true headstart population in the study area.

The proportionally higher incidence of ridleys both sighted and captured at the Fiddler's Point site indicate a potential area for long-term monitoring. Levy Bay is also an area that should be sampled in future years because Rudloe et al. (1991) also captured juvenile ridleys here. However, this may not be the case for Dickerson Bay where we were unsuccessful in capturing ridleys while Rudloe et al. (1991) captured as many in this bay as in Levy Bay. Possibly, Dickerson Bay has changed in resource availability for Kemp's ridleys or our sampling effort was insufficient. Netting sites where turtles were observed (i.e., Whetstone Point and SMNWR lighthouse) are also recommended for future netting efforts.

The high proportion of headstart turtles captured in the study area are of particular interest because little information is available on survival rates of headstart turtles and after some 20 years of headstarting, no headstart turtles have been detected nesting on the primary nesting beach at Rancho Nuevo, Mexico (Eckert et al. 1994). The ease at which we can identify headstart turtles by their living tags is also important because the ability to detect these tags as the turtles mature remains unproven. Information on survival and fitness of headstart turtles compared to wild turtles is valuable for future species recovery efforts.

Although we had a low capture rate, we improved our sampling methods over a relatively short time. Modifications of our methods included netting next to shore where we had previously observed turtles and along channel slopes. Modifications to net deployment may also improve capture efficiency and reduce the probability of avoidance and escape. Netting along channel slopes will most likely be the most successful method of capture because turtles are moving rather than searching for food and possibly less likely to detect nets.

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LITERATURE

Eckert, S.A., D. Crouse, L.B. Crowder, M. Maceina and A. Shah. 1994. Review of the Kemp's Ridley Sea Turtle Headstart Program, 22-23 September 1992, Galveston, Texas. NOAA Technical Memorandum NMFS-OPR-3. U.S. Department of Commerce.

Fontaine, C.T., D.B. Revera, T.D. Williams, and C.W. Caillouet, Jr. 1993. Detection, verification and decoding of tags and marks in head started Kemp's ridley sea turtles, Lepidochelys kempii. NOAA Technical Memorandum NMFS-SEFC-334.

Ogren, L.H. 1989. Distribution of juvenile and subadult Kemp's ridley turtles: Preliminary results from 1984-1987 surveys. Pages 116-123 in Caillouet, C.W., Jr. and A.M. Landry, Jr. (editors), Proceedings of the First International Symposium on Kemp's Ridley Sea Turtle Biology, Conservation and Management. Texas A & M University Sea Grant College Program, (RAMU-SG-89-105).

Ross, J.P., S. Beavers, D. Mundell, and M. Airth-Kindree. 1989. The Status and Distribution of Kemp's Ridley. Center for Marine Conservation. Washington, D.C.

Rudloe, A., J. Rudloe, and L. Ogren. 1991. Occurrence of immature Kemp's ridley turtles, Lepidochelys kempi, in coastal waters of northwest Florida. Northwest Gulf Science. 12:49-53.

Schmid, J.R. and L.H. Ogren. 1991. Subadult Kemp's ridley sea turtles in the southeastern U.S.: Results of long-term tagging studies. Pages 102-103 in Salmon, M. and J. Wyneken (compilers). Proceedings of the Eleventh Annual Symposium on Sea Turtle Conservation and Biology. NOAA, Technical Memorandum NMFS-SEFSC-302. 195 p.

U.S. Fish and Wildlife Service and National Marine Fisheries Service. 1992. Recovery Plan for the Kemp's Ridley Sea Turtle (Lepidochelys kempii). National Marine Fisheries Service, St. Petersburg, Florida.

INFLUENCE OF METEOROLOGICAL AND BEACH SAND PHYSICAL CHARACTERISTICS UPON NEST LOCATION OF THE LOGGERHEAD SEA TURTLE (Caretta caretta)

Jennifer L. Cardinal[1], Bonnie Willis[2], Brian Weaver[3], and Eric T. Koepfler[4]

[1]104 Wofford Lane Conway, SC 29526
[2]273 Calvary Church Rd. Swansey, SC 29160
[3]Coastal Carolina University Conway, SC 29526
[4]Coastal Carolina University Conway, SC 29526

In a study conducted at two locations in South Carolina in 1995, beach sand temperature, water content, granulometry, and slope were examined for influence upon nest location by loggerhead sea turtles. A combination of spatially and temporally intensive transect surveys, combined with NOAA meteorological data, was used to construct a mathematical model that allowed estimates of temperature and water content at nest sites on the evening of their creation. Results were correlated with the distribution and abundance of nests in an effort to understand the importance of these physical parameters in the selection of nesting sites. It seemed that these variables had an effect on nest location. On one beach, beach slope was steeper and average sand grain size was larger. This caused distinct gradients of temperature change on the beach, and nest locations correlated with these areas. The other beach had a less steep beach slope and smaller sand grain size, so more water was withheld and temperature varied more. Turtle nests on this beach varied dramatically in location.

A PASSIVE ENTRAPMENT DEVICE FOR LIVE CAPTURE OF SEA TURTLES IN THE GULF OF MEXICO

James A. Carpenter[1], Brett Williams[2], and Maurice L. Renaud[1]

[1] Southeast Fisheries Science Center, National Marine Fisheries Service, Galveston Laboratory, 4700 Avenue U, Galveston, TX 77551
[2] 4107 Reeves Dr., Sea Isle, Texas 77554

We developed and tested a passive entrapment device (PED) designed to capture sea turtles with the least possible chance of causing turtle mortality, while keeping maintenance and personnel costs for the system low. The PED was constructed of stiff polyethylene fencing material. The material had a height of 2 meters and a square mesh with diagonal measurement of 13 centimeters. The PED had a lead of 100 meters and primary and secondary enclosures of 3 and 5 meters per side. Turtles in the enclosure were retrieved with a dip net. During preliminary tests in laboratory tanks and a 0.1 ha pond, no turtles became entangled and turtles were repeatedly observed entering the enclosures with no apparent adverse effects. Testing at beachfront and bay sites resulted in captures of wild Kemp's ridleys (Lepidochelys kempii) off the beachfront near Sabine Pass, TX and green turtles (Chelonia mydas) in lower Matagorda Bay, Texas. The PED held up well during low wave action and heavy debris loading, but not in heavy surf and storm surges. Nontarget species either escaped or were removed with the dip net. The only noted mortality was one bull shark (Carcharhinus leucas). Preliminary conclusions are that the PED is environmentally safe and effective in capturing sea turtles. Protected species are at low risk of drowning with the device and most bycatch can easily escape. The device is very sturdy and has virtually no maintenance costs. It is particularly suited to shallow inshore waters with relatively low wave action, but also can be used effectively in some beachfront situations. Deployment takes no special equipment and can be done by two people in 2-3 hours in calm water.

BIOLOGIA REPRODUCTIVA Y MARCAJE DE LA TORTUGA BAULA (DEMOCHELYIDAE: Dermochelys coriacea) EN PLAYA GANDOCA, COSTA RICA

Didiher Chacón

Asociación ANAI, Apdo: 170-2070, Sabanilla, Montes de Oca, San José, Costa Rica.

The leatherback sea turtle was studied at an important nesting beach on the southeastern Caribbean coast of Costa Rica. A total of 932 nests was recorded at Gandoca Beach during the 1995 nesting season from February-July. A total of 334 leatherbacks were studied and 309 were tagged, of which 3 were remigrants from 1992 and 1994 season and 22 carried tags from Urabá Gulf, Colombia and Tortuguero-Matina sector of Costa Rica Caribbean north coast. 158 females only nested once and the 52.69% shows renesting. A comparison of from 1990-1995 nesting seasons in Gandoca Beach was made. Mean curved carapace length was 154.07 cm and mean curved carapace width was 114.05 cm. The average incubation period in the hatchery was 59 days. Average hatching rate was 49.14%. Poaching (representing 12.88% of the total nests), beach debris and erosion represent the most crucial problems for females nesting on Gandoca Beach. Key words: Nesting, Leatherback, Caribbean, Hatchery, Tagging. Playa Gandoca (82° 37' oeste, 09° 37' norte) se extiende por 9 Km desde Punta Mona a la esquina sureste de país (desembocadura del río Sixaola, frontera con Panamá), por su posición es una de las playas de menos acceso del país. Esta línea de costa se caracteriza por ser de alta energía asociada a una plataforma continental estrecha prevaleciendo las corrientes marinas fuertes que se mueven en dirección norte-sur.

MATERIAL Y METODO

Cada hembra encontrada sin marca fue marcada después de la ovoposición, con una marca metálica de MONEL. Las marcas fueron colocadas entre la cola y las aletas, siguiendo la metodología propuesta por

Hirth & Ogren (1987). A cada hembra encontrada se le tomarón 4 medidas corporales de acuerdo con la metodología expuesta por Cornelius (1976), Pritchard et. al. (1983), Hirth & Ogren (1987), Bjorndal & Carr (1989) y Guadamuz (1990). En suma, diariamente se anotaron observaciones de la fase lunar y temperatura de la arena en el vivero, además de la hora de anidamiento, zona de la playa donde ocurrió la anidación, localización de cada nido con respecto a los mojones, profundidad del nido y posición del nido en la playa. El vivero fue construído sobre la berma de la playa entre los mojones 53-54, con una área interna de 55 metros cuadrados. Los huevos fueron colocados en cilindros de cedazo metálico para protegerlos de la depredación por el cangrejo fantasma (Ocypode sp.). Los nidos artificiales del vivero, así como en la playa fueron relocalizados a la misma profundidad encontrada en los nidos naturales.

RESULTADOS Y DISCUSION

932 nidadas fueron puestas en esta playa entre 17 de marzo y 17 de julio de 1995; 334 tortugas hembras fueron estudiadas y 309 marcadas. La mayor intensidad de anidación se dio en las áreas de mojones del 15 al 20, 31 al 36, 64 al 76 y 111 al 116 (fig.1), siendo estos datos coincidentes con lo presentado por Chacón et. al. (1995). La presencia de 22 tortugas con marcas foráneas (University of Florida y National Marine Fisheries Service), demuestra la irregularidad en los sitios de remigración y anidación de algunas tortugas. Veintiuna tortugas fueron marcadas entre la desembocuadura del río Matina y la desembocuadura del río Pacuare (com. pers. M.T. Koberg) y una en Playa Acandí, Golfo de Urabá, Colombia (Rueda 1992). Una tortugas marcada en 1992 y dos de 1994 por este mismo proyecto en playa Gandoca fueron localizadas como remigrantes en esta temporada; estos organismos mostraron un ciclo de anidamiento de de 3 y 1 año respectivamente; 176 tortugas baulas se muestrearon dos o más veces; los períodos de reanidación variaron en un ámbito de 8 a 12 días, con una moda estadística de 9 días; esto es coincidente con los datos presentados por National Research Council (1990) y Chacón et. al. (1995). Un análisis comparativo de datos para playa Gandoca, expuso que los más importantes meses para la anidación son abril y mayo de acuerdo con Venegas (1990), Cartín (1991), Quíros (1992) y Chacón et. al. (1995). El número total de nidos en playa Gandoca fue de 932 con una densidad de 12.36 nidos/100 m de playa, y un promedio de 7.34 tortugas por noche. El 54% de las tortugas emergieron durante las fases oscuras de la luna, a pesar de que los análisis estadísticos no mostraron una significancia contundente. El promedio de la longitud curva del caparazón de 334 tortugas fue 154.07 cm, el cual está dentro de los ámbitos expuestos por otros investigadores en Gandoca y otros sitios (Hirth & Ogren 1987, Chu 1990, Hall 1990, Cartín 1991, Quíros 1992, McDonald et. al. 1993). La clase de longitud para la longitud curva del caparazón más importante esta representada entre 150.1-155.0 cm (23.18%) y 155.1-160.0 cm (23.18%) del total de las tortugas medidas. El tamaño promedio de la puesta fue de 111 huevos. Cartín (1991), Quíros (1992) y Chacón et. al. (1995) informaron de 76, 77, 82 huevos normales por nidada respectivamente para playa Gandoca. El diámetro promedio fue de 51.8 mm (D.E.: 3.1) y varió entre 50 y 55 mm. El porcentaje promedio de huevos vanos fue de 27.92% en el total de nidadas. Para las baulas de Gandoca, Cartín (1991) y Chacón et. al. (1995) informaron de un 33% y un 31.5% de huevos vanos por nidada respectivamente. Durante nuestro estudio los más importantes impactos fueron: hueveros (recolectores ilegales de huevos), la depredación por animales domésticos y la erosión oceánica; esos impactos llevaron a la desición de construir del vivero como una estratégia de conservación. El período promedio de incubación en el vivero fue de 59.00 días (ámbito: 47-72 días). La tasa promedio de sobrevivencia fue de 49.14.% (D.E.: 25.1353, ámbito 9-96%). El promedio de la longitud estándar del caparazón de los neonatos fue de 59.51 mm (D.E.: 4.2593) y el promedio del peso total fue de 44.32 g (D.E.: 6.12). Hirth and Ogren (1987) reportaron que el promedio de longitud de caparazón de neonatos para algunas de las mejor conocidas colonias de baulas varió entre 55 y 63 mm y el promedio del peso estuvo entre 39 y 47 g.

REFERENCIAS

Bjorndal, K. and A. Carr. 1989. Variation in clutch size and eggsize in the green turtle nesting population at Tortuguero, Costa Rica. Herp. 45 (2): 181-189.

Cartín, H. 1991. Evaluación de la dinámica poblacional de la Tortuga Baula (Dermochelys coriacea) durante la época de desove en Playa Gandoca, Talamanca, de abril a setiembre 1991. Asociación ANAI. Mimeographed. 134-167 pp.

Cornelius, S. 1976. Marine Turtles nesting activity at Playa Naranjo, Costa Rica. Brenesia. 8:1-27.

Crastz, F. 1982. Embryological stages of the marine turtle Lepidochelys olivacea (Eschscholtz). Rev. Biol. Trop. 30(2):113-120.

Chacón, D., McLarney, W., Ampie, C. & B. Venegas. 1995. Conservation and reproductive biology of the leatherback sea turtle (Dermochelyidae: Dermochelys coriacea) on Gandoca beach, Costa Rica. Rev. Biol. Trop. (in press).

Chu, L. 1990. Observations on the nesting population of leatherback turtles Dermochelys coriacea in Trinidad. Caribb. Mar. Stud. 1:48-53.

Guadamuz, N. 1990. Registro de Anidamiento de Dermochelys coriacea (tortuga Baula) en Playa Grande de Matapalo, Santa Cruz-Guanacaste. Investigación por Tutoría, Universidad Nacional, Heredia. 60 p.

Hall, K. 1990. Hatchling success of leatherback turtle (Dermochelys coriacea) clutches in relation to biotic and abiotic factors. Richardson, T.H.; H.I. Richardson & M. Donnelly (compilers). Proc. of the Tenth Annual Workshop on Sea Turtle Biology and Conservation. NOAA. Technical Memorandum NMFS-SEFC-278. 286 p.

Hirth, H. & L. Ogren. 1987. Some Aspects of the Ecology of the Leatherback Turtle Dermochelys coriacea at Laguna Jalova, Costa Rica. NOAA Technical Report NMFS 56. 14 p.

Mc Donald, D., Dutton, P. & R. Boulon. 1993. Tagging and Nesting Research on Leatherback Sea Turtles (Dermochelys coriacea) on Sandy Point, St. Croix, U.S. Virgin Islands, 1993. U.S. Fish and Wildlife Service, Dept. Planning and Natural Resources. 26 p.

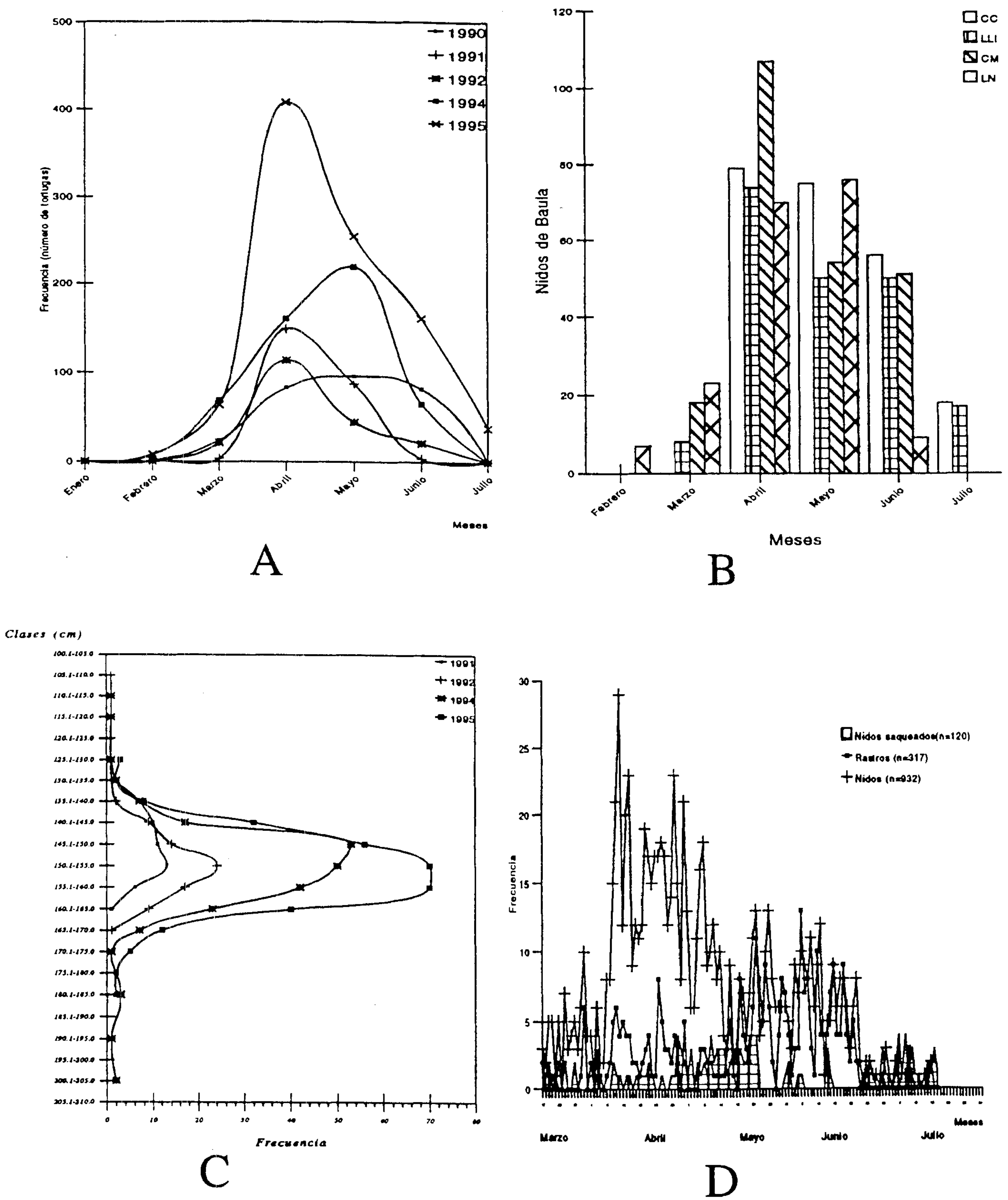
Meylan, A., Meylan, P. & A. Ruiz. 1985. Nesting of Dermochelys coriacea in Caribbean Panama. J. Herp. 19(2): 293-297. National Research Council. 1990. Decline of the sea turtles: Causes and Prevention. National Academy Press. Washington. 259 p.

Pritchard, P.; P. Bacon; F. Berry; A. Carr; J. Fletmeyer; R. Gallagher; S. Mopikins; R. Lankford; R. Marquez; L. Ogren; W. Pringle; H. Reichard & R. Whitan. 1983. Manual sobre tecnicas de investigación y conservación de las tortugas marinas. Center for Environmental Education. Washington, D.C. 133 p.

Quirós, J. 1992. Proyecto de manejo de la Tortuga Baula (Dermochelys coriacea) en Playa Gandoca, Refugio Nacional de Vida Silvestre Gandoca/Manzanillo. Asociación ANAI. Costa Rica. Mimeographed. 20 p.

Rueda, J.V.; G.A. Ulloa y S.A. Medrano. 1992. Estudio sobre la Biología reproductiva, la ecología y el manejo de la tortuga canal (Dermochelys coriacea) en el Golfo de Urabá. Inst. Nac. De los Recursos Nat. Renov. y del Amb. (INDERENA). Colombia, 62-65 pp.

Venegas, B. 1990. Plan estratégico de la Tortuga Baula (Dermochelys coriacea) en Playa Gandoca, Refugio de Fauna Silvestre Gandoca/Manzanillo, Sixaola, Talamanca. Prepared to WWF. ANAI Association, Costa Rica. Mimeographed. 12 p.

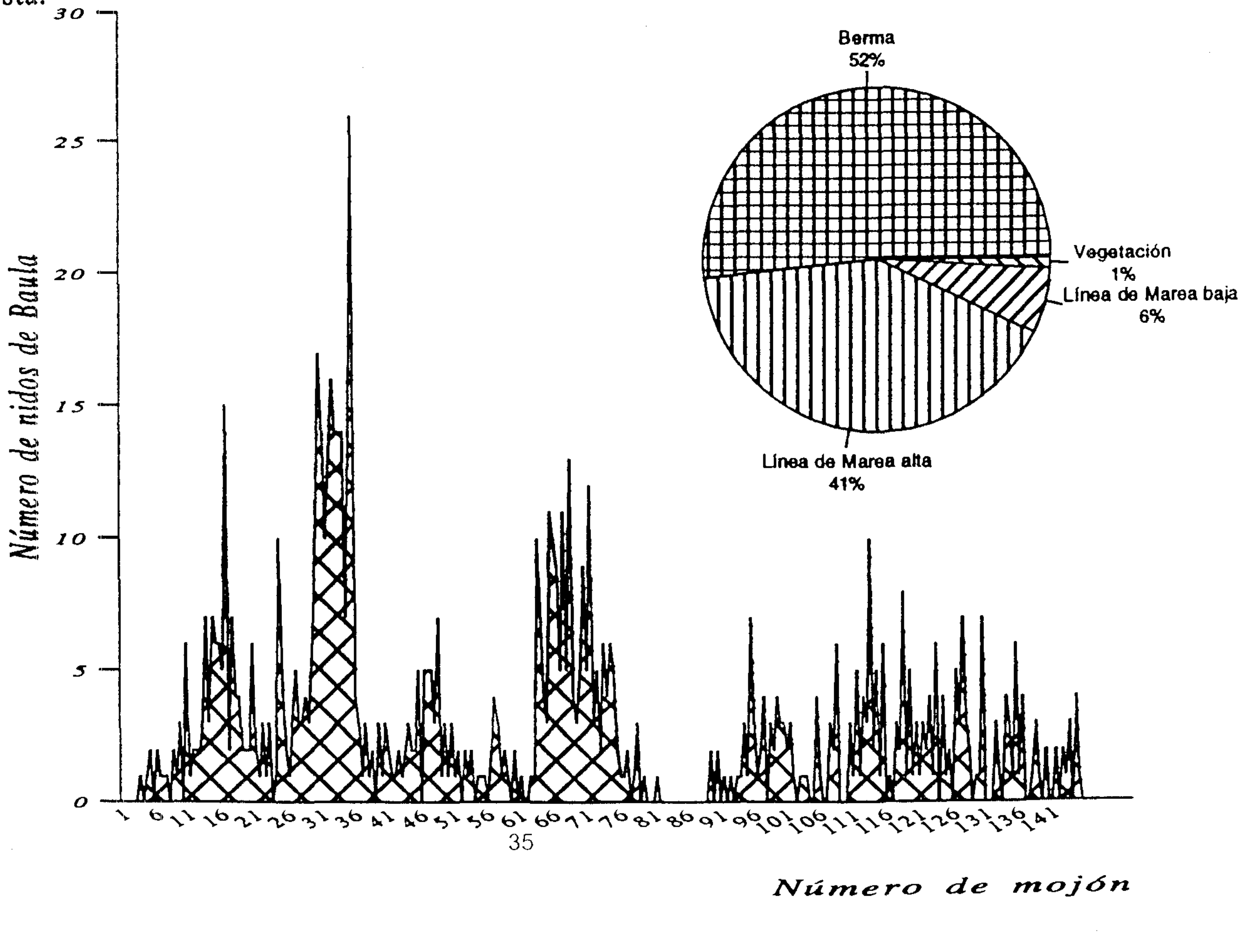


A.Comparación de los desoves totales mensuales entre 1990 y 1995.
B.Cantidades de desoves para cada fase lunar.
C.Distribución de las clases de longitud curva del caparazón de la colonia.
D.Registro total de nidos, rastros y nidos saqueados.

Cuadro 1: Variables generales de la colonia anidadora de tortugas Baula en Playa Gandoca, temporada 1995 (D.E.= desviación estándar).

N_t=334	Promedio y/o valor	D.E.	Ambito
Longitud linear (cm)	144.9727	10.1298	102-164
Ancho linear (cm)	87.7581	9.3929	46-120
Ancho curvo (cm)	114.0548	8.4939	87-149
Total estimado de huevos relocalizados	48353		
Huevos normales/nido	79.4209	17.7836	1-156
Huevos vanos/nido	31.3347	14.1968	2-84
Eclosión en vivero	49.14	25.1353	9-96
Peso total neonatos (gr.)	44.32	6.12	32.5-61.0
Longitud total neonatos (mm)	59.51	4.2593	47.9-68.6
Periodo de incubación (días)	59.00	4.1424	47-72

Fig.1:Cantidad de nidos encontrados y su distribución vertical y horizontal con respecto a la costa.



1996 SEA TURTLE SYMPOSIUM COMPUTER POSTER

William Coles

This is a synopsis of the computer poster presented at the 1996 annual sea turtle symposium. Please send any questions or suggestions to cturtle@vims.edu. The poster is available for your enjoyment using a network browser at the address: http://www.vims.edu/~cturtle/96poster.html
Please remember that this is a continuously evolving web page so your input is essential.

Sea Surface Temperatures and Sea Turtle Position Correlation's - William Coles and Jack Musick

Aerial surveys were used to determine temperature ranges and preferences of sea turtles off the North Carolina outer banks. The variance of sea turtle position temperatures were significantly different than the variance of available temperatures. This suggests that sea turtles are not geographically randomly distributed. A thermal minimum and maximum was found. The turtles occupied water with temperatures ranging between 14°C and 28°C. This study also suggests that the turtles preferred temperature range is seasonally variable.

Magnetic Resonance Imaging of Green and Leatherback Sea Turtles - William Coles and Peter Lutz

Coronal, oblique, sagittal and transverse Magnetic Resonance (MR) images were made of thawed Leatherback and Green sea turtle heads. The images were created during August of 1991 at the University of Miami, on a Vista 1.5 tesla imaging spectrometer. Even though the center of the heads had not completely thawed before imaging a lot of important information regarding soft tissue anatomy can be seen. This includes but is not restricted to anatomical relationships between organs, regions of muscle location and insertion, musculature of various organs, organ volume, etc. We focus our attention on the salt gland in this paper.

Measurements of oblique sections of the Leatherback and Green turtle heads show that the salt glands have similar dimensions. However the salt gland in the Leatherback turtle occupies a much larger lateral volume than the Green turtle. The lateral (normalized) dimension for the Green turtle salt gland is on the order of 4.46 where the Leatherback has normalized dimensions on the order of 12.8. This means that the size of the salt gland in the Leatherback sea turtle is nearly 3 times the normalized width of the Green sea turtle. This corresponds to a difference in organ volume, that may be due to the differences in diet and amounts of sea water consumed.

VIMS Sea Turtle Strandings - William Coles, Jack Musick, Soraya Moein and Barbara Bell

The data from the Virginia Institute of Marine Science (VIMS) sea turtle research project has provided valuable information on sea turtles over the last 17 years. The data has focused particularly on juvenile loggerheads and Kemp's ridleys. Hawksbill, Green Turtles and Leatherback sea turtles are rare members of the bays community. The latter is one of the most endangered animals on earth. There are few other places where juvenile sea turtles congregate in such numbers, the Chesapeake Bay is a major developmental habitat for juvenile loggerhead and ridley sea turtles. The juvenile turtles from Virginia's waters are important to the continued existence of the species, as they will be recruited into the breeding population in the next few years. Since hatchling or nesting females are the only wild sea turtles normally available to researchers, VIMS scientists are fortunate to be able to study wild, juvenile sea turtles. The VIMS database on demography and life history of juvenile loggerheads and ridleys is the longest in existence. The VIMS database includes records of dead and live strandings, incidental captures, and occurrences of nesting. We show here a summary of our data covering three periods, 1979-1989, 1990-1994, and 1995 (last years data).

Length frequency curves of stranded Loggerhead, Kemp's Ridley, Green and Leatherback sea turtles recovered in the Chesapeake bay have been calculated. The curves tell us what the age classes of the turtles are that utilize the bay. The preadult Loggerhead and Kemp's ridley are the most common sea turtles in the bay. We also get the occasional juvenile Green. All of the Leatherback sea turtles seen in the Chesapeake bay are adult turtles.

We calculated mean monthly deaths for the two time periods 1979-1989, and 1990-1994 for Loggerhead, Kemp Ridley sea turtles. We also plotted monthly deaths for Green and Leatherback sea turtles for the time period 1979-1994. The current, 1995, data is included on a separate graph. All four species of turtle enter the bay at the same time (May). Water temperatures start to increase and generally reach a "preferred" (See the Satellite Images section of this Poster) temperature by May. This affects not only the movements of the turtles but also the food sources. Jelly fish, and other potential food sources become common as the water warms. The Loggerhead deaths peak population occurs in June and they have generally slowly taper off to November. Kemp's ridley's oddly enough have two peaks one in June and the other occurring in October. Unfortunately we do not have an explanation for this behavior. The Ridley's also leave the bay in the November/December period. Green and Leatherback sea turtles are not nearly as common and the Loggerhead and Ridley's. The Leatherback peaks in June with a much smaller peak occurring in November, and they have left the bay by December. Green sea turtles death peaks are much smaller with a peak in October, and they leave the bay by December.

We try and determine a cause of mortality for all the stranded sea turtles we see in the Chesapeake Bay. Unfortunately, as we all well know, the turtles are usually in a severe state of decomposition before we get to see them. This means that most of the causes of mortality are unknown. We have graphed the causes of mortality for the periods 1979 to 1989 and 1990 to 1994 for Loggerhead and Kemp Ridley sea turtles. We have included a separate graph for the 1995 deaths. It is clear that the majority of the causes of death are unknown for both species. The first most important group is boat caused mortality. We can not determine if the animal was compromised before being struck, due to illness or other injury. Some of the animals may have been struck after death, we tried to determine whether the wounds were pre or post mortem. This may be reflected in the elevated numbers of boat related mortality. It is interesting to notice that the loggerheads had much higher deaths due to trash than the Ridleys. The trash was found to be both internal (plastic and glass) and external (plastic). Another common cause of mortality was that of being hooked, either commercially or recreationally. The hooks found were generally clean and relatively rust free, indicating that the injury resulting from the hook was very recent, and is the likely cause of death. Rope and/or net constriction marks were also common, but did not make up as much of the overall total as we expected. However many of the unknown deaths could have been due to constriction and drowning due to entanglement.

INTERNAL CONTROLS ON BEACH TEMPERATURE; ARE PREDICTIONS POSSIBLE?

Christopher D. Cornelisen and Randall W. Parkinson

Division of Marine and Environmental Systems, Florida Institute of Technology, Melbourne, Florida 32901

PROJECT OVERVIEW

Mrosovsky (1988) has shown that the duration of incubation and the sex ratio of sea turtles is directly influenced by beach temperature. Therefore, temperature is frequently included in beach nourishment monitoring programs. Unless nourishment projects use fill material identical to native/natural sand and utilize procedures that emulate natural deposition, it can be assumed that the physical characteristics measured on a nourished beach, including temperature, will be different from those measured on a natural beach. Ideally, if the temperature of a nourished beach could be predicted using known relationships with other physical parameters of the fill (i.e., grain size, penetrability), projects could be designed so as to minimize potential problems associated with abnormal temperature.

The potential impact of abnormal beach temperature to sea turtle populations should not be overlooked. In the state of Florida, where 90% of the Western Atlantic loggerhead population nests, 40% of the beaches have been recommended for nourishment due to extensive erosion (Clark, 1989). The goal of this project is to evaluate the feasibility of predicting beach temperature using known geotechnical and physical relationships with other physical attributes of the fill. Careful selection of borrow sites, implacement procedures and post-depositional modification (i.e., tilling) could then be utilized to minimize abnormal temperatures during turtle nesting and development.

STUDY AREA

The study area is located in the Sebastian Inlet State Recreational Area along the east-central coast of Florida. This high-density sea turtle nesting area is located within the Archie Carr National Wildlife Refuge. Approximately every 2 years, as much as 150,000 yds^3 of sand is mechanically pumped from the inlet's sand trap and flood shoal to a feeder beach located 1,300 m south of the inlet. The control beach is located approximately 1,000 m north of the Inlet. This beach, free of nourishment activity and inlet influence, is representative of a natural beach (Venanzi, 1993). The area has been subjected to extensive monitoring since 1989, and many of the techniques used in this study have emerged from this program.

METHODS AND RESULTS

Methods were designed to: (1) quantify subsurface beach temperature, moisture content, penetration resistance, and grain size at a treatment and control beach; (2) determine if a significant multiple linear relationship exists between the internal variables and beach temperature; and (3) if a significant relationship exists, evaluate the ability to predict beach temperature. Sampling was conducted monthly during the sea turtle nesting season (May-October) for the project's 4-year duration (1992-1995). During each sampling event, 12 stations were established on two beaches. Stations were occupied at the toe of the dune, mean backshore, and mean high water, and samples collected at -30 cm.

Beach temperature was recorded at each station over a 24-hour period using a digital thermometer and thermocouples. Moisture content was determined gravimetrically by weighing sediment samples before and after drying at 105°C for 24 hours. Penetration resistance was measured using a cone enetrometer. The mean grain size of each sand sample was determined using a rapid sediment analyzer.

Multiple linear regression analysis was used to investigate whether the three internal variables penetration resistance, grain size, and moisture content) are functionally related to temperature. Results were obtained using the multiple linear regression function on SIGMASTAT. Multiple regressions were conducted for 26 separate data sets. Results from only three (the best to interpret our observations) are given in table 1. The first data set analyzed included all data collected in the past 4 years. To reduce possible seasonal effects, due to changes in external variables, the entire data set was then segregated by month (i.e., all July data). We then chose to analyze individual sampling events to further minimize external influences to the data.

DISCUSSION

The correlation between variation in beach temperature and variation in internal variables is minimal when data collected on multiple sampling events is analyzed. When single sampling events are analyzed, correlation is the greatest (Table 1). It is therefore evident that temperature is not only dependent on internal variables but also on external variables. Beach temperatures measured at the beaches fluctuate throughout the season, not solely due to variation in internal variables, but also seasonal changes in the amount of solar energy being absorbed by the beach. The effect of solar energy on temperature variation may also be observed over a 24-hour period (Parkinson and Vann, 1994).

CONCLUSION

Results using data from individual sampling dates reveal a significant relationship between temperature and the internal variables measured in this study (figures 1-2). As a result, it is apparent that variations among physical variables exist, and that moisture content, penetration resistance, and grain size, or a combination thereof, influence beach temperature. However, due to seasonal variation in external variables, one is not able to make accurate predictions of beach temperature based solely on the multiple linear relationships among internal variables measured in situ. We intend to continue the investigation of the relationship between internal variables and effects on temperature in different substrates in a controlled laboratory setting. This would reduce variability due to external variables.

LITERATURE

Clark, R.R. 1989. Beach Conditions in Florida: A statewide inventory and identification of the beach erosion problem areas in Florida. Technical and design memorandum 89-1. Florida Dept. of Natural resources, Division of Beaches and Shores.

Harrison, S.J., and Morrison, P. 1993. Temperatures in a sandy beach under strong solar heating: Patara Beach, Turkey. In: Estuarine, Coastal and Shelf Science. 37:89-97.

Mrosovsky, N. 1988. Pivotal temperatures for loggerhead turtles (Caretta caretta) from northern and southern nesting beaches. In: Can. J. of Zool. 66:661-669.

Parkinson R.W., and J. Vann. 1994. Physical attributes of a natural (control) and renourished (treatment) beach, Sebastian Inlet, Florida. Technical Report submitted to the Sebastian Inlet Tax District Commission.

Vasquez, L., D.L. Myhre, E.A. Hanlon, and R.N. Gallaher. 1991. Soil penetrometer resistance and bulk density relationships after long-term no tillage. In: Commun. Soil. Sci. Plant Anal. 22:2101-2117.

Venanzi, P.F. 1992. Surficial sediment grain-size distribution patterns: A measure of Inlet Influence? Unpubl. Master's Thesis, Florida Institute of Technology.

DATA SET	n	R^2	Independent variables	Level of Significance (P)	Conventional Regression coefficients
All data collected for May-September 1992-1995	467	0.08	Penetrability	0.001	Intercept =31.1
			Grain size	0.229	-0.257
			Moisture content	<0.001	-0.630
					-0.234
All data collected during the month of July 1992-1995	116	0.42	Penetrability	0.005	Intercept =33.1
			Grain size	0.023	-0.191
			Moisture content	<0.001	-0.876
					-0.426
Data collected on August 7, 1992	24	0.83	Penetrability	<0.001	Intercept =30.2
			Grain size	0.365	-0.310
			Moisture content	0.036	+0.547
					+0.116

TABLE 1. Results of multiple regression analysis for the dependent variable beach temperature as a function of the independent variables; penetrability, grain size, and water content for three data sets.

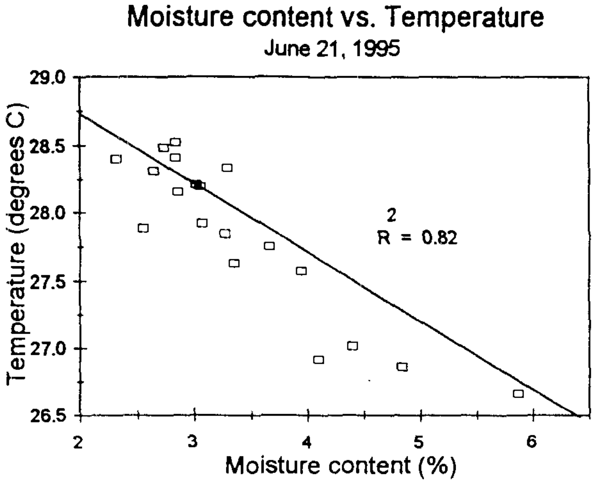


FIGURE 1. The linear relationship between moisture content and temperature from data collected on September 21, 1995 at the two beaches. An increase in moisture is accompanied with a decrease in temperature. Heat capacity is directly influenced by moisture content. Sediment with a higher moisture content will have a higher heat capacity, and as a result, will require more heat to increase its temperature (Harrison and Morrison, 1993).

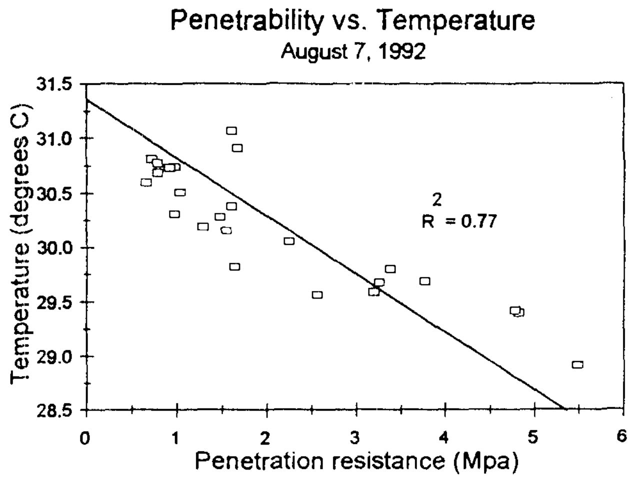


FIGURE 2. The linear relationship between penetration resistance and temperature from data collected on August 7, 1992. Because penetrability is influenced by several factors, including moisture content, grain size characteristics, and bulk density, it is difficult to determine which factor is playing the most important role in temperature variation (*Vazquez, et al.* 1991). However, in general, results have indicated that an increase in penetration resistance is accompanied with a decrease in temperature.

SEVENTEEN AREAS OF SEA TURTLE NESTING ALONG TURKISH MEDITERRANEAN COAST

F. Demirayak and A. Oruc

Coastal Management Section, The Society for the Protection of Nature, Turkey, P.O. Box 18, 80810,
Bebek, Istanbul, TR

The Mediterranean coastline of Turkey hosts 17 major nesting sites of the endangered marine turtle species, Caretta caretta and Chelonia mydas. On these 17 nesting sites, identified for an extensive WWF survey in 1988, CMS is carrying on the "Eastern Mediterranean Marine Turtles," a project that originated around 1986, with heated campaigns both in Turkey and internationally against the construction of a huge tourism complex destroying the rare coastal ecosystem of Dalyan. This Turkish-German joint venture project was canceled, and the unique success of these campaigns, in which DHKD took a leading role, became a starting point for the full-fledged WWF project in 1989.

Turkish Mediterranean is becoming increasingly more popular, especially for the European tourist, who now seeks new destinations yet unspoiled and attractive. Despite the argument that Turkey is heading for "eco-tourism," the implementation is clearly one of mass tourism, and the investment plans are far from any effort to prevent or remedy the damage to nature. Accompanied by the intensive trend for summer housing, our coastline is now swarming with badly planned tourism investments and cooperative housing.

The first accomplishment of the project was the establishment of a government commission for sea turtles, the National Committee on Sea Turtles, consisting of representatives from all relevant ministeries, universities, local authorities, and NGO's was formed and it visited the 17 nesting sites and formalized the suggestions of the WWF survey to mitigate the major threats to the nesting habitats. Since then, CMS has been lobbying government authorities for necessary measures to be taken, among which is the designation of protected areas on threatened beaches, intervening with badly planned investment, and implementations on the coastline; requiring urgent action in cases of illegal activities, and the link with national and international organizations with similar aims, soliciting expert study on relevant issues on sites.

Interaction Between Fisheries and Sea Turtles Project

The coastal line between Mersin and Iskenderun in the East Mediterranean region of Turkey is quite important in terms of fishery activities. The East Mediterranean is known to be an important breeding, feeding, and wintering area. The region is particularly important in terms of being the habitat of the endangered green turtles, Chelonia mydas. Chelonia mydas mates in the waters of the East Mediterranean, lays its eggs in the sands of the same region, and winters in the same waters. However, the studies in this field are known to be inadequate.

Before 1972, the sea turtles in the East Mediterranean were caught for commercial purposes and exported. As of 1972, sea turtle hunting was legally prohibited in Turkey as in many other countries in the world. The present statistics and short-term observations indicate that sea turtles are caught incidentally during fishery.

The DHKD project aims to identify the number of different species and other protected species affected by fisheries activities. To identify the total number of sea turtles caught, the size (including tail) of sea turtles, the death of sea turtles during a trawling season, the use of sea turtles caught are also among the aims of this project.

Activities planned for 1996 include: Identification of important harbors, their potential, establishment of contacts with fishermen and related authorities, identification of the number of trawling boats, long liners, gill nets, and boats coming from other areas, recruitment of daily paid staff and their training on the project, following the trawling boats with daily paid workers, concentrating on the number of incidentally caught sea turtles in a certain period and preparation of a situation report at the end of the year.

The study will further concentrate upon the analysis of fishermen classified in two groups, depending on the data obtained through field study and literature survey, as well as the fishing equipment used, the size of the boats, and the fishing prohibitions.

Priority will be placed upon trawling boats and seine boats during the months of September and May. A certain number of boats will be selected within those fishing in Yumurtalik and in the mouths of Seyham-Ceyhan rivers where sea turtles are often caught incidentally in the nets. To have more reliable results, it is planned that certain people will be selected among the inhabitants of the region to be recruited in these boats in return for daily payment.

In June and August, it is planned that the boats fishing through the year being disregarding the fishing prohibition should be studied. There are a lot of such small fishing boats in the East Mediterranean and their affect on the sea turtles should be analyzed.

The fields in which fishermen are not well educated will be discovered during these studies and relevant, educational programs will be prepared. The study will be made in cooperation with the Ministry of Agriculture and Village Affairs and Coastal Security Guards.

USE OF MOLECULAR GENETICS TO IDENTIFY INDIVIDUALS AND INFER MATING BEHAVIOR IN LEATHERBACKS

Peter H. Dutton[1] and Scott K. Davis[2]

[1]NOAA-NMFS, SWFSC, P.O. Box 271, La Jolla, CA 92038
[2]Dept. Animal Sciences, Texas A&M University, College Station, TX 77843

Multiple polymorphic microsatellite loci were used as genetic markers to identify individual leatherback turtles *Dermochelys coriacea*. Blood samples were taken from almost all the adult females nesting on St. Croix, U.S. Virgin Islands between 1992 and 1994 (n=92 individuals). In addition, tissue was salvaged from dead hatchlings from different clutches laid by individual females throughout a nesting season. Primers designed by Fitzsimmons (1995) for *Chelonia mydas* (Cm3), *Caretta caretta* (Cc117), and *Eretmochelys imbricata* (Ei8), and by Louis (unpublished) for Geochelone sp. (N200 and N32) amplified polymorphic microsatellite loci in *D. coriacea*. Three additional microsatellites were found in leatherbacks (P186, DC99, and DC28; Dutton 1995), and the number of alleles ranged from 2 to 17 (Table 1) among the females nesting in St. Croix. We constructed genetic fingerprints using genotype data from all 8 microsatellites. Probabilities of obtaining genotype profiles by chance were estimated from allele frequencies for the population, and were less than 1x10-8, indicating that this microsatellite system will be reliable as a genetic "tag" to identify individuals.

Multiple paternity was inferred from genotype frequencies among offspring from different clutches laid by each of two individual females throughout the nesting season. Although individual clutches appear to have been fertilized by only one male, preliminary data suggests that different males have fertilized clutches laid at different times of the season by each female.

Analysis of genetic distances calculated from combined data from 3 loci (DC99, N200, and N32) (Dutton, 1995) produces a phylogeny that is congruent with the geographic relationships between 8 major nesting populations worldwide, suggesting that microsatellites may be useful to distinguish leatherback nesting populations, as well as individual turtles.

LITERATURE

Dutton, P.H. 1995. Molecular evolution of sea turtles with special reference to the leatherback, *Dermochelys coriacea*. Ph.D. Dissertation, Texas A&M University, College Station, 137pp.

FitzSimmons, N.N., Moritz, C., and Moore, S.S. 1995. Conservation and dynamics of microsatellite loci over 300 million years of marine turtle evolution. Mol. Biol. Evol. 12:432- 440.

TABLE 1. Number of alleles found among leatherbacks nesting in St. Croix at 8 microsatellite loci.

Locus	No. Alleles	Locus	No. Alleles
Cm3	5	P186	7
Ei8	17	DC28	6
Cc117	10	DC99	6
N200	2	N32	4

OPERATION GREEN TURTLE REVISITED

Peter J. Eliazar, Karen A. Bjorndal, and Alan B. Bolten

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

From 1959 through 1968, Archie Carr, with the assistance of the U.S. Navy, distributed over 130,000 green turtle hatchlings and eggs from Tortuguero, Costa Rica, to 17 countries throughout the Greater Caribbean. This massive relocation--called "Operation Green Turtle"--was undertaken in an attempt to reestablish extirpated green turtle nesting populations throughout the region. A major impetus for this effort was the excessive harvest of female green turtles at Tortuguero, the largest green turtle nesting colony in the Atlantic, and the bleak survival outlook of the population if the harvest continued. We have summarized the numbers of hatchlings released and the release sites during Operation Green Turtle because these data have never been presented and because of the current interest in genetic structure of sea turtle populations in the region.

During Operation Green Turtle, eggs were moved to a hatchery where they were screened and protected and the hatchlings could be easily collected. Before shipment, hatchlings were held in troughs under a thatched roof adjacent to the Tortuguero nesting beach. Sea water had to be carried daily from the ocean, usually by hand. Turtles were shipped in wooden boxes lined with plastic and with an absorbent mat to maintain moisture during shipment. Each box contained approximately 200 hatchlings. US Navy Grumman aircraft would land on the Tortuguero River to pick up hatchlings for transport to distant release sites.

Operation Green Turtle was discontinued after 1968 because of increasing demands on the military for the Vietnam War, the low number of nests at Tortuguero in 1968, and the lack of evidence that any rookeries had been reestablished (remember, that then, biologists believed that green turtles reached sexual maturity in 6 years). Although there has been no known nesting resulting from Operation Green Turtle, the effort was a great success in raising awareness of the plight of sea turtles in the Caribbean and beyond.

Because these translocated green turtles may have contaminated the genetic composition of natural populations, studies on the genetic structure of green turtle populations in the Greater Caribbean have stimulated interest in the number, distribution, and survival potential of these hatchlings. We believe that the releases of hatchlings during Operation Green Turtle have probably had a minimal effect on genetic composition of green turtle populations. Current understanding of hatchling biology would suggest that the hatchlings would have had low potential for survival as a result of being held in water at Tortuguero past their swim frenzy period. Thus the hatchlings, when released, had depleted nutrient reserves and probably could not reach appropriate post-hatchling pelagic habitats. Looking back on the project in later years, Archie Carr realized, as he wrote in his epilogue to So Excellent a Fishe, that it would have been better to have transported eggs rather than hatchlings because of imprinting and the problems of holding hatchlings past the swim frenzy period. The 2,000 eggs that were distributed during Operation Green Turtle had low survivorship due to poor handling techniques. Those hatchlings held in captivity and released as yearlings in Florida, Bermuda, and Colombia, probably had better survivorship, but their migratory behavior may have been compromised with negative effects on reproduction. Those turtles that survived would now be approaching sexual maturity and would probably not have compromised recent genetic studies involving juvenile turtles.

Data used in this summary were gleaned from reports written by Archie Carr (annual reports of the Technical Director to the Caribbean Conservation Corporation and reports to the Office of Naval Research), correspondence between Dr. Carr and recipients of the turtles, and notes in regional publications (e.g., the West Indies' Fisheries Bulletin published in Trinidad). We thank Marjorie Carr for housing the Archie Carr Archives at the University of Florida that allowed us access to these records.

DEVELOPMENT OF AN INDEX OF SEA TURTLE ABUNDANCE IN THE PAMLICO-ALBEMARLE ESTUARINE COMPLEX

Sheryan P. Epperly and Joanne Braun

NOAA, National Marine Fisheries Service, Southeast Fisheries Science Center, Beaufort Laboratory, 101 Pivers Island Road, Beaufort, NC 28516, USA

The National Marine Fisheries Service is one of two federal agencies with responsibility for protecting and recovering listed sea turtle species. The NMFS must know the status of the stocks to formulate recovery actions and to monitor recovery. Historically, such information has come from nesting beach surveys. The populations' responses to recovery actions eventually would be realized on the beach, but not fully appreciated for many years. In contrast, the response of the in-water juvenile population is more immediate. Thus, the best way to measure the effectiveness of management actions taken to recover sea turtles is to monitor in-water juvenile populations.

Surveys conducted since 1988 have underscored the importance of North Carolina's inshore waters, particularly the Pamlico-Albemarle Estuarine Complex, to juvenile loggerhead (Caretta caretta), green (Chelonia mydas), and Kemp's ridley (Lepidochelys kempii) sea turtles (Epperly et al. 1995a, b). The Complex is the largest estuarine system in the southeast U.S. Sea turtles are present in these inshore waters April-December. During their emigration in fall and early winter, the turtles are vulnerable to capture in pound nets set behind the barrier islands. Pound nets, as set in North Carolina, are a passive gear that allow turtles to feed and to surface to breathe; they may not be a significant source of turtle mortality. Approximately 430 sets containing 1,300 pounds were registered to about 125 fishermen in the study area (N.C. Division of Marine Fisheries, unpubl. data).

The Core Sound and eastern Pamlico and Albemarle Sounds area was established as a pilot index area for sea turtles in 1995. During September-December, the catches of pound net fishermen of Core Sound and eastern Pamlico and Albemarle Sounds were sampled at random to evaluate incidental captures of sea turtles as an index of sea turtle abundance in both the sounds and along the Atlantic coast. At the peak of the season, there were 267 sets containing 882 pound nets in the study area. Results of weekly aerial censuses indicated we sampled about 10% of the pound nets set each week, and about 5% of those fished each week. One hundred ten trips (1,084 pound nets in 381 sets) were sampled during the 13 week study and yielded 144 turtles. Catches ranged from 0/trip to 17/trip. Turtles were caught every week of the study and continued to be caught even as water temperatures dropped below 10°C. Green turtles began emigrating 3 wk. before loggerhead turtles. CPUE of both species peaked during the week of November 5-11, when water temperatures dropped rapidly below 20°C. Loggerheads (N=102) ranged in size from 41-81 SCL; the sizes of greens (N=41) ranged from 21-75 cm SCL and the Kemp's ridley (N=1) was 56 cm SCL. We estimate 2372 loggerheads (95% C.I.=1861-2918), 935 greens (95% C.I.=682-1205), and 32 Kemp's ridleys (95% C.I.=1-92) were caught. Blood samples were drawn for mtDNA and sexing analyses. Turtles were double-tagged in the rear flippers with inconel tags and were P.I.T. tagged in the left front flippers; 17 recaptures were recorded. Recaptures and tag loss will be evaluated in future years.

LITERATURE CITED

Epperly, S.P., J. Braun, and A.J. Chester. 1995a. Aerial surveys for sea turtles in North Carolina inshore waters. Fish. Bull. 93:254-261.

Epperly, S.P., J. Braun, and A. Veishlow. 1995b. Sea turtles in North Carolina waters. Conserv. Biol. 9:384-394.

SEA TURTLE EGG COMMERCIALIZATION IN ISLA DE CANAS, PANAMA

Kirsten E. Evans and Aida Rosa Vargas

Peace Corps/Panama, Republic of Panama; current address: 29 Turning Mill Rd., Lexington, MA 02173
Islenos Unidos Cooperative, Tonosi, Provincia de Los Santos, Republica de Pananma

The collection and sale of sea turtle eggs represents the principal source of income in Isla de Canas, a national wildlife refuge which is home to an impoverished community of 500 people in southern Los Santos province on the Pacific coast of Panama. Four species of sea turtles nest in Isla de Canas: olive ridley (Lepidochelys olivaceae), leatherback (Dermochelys coriacea), East Pacific black (Chelonia agassizi) and hawksbill (Erytmochelys imbricata). The olive ridley nests throughout the year as solitarias (one-nesters) as well as in arribadas. There are generally 3 to 5 arribadas annually during the months from August to December, occurring over a 1.5 - 3.0 km stretch of the 14 km nesting beach. Rough estimates of the size of the arribadas range from 5,000 to 12,000 turtles (Marta Arauz, pers. comm.; Lyneth Cordoba, pers. comm.), although there is no ongoing monitoring program using established techniques.

The community of Isla de Canas has formed a cooperative to manage the egg commercialization and sea turtle conservation projects, as well as to diversify income-generating activities to lessen the dependence on sea turtle eggs. The 1995 collection schedule designed by INRENARE (the Panamanian natural resources agency) to leave 50% of the nests in place for the conservation of the species, provided for a no-collection week each month during which residents patrolled the beach to protect the nesting turtles from poachers. During arribadas, the community could harvest all the eggs of the first night, but not for 6 nights thereafter.

Recognizing the importance of solid scientific information in the management of the resource, the Islenos Unidos Cooperative hopes to develop a monitoring program incorporating its members in the data collection. Technical assistance and financial support are urgently needed to provide reliable estimates of the size of the arribadas and a scientific base to the management of this sea turtle population.

MULTIPLE PATERNITY IN GREEN TURTLES?

Nancy N. FitzSimmons

Department of Zoology, University of Queensland, Brisbane, QLD 4072, Australia

Multiple matings of females have been observed in green turtles (Chelonia mydas) (Booth and Peters 1972, Limpus 1993, Ulrich and Parkes 1978) but the frequency and success of these matings is unknown. Multiple matings may be advantageous for females if mating success varies and multiple paternity is a possible consequence. How prevalent multiple paternity is will depend in part upon the sex ratios of breeding adults at courtship areas, the duration of female receptivity, and the mechanisms of sperm storage and sperm competition.

The question of multiple paternity in marine turtles has received little investigation until just recently (i.e., these proceedings). A previous study by Harry and Briscoe (1988) looked at paternity of loggerhead turtle clutches at the Mon Repos Rookery in Queensland, using allozymes as genetic markers. They suggested that multiple paternity had occurred in one third of the clutches analyzed, but their study was limited by a small number of alleles and unknown genotypes of the mothers. I chose to investigate multiple paternity in green turtles and if it existed, to quantify male reproductive success across successive clutches, and test for a correlation between hatching success and multiple paternity.

METHODS

I investigated clutch paternity in green turtles of Heron Island in the Southern Great Barrier Reef in Queensland during the 1991/92 and 1992/93 nesting seasons (see FitzSimmons in press). I took blood samples from 13 females and transferred the eggs they laid to a simple hatchery. Throughout the season I patrolled the beach to re-encounter those females while they laid alternate successive clutches that I also relocated to the hatchery for sampling. Once hatchlings had emerged, I took 1-2 drops of blood from (up to) 50% of each clutch before releasing them as a group back on the beach. This large sample size was collected to insure 95% probability that any male fathering 5 or more offspring would be observed

(Galbraith et al. 1989). I also took tissue samples from all unhatched, but developed embryos to see if their fathers were the same as those of emergent hatchlings. I selected four of those successive clutches (from separate females) to analyze, each of which was laid 6-8 weeks after the 1st clutch sampled.

Paternity was investigated at highly polymorphic nDNA microsatellite loci (FitzSimmons et al. 1995) by the identification of alleles in offspring and their mother across five loci and the interpretation of data through principles of Mendelian inheritance. The loci I used are quite variable, with 12 to 42 alleles present in Australian green turtles. At each locus a hatchling receives one allele from each parent, so knowing what the mother's genotype was I could deduce the genotype of the father and determine if multiple paternity had occurred in the clutch.

RESULTS AND DISCUSSION

To date, about 42 (+ 9) offspring have been analyzed per clutch. It appears that multiple paternity is either not present in the clutches studied, or present in only a few clutches at very low frequencies. For 10 of the females, there was no evidence of multiple paternity in the clutches sampled. In three clutches, there may be a few individuals that indicate multiple paternity, but I need to reanalyze those samples. In the four successive clutches studied, there was no evidence of either multiple paternity, or of a change in offspring paternity. Mutations were observed in several offspring, with a rate that appears to be consistent with other microsatellite studies (10-2 to 10-3 mutations per gamete per generation). Statistical analyses have not yet been performed on the data set, so these results should be considered as preliminary.

How to explain this lack of multiple paternity? It may be that there were few males relative to females at the courtship area during the years of the study. Previous data from the 1978/79 season indicated that 71% of the courtship groups were comprised of just a single male and female (Limpus 1993) that could suggest limited opportunity for multiple matings. It should be noted that none of the multiple matings observed in the wild have been quantified as to the duration of the mating, or the probability of successful insemination. Alternatively, multiple matings may occur with regularity but this could be coupled with effective sperm competition. Under this scenario, sperm from the first mating male might travel to preferential storage areas in the upper oviduct. Sperm from subsequent matings by other males may only be able to occupy glands in the lower oviduct, where they have been observed by Solomon and Baird (1979). These sperm would be well downstream of the fertilization sites, and may easily be flushed out as eggs pass down the oviduct. Whatever the explanations, it will be interesting to see how these results compare with green turtle populations in other regions and to other marine turtles in which we know very little about mating.

ACKNOWLEDGMENTS

I extend my thanks to my supervisors Col Limpus and Craig Moritz for their ever present support, and to my field assistants; Meaghan Baird, Anita Heidman, and volunteers of the Queensland Turtle Research Project. I am grateful for the undaunted assistance of Alan Goldizen in preforming an endless amount of lab work.

LITERATURE

Booth, J. and J. A. Peters. 1972. Behavioural studies on the green sea turtle (Chelonia mydas) in the sea. Anim. Behav. 20:808-812.

FitzSimmons, N. N., C. Moritz, and S. S. Moore. 1995. Conservation and dynamics of microsatellite loci over 300 million years of marine turtle evolution. Mol. Biol. Evol. 2: 432-440.

FitzSimmons, N. N. in press. Use of microsatellite loci to investigate multiple paternity in marine turtles. In: Proceedings of the Sea Turtle Genetic Workshop Sept. 12-14, 1995, Miami, Florida. B. Bowen and W. Witzel (eds.). U. S. Dep. of Commer., NOAA Tech memo in press.

Galbraith, D. A., P. T. Boag, and B. N. White. 1989. Sample size decisions in fingerprinting large clutches. Fingerprinting News 2:8-10.

Harry, J. L. and D. A. Briscoe. 1988. Multiple paternity in the loggerhead turtle (Caretta caretta). J. of Hered. 79:96-99.

Limpus, C. J. 1993. The green turtle, Chelonia mydas, in Queensland: breeding males in the Southern Great Barrier Reef. Wildl. Res. 20:513-23.

Solomon, S. E. and T. Baird 1979. Aspects of the biology of Chelonia mydas L. Oceanogr. Mar. Biol. Ann. Rev. 17: 347-361.

Ulrich, G. and A. S. Parkes. 1978. The green sea turtle (Chelonia mydas): further observations on breeding in captivity. J. Zool., Lond. 185:237-251.

MEASUREMENT ERROR: THE GREAT CHELONIAN TABOO

J. Frazier

CINVESTAV - IPN, Unidad Mérida, Mérida, Yucatán, México

A requirement of science is that its information be objective - free from bias. The most usual way to achieve this is by taking measurements and reporting results as numbers. However, there is a common misconception that once measurements are obtained, they need only be described and analyzed. Clearly, numbers are objective values, but measurements are approximations, no matter how sophisticated the instruments and procedures used in making them (Brown, 1994). Hence, measurements are subject to various sources of error. The biological sciences involve a multitude of variables, interactions, levels of organization, and boundary conditions (Brown, 1994); in this light, it has been argued that ecology is far more difficult than rocket science (Hilborn and Ludwig, 1993). If biological phenomena are to be correctly detected and interpreted from within this conceptual Gordian knot, it is essential that true biological variability (or stability) be differentiated from variability (or constancy) that is due to errors in measurements.

Turtle researchers habitually employ a swarm of measurements, on a diverse variety of objects and phases of the life cycle, such as body morphology, growth, and conditions; reproductive parameters; nest values and contents; habitat measurements; and movement and dispersion. Without a doubt, dimensions of body size are among the simplest and the most commonly taken measurements. Comparisons are often made between investigators, study sites, study periods, species, techniques, etc., under the assumption that the differences (or similarities) reflect biological phenomena. Based on these findings, theories are constructed, and conservation and management plans are designed.

Simple and direct as they may be, body measurements are subject to various sources of error, including: the measuring instruments used (e.g., new tape or stretched tape), the ways in which these instruments are read (or misread), the points of measurement (e.g., posterior extension or notch), the measurement type (e.g., curved or straight), "personal style," and random error. Ideally, one wants to restrict error to the last category, and standardize all the other sources of variation. Although basic problems with measurement error in anurans and lizards have been clearly described (Lee, 1982; 1990), few researchers on turtles have dealt with this issue. Mrosovsky (1983) was the first to draw attention to the problem; Shoop and Ruckdeschel (1986) presented the results of an experiment that showed the level of intra- and inter-investigator error can be cause for concern; while Bjorndal and Bolten (1989), Diez and Van Dam (1995) attempted to standardize for different sources of error in body measurements. However, measurement error is generally treated as a taboo. The present study is to show that error is an intrinsic part of scientific work, especially research on sea turtles; unless the diverse sources of error are carefully evaluated and understood, they may lead to misleading or bogus conclusions.

MATERIALS AND METHODS

Four experiments (Exp.) were carried out, using a total of seven desiccated turtle specimens. All specimens were measured for standard carapace lengths and widths; minimum carapace length (see Fritchard et al., 1983: 65) was taken only for specimen T-7.

Exp. I: Eleven marine turtle biologists measured the same carapace of an adult-sized Chelonia mydas (T-1), using the same flexible, fiberglass tape. Curved carapace length (CCL) and curved carapace width (CCW) were recorded. Five of the same people each made a replicate measurement of both CCL and CCW. Each person read and reported their own measurements. Exp. II: six students each measured two shells, and a total series of six parameters. A juvenile Chelonia mydas (T-2) was measured for CCL, CCW, straight carapace length (SCL), and straight carapace width (SCW), and the carapace of a juvenile Eretmochelys imbricata (T-3) was measured for CCL and CCW. Exp. III: six students each measured two shells, and a total series of six parameters: CCL, CCW, SCL, and SCW of T-2, and CCL and CCW of another juvenile Chelonia mydas (T-4). Exp. III was carried out 8 weeks after Exp. II. One student who participated in II, also participated in III. A seventh person measured CCL, CCW, SCL and SCW of just T-2. Exp. IV: was carried out by six people, four who had worked in turtle camps, and two who participated in Exp II. Four shells were measured: T-2, a juvenile Caretta caretta (T-5), an adult-sized Lepidochelys kempii (T-6), and an adult-sized Eretmochelys imbricata (T-7). CCL, CCW, SCL and SCW were measured for all four specimens; in addition, straight and curved minimum carapace lengths were taken for T-7. In total, a series of 18 parameters were measured. Exp. IV was conducted more than 8 months after Exp. II. In Exps. II, III and IV, each person measured a full series; they then repeated the series until they had made a total of 10 of each of the different measurements. The same flexible fiberglass metric tape and caliper were used for the same respective curved and straight measurements of each carapace. For each individual measure, the person making the determination showed the tape or caliper to an observer, who then recorded the value: the person who made the measurements was not to know the values that they were obtaining.

RESULTS

Exp. I: CCL and CCW measurements averaged 96.0 and 90.0 and varied by 3.5 cm and 7.5 cm, respectively. The ranges were less than 4% of mean CCL and more than 8% of mean CCW. Intra-measurer differences between first and second CCL values averaged 0.36 cm, 0.4% of mean CCL; the greatest discrepancy was 1.5 cm, nearly 2% of the mean. For CCW, mean difference between first and second measurements was 0.82 cm, nearly 1% of the mean; greatest discrepancy was 2.7 cm, nearly 3% of the mean.

Exp. II: Analysis of variance (ANOVA) showed significant differences ($p<0.001$) between the means in each of the six sets of measurements. Straight measurements of T-2 were more precise than the respective curved measurements. The values for T-3 were remarkably variable; the range of CCW values was 4.4 cm, or 8.8% of the mean. This shell was not normal, for some scales were warped and raised from the bones below.

Exp. III: ANOVA showed highly significant differences ($p<0.001$) between the means in each of the six sets of measurements. Straight measurements of T-2 were less variable than the respective curved measures.

Exp. IV: ANOVA showed significant differences between means for all values, except the SCW of T-2. As in the earlier experiments, straight measurements were less variable than curved for T-2 and T-5. In T-6, curved lengths were more precise for 2/3 of the measurers while straight widths were more precise, for 2/3 of the measurers. In T-7, straight measures were more generally more precise. Most people "forced" width measurements of T-6, when in fact a deep notch on the side made these measures impossible.

The three students who participated in two experiments (one in Exp. II and III, and two in Exp. II and IV) each made the full series of 10 replicates of four measurements of T-2 on two different occasions. There were significant differences between the means of the measurements taken on the two dates: for CCL (2 of 3 students; $t > 4.6$, $p<0.001$), CCW (all 3 students; $t > 2.1$, $p< 0.05$), SCL (2 of 3 students; $t > 2.8$, $p< 0.02$) and SCW (2 of 3 students) ($t > 7.1$, $p<0.001$).

CONCLUSIONS AND DISCUSSION

Straight carapace measurements are less variable than curved; some people are more precise measurers than others; some individual turtles and some species of turtles are more difficult to measure precisely than others. There is a tendency for more variation, and more divergent values, in the first of a series of measurements, therefore, there may be an experience-dependent (learning) effect involved in measurement variation. Measurements of the same carapace, made by different people using with the same equipment and same measuring techniques, can be significantly different in both variance and average values. Even the same person measuring the same carapace and using the same equipment and technique, but on different occasions, may produce statistically different results.

Comparisons in body measurements are used to differentiate species, populations, sexes, age classes, growth rates and other biological characters. However, if measurement error is not accounted for, important biological differences (or similarities) may be obscured or exaggerated. For example, in the present study, the differences between average measurements could have been interpreted as differences between populations, when in fact the same person was measuring the same carapace with the same tape, on different occasions.

Are the kinds, and magnitudes of error documented in these experiments really relevant? First, the errors reported here are likely to be less than what normally occurs in field conditions: (a) the measuring equipment was identical between measurers; (b) measuring conditions were unusually comfortable (e.g., daylight, immobile shell, no biting flies, etc.); (c) people were conscious that their measurements were being evaluated, so were being especially careful; (d) many values from repeated measurements are likely to NOT be independent (as shown by the consistency of "forced" measures). Secondly, the magnitude of the errors reported here are less than annual growth rates reported for various studies in different areas.

During this study five flexible tapes were used; one used in the field measured 1.485 beside a new tape that checked with a caliper at 1.500 m (i.e., a discrepancy of 2.5 cm in 1.5 m). Clearly, any measurements taken with this used tape would be inaccurate, just because of the instrument used in measuring. Unfortunately, this kind of problem is common, for often field workers are rather "casual" about the condition of their equipment, including that used for measuring. Indeed, often the objectives, and basic requirements, of research activities are not clear (Frazier, 1993; 1994).

In many conservation and research activities involving sea turtles, it is usual to engage different people to carry out measurements and observations at different times and places. These may be technicians, assistants, volunteers, or other types of collaborators, and it is common for the personnel to change from year to year or place to place (Frazier, 1993). If researchers are not even calibrating their measuring equipment, it is even less likely that they will be training personnel and making organized efforts to avoid, or reduce, errors between people. As a result, many data - though they involve the simplest of technologies - may be subject to diverse sources of error. Conclusions based on differences or similarities in these data may be completely erroneous, and higher levels of inferences and conceptual constructs may be totally fallacious. When conservation and management decisions are based on data that are subject to diverse sources of error, the problems may be more than intellectual and academic. Inappropriate decisions could easily be counterproductive in the efforts to protect species and their habitats.

RECOMMENDATIONS

Objectives: It is imperative that research objectives be clear: why are measurements being taken? (Is "reflexive measuring" valid?). The methodology must be designed with reference to the objectives: if the data collected are not sufficiently precise, they may not be usable for certain types of analysis.

Personnel: All measurers must be trained to standardize techniques and reduce variation, especially if volunteers and a number of different people are involved in measuring activities. Measurers must be tested for internal (intra-measurer) precision, and variability with other measurers. The most precise measurers should be relied upon. Measurements must not be "forced" when they are not accurately obtainable.

Equipment: Appropriate instruments must be used for the measurements needed (e.g., tree calipers with long, unstable jaws are unsuited for turtles). Measuring equipment must be maintained and calibrated regularly.

Measurements: Measurements must be tested for precision. Only those measurements that give the best precision should be used, and confidence limits should be calculated and considered, especially when converting values, e.g., curved to straight.

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LITERATURE CITED

Bjorndal, K. A. and A. Bolten. 1989. Comparison of Straight-line and Over-the-curve Measurements for Growth Rates of Green Turtles, Chelonia mydas. Bull. Mar. Sci. 45(1): 189-192.

Brown, A. C. 1994. Is Biology a Science? Trans. R. Soc. S. Afr. 49, Pt. 2: 141-146.

Diez, C. E. y R. Van Dam. 1995. Foraging Ecology and Population Dynamics of the Hawksbill Eretmochelys imbricata) at Mona Island, Puerto Rico. Unpublished Research Report, Japan Bekko Association, Departamento de Recursos Naturales de Puerto Rico.

Frazier, J. 1993. Una Evaluación del Manejo de Nidos de Tortugas Marinas en la Península de Yucatán. In: J. Frazier (chief ed.) Memorias del IV Taller Regional de Tortugas Marinas en la Península de Yucatán. Universidad Autónoma de Yucatán; Mérida, México. pp. 37-76.

Frazier, J. 1994. La Tortuga Marina: ¿Dios, Seducción, Excusa, o Recurso? Bol. Soc. Herpetol. Mex. 60(1): 9-14.

Hilborn, R. and D. Ludwig. 1993. The limits of applied ecological research. Ecological Applications 3(4): 550-552.

Lee, J. C. 1982. Accuracy and Precision in Anuran Morphometrics: Artifacts of Preservation. Syst. Zool. 31(3): 266-281.

Lee, J. C. 1990. Sources of Extraneous Variation in the Study of Meristic Characters: The Effect of Size and of Inter-Observer Variability. Syst. Zool. 39(1): 31-39.

Mrosovsky, N. 1983. Conserving Sea Turtles. British Herpetological Society, London. (vii) + 176 pp.

Pritchard, P. C. H., P. Bacon, F. Berry, A. Carr., J. Fletemeyer, R. Gallagher, S. Hopkins, R. Lankford, R. Márquez M., L. Ogren, W. Pringle, Jr., H. Reichart and R. Witham. 1983. Manual of sea turtle research and conservation techniques (2nd ed.) K. A. Bjorndal and G. H. Balazs (eds). Center for Environmental Education; Washington, D. C. 108 pp + 40 pls.

Shoop, C. R. y C. Ruckdeschel. 1986. Guest Editorial: Measuring Sea Turtles. Mar. Turtle Newsletter 36: 10-12.

MIGRACION DEL CAREY (Eretmochelys imbricata) EN LA PLATAFORMA CUBANA

Felix G. Moncada Gavilan

Centro de Investigaciones Pesqueras, Cuba

INTRODUCCION

El Presente trabajo tiene como objetivo ampliar los resultados obtenidos por Moncada (1994) y Moncada et.al. (1995), del estudio de las migraciones del carey en la plataforma cubana, principalmente en la Cayeria de las Doce Leguas, región de reproducción y alimentación más importante de esta especie en el archipiélago cubano.

METODOS

Para este trabajo se aplicó la metodología y se utilizó la información de los trabajos citados anteriormente, adicionándose los datos obtenidos hasta diciembre de 1995.

En total se han marcado 514 careyes, fundamentalmente en los meses de mayo a julio en las regiones nororiental y suroccidental de Cuba y de septiembre a diciembre en la región suroriental. Se marcaron careyes de los sexos en áreas pesqueras de Nuevitas (Punta de Ganado), Las Tunas (Morrillo, Cobarrubia y Palancón), Cayería de las Doce de Leguas y S de la Isla de la Juventud. También se marcaron hembras anidadoras en la Cayería de las Doce Leguas así como juveniles del Criadero Experimental de Tortugas Marinas de las Isla de la Juventud y de algunas lagunas de las Doce Leguas (Fig.1).

RESULTADOS Y DISCUSION

En total se han recapturado 43 careyes marcados (44 recapturas) en diferentes localidades de la plataforma cubana, equivalente al 8.3%. Los datos referentes a todas las recapturas se presentan en las Tablas 1 y 2.

Los lugares en donde fueron recapturados los careyes marcados en las áreas de Nuevitas y Las Tunas y las posibles trayectorias de los mismos, se muestran en la Fig. 2.

De 27 recapturas (23 hembras y 4 machos) 15 se hallaron hasta a una distancia de 36 km al E de Nuevitas, entre Morrillo y Cobarrubia, 2 a unos 90 km entre Gibara y Punta de Mangle, uno a 320 km al N de Baracoa, 6 cercanos a los 370 km entre el N ye el S de la Punta de Maisí y uno a 744 km en la costa S cerca de Cabo Cruz. Dos careyes se recapturaron al N de Cayo Confite, al W de donde fueron marcados, siendo y uno de ellos reportado dos veces; la primera vez cerca de Cobarrubia a los 6 días de la marcación y la segunda cerca del cayo antes mencionado 425 días después.

Los sitios y la secuencia del marcado-recaptura, los días de liberación, la distancia recorrida y la velocidad desplegada, indican que los careyes recapturados nadaron cerca de la costa a favor de la corriente, con velocidades entre 0.8 y 18 km/día; en una región donde no se han reportado playas de anidación por lo que se deduce que esta sea un área de tránsito de los careyes que se dirigen a la costa S de Cuba.

Según García (1990) la corriente en la costa S de la plataforma cubana se dirige de E a W todo el año, y en la costa N de W a E en el verano y a la inversa en el invierno. Teniendo esto en cuenta, los do careyes recuperados cerca de Cayo Confite, pudieron desplazarce alrededor de la Isla nadando a favor de la corriente, haberse trasladado hacia el E y virar contracorriente o moverse hacía el E y virar al invertirse la corriente en la época de invierno.

Con relación a los careyes marcados y recapturados en la Cayería de la Doce Leguas, los resultados sugieren un comportamiento diferente a los explicado para la región nororiental.

La Cayería de la Doce Leguas está formada por más de 15 cayos pequeños y continuos que suman cerca de 100 km. De ellos alrededor de 45 km son playas arenosas, disponibles para la anidación. Está rodeada de arrecifes coralinos y es la principal zona de reproducción de esta especie en el archipiélago cubano (Moncada et. al. 1987).

De los 514 careyes marcados en la platforma cubana 141 se marcaron en la Cayería de las Doce Leguas, de los cuales se obtuvieron 17 recapturas dentro de la misma Cayería (Fig. 3).

Seis careyes (3 machos, 2 hembras y 1 subadulto) marcados cerca de los cayos Caballones y Anclitas, entre septiembre y noviembre, fueron localizados en esta misma área al año siquiente; los adultos entre agosto y diciembre, meses principales de reproducción del carey en esta zona con la excepción de agosto y el sub adulto en el mes de junio.

Dos careyes (1 hembra y 1 macho) marcados el la misma área y meses que los anteriores, fueron recapturados en el período reproductivo y en el mismo lugar, a los dos años de liberados.

Un ejemplar macho marcado al S de cayo Anclitas en època de reproduccion, fue localizado a los 46 días en el Canal del Pingue (noroeste de la Cayería) aproximadamente a 70 km de donde fue marcado.

Tres ejemplares (1 macho y 2 subadultos) liberados en la costa N de Caballones, se recuperaron de la siguiente forma; el macho a los 120 días frente a la playa de anidación de Cayo Anclitas, en época de reproducción; uno de los subadultos a los 310 días en Cayo Carabela al noreste de la Cayería, a 80 km del lugar del lugar de marcación y el otro subadulto en la costa norte de Cayo Anclitas dos años y medios después de la liberacion.

Una hembra marcada también cerca de cayo Caballones en la temporada de reproducción, fue hallada a los dos años y tres meses al N de la Cayería cerca de cayo Palomo, fuera de la época de reproducción.

Con relación a los 4 careyes restantes (3 hembras y 1 macho), estos se recapturaron en un intervalo de tiempo muy corto, entre 2 y 22 días por lo que no se obtuvo información sobre la migración. Sin embargo si se obtuvieron datos sobre el intervalo de anidación para dos hembras marcadas anidando en Playa Bonita (Caballones), que fueron recapturadas en las misma, encontrándose que estas volvieron a anidar a los 18 y 22 días después.

Como se puede observar los resultados obtenidos en la Cayería de las Doce Leguas, indican la posibilidad de que algunos careyes permanecen estables dentro de la misma durante un tiempo considerable; deduciéndose que se mueven en todas las direcciones de la Cayería, en dependencia quizás de la fase de vida del individuo y de la época del año. Bustard (1979) plantea que la existencia de playas de anidación cercanas a los arrecifes coralinos, condiciona la presencia de careyes residentes y Carr (1980) suguiere para la tortuga verde (Chelonia mydas), que cuando la alimentación y la anidación son posibles en un área con condiciones óptimas (temperaturas de las aguas superiores a 15°C), parece no haber obligación ecológica para que las tortugas abandonen el lugar. En el caso de la Cayería de las Doce Leguas, existen numerosas playas de anidación muy cerca de la barrera coralina que bordea la misma; las temperaturas promedio de las aguas son siempre superiores a los 23°C (Garcia, 1981) y según Anderes y Uchida (1994), esta es la principal área de alimentación del carey en toda la plataforma. Por tanto los condiciones planteados por estos autores al parecer se presentan en esta región.

Con relación a la velocidad de desplazamiento dentro de lay Cayería, esta no se pudo precisar como en la zona nororiental, debido a que casi todas las recapturas se obtuvieron much tiempo después de la marcación y la mayoría cerca del lugar del marcado. Solo para dos ejemplares se obtuvo esta información, calculándose una velocidad de 0.3 y 1.5 km/día.

En general los resultados de las marcaciones obtenidos por diferentes autores revisados y recopilados por Meylan (1981) y Witzell (1983), evidencian que el carey en algunos casos migran largas distancia moviéndose incluso hacia otras áreas) y en otros se comporta de manera residente.

Los resultados obtenidos de la marcación en Cuba hasta la fecha confirman estas dos posibilidades: careyes que efectúan movimientos largos, que en este caso lo hicieron dentro do la plataforma y careyes que se mantienen practicamente estables en una región durante un tiempo considerable.

Con relación a los careyes marcados en el S de la Isla de la Juventud no se ha encontrado hasta el presente ninguna recaptura.

CONCLUSIONES

- Se han marcado 514 careyes en toda la plataforma, recapturándose 43 ejemplares (44 recapturas) equivalente al 8.3%.
- Los Careyes marcados en Nuevitas y Las Tunas se recapturaron a lo largo de las costas N y S de la región oriental de Cuba.
- Se recapturaron 17 careyes cerca de las mismas áreas de donde fueron marcados, en la Cayería de las Doce Leguas.

- Los resultados obtenidos hasta el presente indican que en Cuba existen careyes que efectúan movimientos largos y cortos dentro de la plataforma y careyes que se mantienen estables por un tiempo considerable.

REFERENCIAS

Anderes, B.L. and I. Uchida. 1994 Study of hawksbill turtle (Eretmochelys imbricata) stomach contents in Cuban waters. In: Study of hawksbill turtle in Cuba (1) Ministry of Fishing Industry in Cuba.

Bustard, H. 1979. Population dynamics of sea turtle. In: Turtles: Perspectives and research. Ed. M. Harless and H. Morlock. New York, John Witey and Sons. 523-40 pp.

Carr, A.F. 1980. Some problems of sea turtles ecology. Amer. Zool. 20:489-498.

Garcia, C. 1981. Temperaturas oceanicas de las aguas de Cuba. Temperaturas superficiales (I). Rev.Cub.Invest.Pesq.

_______. 1990. Dos años de trabajo. B.I.C. "Ulises." Folleto CIP/MIP Cuba 17.

Meylan, A. 1981. Sea turtle migration evidence from tag returns. In: Biology and conservation of sea turtles. Edit: K. Bjorndal. Smithsonian Institution, Washington, D.C. 91-100 pp.

Moncada, F. 1994. Migration of hawksbill turtle (Eretmochelys imbricata) in the Cuban platform. In: Study of hawksbill turtle in Cuba. (1) Ministry of Fishing Industry, Cuba.

_______. E, Carrillo, S. Elizade, G. Nodarse, B.L. Anderes. C. Scantelbury, A. Alvarez y A. Rodriguez (en prensa). Migración de las tortugas marinas en la plataforma cubana. In: Proc. XV Symposium on Sea Turtles Biology and Conservation. Hilton Head Island, South Carolina, USA. 1995.

_______. R. Cardona y G. Nodarse. 1987. Comportamiento reproductivo de los quelonios marinos en el archipiélago cubano. I Congreso Ciencias del Mar, MarCuba 1987. Cuba.

Witzell, N.W. 1983. Synopsis of biological data on the hawksbill turtle Eretmochelys imbricata (Linnaeus, 1766). FAO. Fisheries Synopsis (137):78 pp.

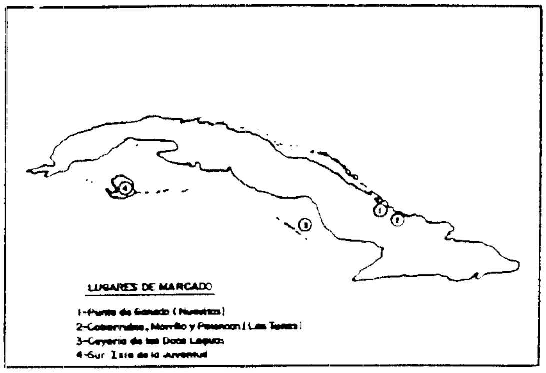

Fig 1 -Lugares donde se realizo la marcación

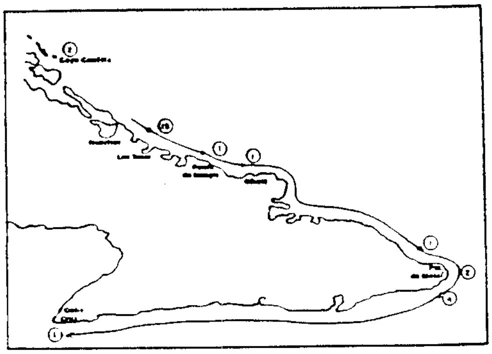

Fig 2 -Lugares de recaptura y posible trayectorias de los careyes recapturados, procedente de las areas pesqueras de Nuevitas y Las Tunas

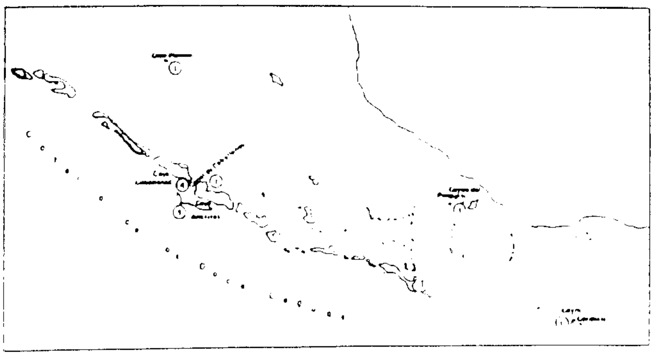

Fig 3 -Lugares donde fueron recapturados los careyes en cayeria de las Doce Leguas

Tabla 1.- Relación de careyes recapturados que fueron marcados en Nuevitas y Las Tunas.

Recap.	Marca	Sexo	Largo (cm)	Fecha marcado	Feha recaptura	Días libre	Lugar marcado	Forma captura y recaptura	Lugar recaptura	Recorrido (km)	Velocidad Promedio
1	CU0308	M	69	12.05.89	17.05.89	5	Pta.Ganado	Redes	Cobarrubia	36	7.2
2	CU0317	H	65	19.05.89	25.05.89	6	Pta.Ganado	Redes	Cobarrubia	36	6.0
3	CU0319	M	68	19.05.89	25.05.89	6	Pta.Ganado	Redes	Cobarrubia	36	6.0
4	CU0352	H	71	13.06.89	18.06.89	5	Pta.Ganado	Redes	Cobarrubia	36	7.2
5	CU0353	M	84	14.06.89	24.06.89	10	Pta.Ganado	Redes	Palancón	41	4.1
6	CU0359	H	78	18.06.89	13.07.89	25	Pta.Ganado	Redes	N.Baracoa	320	12.8
7	CU0367	M	72	22.06.89	13.07.89	21	Pta.Ganado	Redes	S.Pta Maisí	348	16.6
8	CU0369	H	77	23.06.89	28.06.89	5	Pta.Ganado	Redes	Cobarrubia	36	7.2
9	CU0371	H	71	24.06.89	29.06.89	5	Pta.Ganado	Redes	Cobarrubia	36	7.2
10	CU0373	H	75	24.06.89	01.07.89	7	Pta.Ganado	Redes	Cobarrubia	36	5.1
11	CU0377	H	76	26.06.89	25.07.89	29	Pta.Ganado	Redes	Cobarrubia	372	14.3
12	CU0517	H	73	25.05.89	01.07.89	37	Pta.Ganado	Redes	S.Pta Maisí	372	10.1
13	CU0536	H	63	25.06.89	19.09.89	24	Cobarrubia	Redes	S.Pta Maisí	372	15.5
14	CU0382	H	69	30.06.89	26.06.89	26	Pta.Ganado	Redes	S.Pta Maisí	372	6.2
15	C3121	H	70	18.05.90	01.06.90	14	Pta.Ganado	Redes	Cobarrubia	36	2.2
16	C3124	H	76	20.05.90	26.06.90	36	Pta.Ganado	Redes	S.Pta.Maisí	372	6.2
17	C3128	H	72	22.05.90	21.08.91	455	Pta.Ganado	Redes	C.Confites	2040	4.5
18	C3146	H	77	31.05.90	24.07.90	54	Pta.Ganado	Redes	Cabo Cruz	744	13.8
19	C3155	H	67	06.06.90	08.06.90	2	Pta.Ganado	Redes	Cobarrubia	36	18.0
20	C3162	H	78	08.06.90	14.06.90	6	Pta.Ganado	Redes	Cobarrubia	36	6.0
21	C3162			14.06.90	07.08.92	425	Cobarrubia	Redes	C.Confites	2020	4.8
22	C3163	H	72	08.06.90	13.06.90	5	Pta.Ganado	Redes	Cobarrubia	36	7.2
23	C3169	H	76	12.06.90	14.06.90	2	Pta.Ganado	Redes	Cobarrubia	36	18.0
24	C3185	H	81	22.06.90	06.08.90	45	Pta.Ganado	Redes	Gibara	96	2.1
25	C3192	H	82	24.06.90	20.09.90	88	Pta.Ganado	Redes	Pta.Mangle	74	0.8
26	C3293	H	71	26.05.90	31.05.91	5	Pta.Ganado	Redes	Morrillo	21	4.2
27	C3348	H	72	25.06.91	27.06.91	2	Pta.Ganado	Redes	Morrillo	21	10.5

Tabla 2.- Relación de careyes que fueron marcados y recapturados en la Cayería de las Doce Leguas.

Recap.	Marca	Sexo	Largo (cm)	Fecha marcado	Feha recaptura	Días libre	Lugar marcado	Forma colecta	Lugar recaptura	Forma recaptura	Recorrido (km)	Velocidad Promedio
1	CU0455	M	86	17.09.89	02.08.90	319	S.Cayo Anclitas	Redes	S.Cayo Anclitas	Redes	-	-
2	CU0453	H	75	17.09.89	08.10.91	692	S.Cayo Anclitas	Redes	S.Cayo Anclitas	Redes	-	-
3	CU0477	M	78	29.09.89	21.09.91	720	S.Cayo Anclitas	Redes	S.Cayo Anclitas	Redes	-	-
4	C4402	H	68	07.10.91	09.10.92	367	S.Cayo Anclitas	Redes	S.Cayo Anclitas	Redes	-	-
5	C4404	H	70	08.10.91	11.10.92	368	S.Cayo Anclitas	Redes	S.Cayo Anclitas	Redes	-	-
6	C4003	H	72	10.10.91	08.01.94	810	Canal Caballones	Redes	Cayo Palomo	Redes	-	-
7	C4004	M	68	14.10.91	16.09.92	337	Canal Caballones	Redes	Canal Caballones	Redes	-	-
8	C0138 C0139	M	68	15.05.92	13.09.92	120	N.Caballones	Redes	S.Cayo Anclitas	Redes	-	-
9	C0129 C0150	I	42	15.05.92	20.03.93	310	N.Caballones	Redes	S.Cayo Carabela	Redes	80	0.3
10	C0128	I	39	15.05.92	20.12.94	947	N.Caballones	Redes	N.Cayo Anclitas	Redes	-	-
11	C0152	M	78	04.11.93	20.12.93	46	S.Cayo Anclitas	Redes	Cayos del Pingue	Redes	70	1.5
12	C0163	I	45	11.09.93	15.06.94	218	S.Cayo Anclitas	Redes	S.Cayo Anclitas	Redes	-	-
13	C0311	M	75	17.10.94	19.10.94	2	Canal Caballones	Redes	Canal Caballones	Redes	-	-
14	C0316	H	74	20.10.94	22.10.94	2	Canal Caballones	Redes	Cayo Caballones	Anidando	-	-
15	C0164	H	83	22.10.94	09.11.94	18	Cayo Caballones	Anidando	Cayo Caballones	Anidando	-	-
16	C0165	H	80	05.11.94	27.11.94	22	Cayo Caballones	Anidando	Cayo Caballones	Anidando	-	-
17	C0312	M	75	17.10.94	08.12.95	416	Cayo Caballones	Redes	Cayo Caballones	Redes	-	-

NUTS, BOLTS, PLATES, AND SCREWS: PRACTICAL TECHNIQUES FOR REPAIRING FRACTURED TURTLE SHELLS

Robert H. George[1&2], Marianne Lee[2], and Soraya Moein-Bartol[1]

[1] Sea Turtle Program, Virginia Institute of Marine Science, Gloucester Point, VA. 23062
[2] Gloucester Veterinary Hospital, Gloucester, VA. 23061

Turtles are frequently struck by pleasure boats and other man-made objects. These collisions often result in fractures of the carapace and/or plastron and the underlying bones. In the past, most techniques for bone and shell repair employed fiberglass and epoxy resins (Frye, 1991). Schoelkopf (1992) used human orthopedic plates to repair the shell of a damaged sea turtle. Surgical plates were attached to the shell and underlying bone with stainless steel screws. Plates and screws were placed on a turtle to help return the fractured bone to its normal position and stabilize the bone and shell while the turtle's body healed the fracture. Schoelkof's technique can be modified to use material available in most hardware stores. Holes are drilled in the shell, damaged pieces of shell are placed in apposition, and plates are screwed in place. Plates and screws provide temporary support until the turtle's body can produce enough scar tissue to hold the shell in place. Hardware is removed after a month, and the turtle can be released shortly thereafter. This technique has been successfully employed with marine and freshwater turtles.

METHODS

In July of 1994, a live loggerhead sea turtle, (Caretta caretta) stranded in Chesapeake Bay, VA. and was retrieved by the Virginia Marine Mammal and Sea Turtle Stranding Network. The 29 kg animal was floating and non-responsive to external stimuli. It had a fractured skull with a fragment of bone displaced inward, putting pressure on the right eye. The eye was deviated in a ventro-caudal direction and was not responsive to light.

We anesthetized the turtle with intravenous ketamine (George et al., 1990) and the wounds were cleansed with iodine surgical scrub and alcohol. Aseptic technique was employed as much as possible. Plates and screws were disinfected with solutions of iodine and alcohol while the drill and bits were gas sterilized with ethylene oxide. A pilot hole was placed in the center of the loose bone fragment using a Black and Decker 1/4" electric drill. A .5" long #8 steel screw was inserted in the pilot hole and screwed into the bone. The screw was grasped with pliers and lifted, this action pulled the attached bone into its normal position. The first screw was removed from the bone fragment and, using the same hole, an L-shaped zinc coated steel plate was screwed to the fragment. Once the bone fragment and plate were in the desired position, another hole was drilled medial to the fracture. A second screw was then placed through the plate and into the hole. The plate was removed once and slightly bent. At this time, a nut was placed between the screw and plate. Bending the plate allowed for fine positioning of the bone fragment and the nut allowed the screw to be tightened without penetrating too deep into the skull. Wound care consisted of covering the fracture site with New Skin TM; the turtle was allowed to recover (24 hours) in 4 in. of water. Amikacin was administered for 2 weeks post-surgery. Normal activity was noted the day after surgery and the turtle's eye had returned to its normal position and appeared to function.

One month post-surgery the plate and screws were removed and the hole sealed with a commercial epoxy resin. Since the turtle was eating and the wound was stable, the turtle was released approximately 4 months post-surgery.

RESULTS AND DISCUSSION

Although the turtle was maintained in salt water, little corrosion was noted on the plate and screws when they were removed. While not fully healed, the fractured bone remained stable and in a normal position. Multiple plates or plates of various shapes can be used to repair more complicated fractures. This technique of external fracture repair allows for proper alignment of bone and shell fragments, provides excellent stabilization, does not harbor infection, and does not interfere with the body's healing processes. It allows fractured shells to be stabilized with inexpensive, readily available hardware and a minimum of surgical instrumentation.

LITERATURE CITED

Frye, F. L. 1991. Reptile Care, An Atlas of Diseases and Treatments. TFH Publications, Neptune City, New Jersey. Vol.2, pp. 449-452.

George, R. H., S. Bellmund, J. Musick. 1990. Alphaxalone/alphadolone and Ketamine HCl as anesthetic agents in the loggerhead sea turtle, Caretta caretta. In: Proceedings Ninth Annual Workshop on Sea Turtle Conservation and Biology. Jekyl Is. Ga. p.65

Schoelkopf, R. C. 1992. Surgical reconstruction of the carapace of a loggerhead sea turtle. In: Mar.Tur. Newsletter, K. Eckert and S. Eckert (eds.) No. 57, pp. 9-11.

DENSITY-DEPENDENT HATCHLINGS SEX-RATIO IN LEATHERBACKS (Dermochelys coriacea) ON A FRENCH GUIANA NESTING BEACH

Marc Girondot[1] and Anton Tucker[2]

[1]2URA "Formations squelettiques", 2 place Jussieu, 75251 Paris cedex 05, France
[2]Department Zoology, Univ. Queensland, Brisbane 4072 Qld, Australia

INTRODUCTION

For marine turtles, the indirect influence of a dynamic beach environment has importance for the success or failure of each nest. At high density nesting beaches, intraspecific nest destruction may be at least as important in determining nest success as are other factors (e.g., erosion, flooding, and predation) (Bustard and Tognetti, 1969). In addition, the conditions of nest incubation directly influence the secondary sex ratio because marine turtles have temperature dependent sex determination (Pieau et al., 1994). However, the combination of direct and indirect processes on the outcome of the sex ratio of hatchlings is seldom considered.

To address this topic, we used a mathematical model to predict how density-dependent nest destruction would affect the sex ratio of hatchlings when the mean temperature at a beach (and therefore the primary sex ratio) varies during the season. To test the model required time series data on intraspecific nest destruction, pivotal temperatures, and temporal changes in the thermal profile of the beach. We collected these data in French Guiana at the highest known nesting density for Dermochelys coriacea in the Atlantic (Fretey and Girondot, 1989).

In this region, the nesting species of decreasing numerical importance are: Dermochelys coriacea, Chelonia mydas, Lepidochelys olivacea and sometimes also Eretmochelys imbricata. The Ya:lima:po beach is located at the estuary of the Mana and Maroni rivers near the Surinam border. This is the main nesting beach and 90-95% of the nests of French Guiana are deposited on that 8 km beach. The nesting season extends from early March in the cooler rainy season to middle August in the dry season. The thermosensitive period of development for sex determination (TSP) is in the middle-third part of the embryonic development (Desvages et al., 1993). Previous studies have shown that nests deposited with TSP within the rainy season are mostly masculinized and those deposited within warm season are feminized (Rimblot-Baly et al., 1986).

MATERIAL AND METHODS

At the peak of the nesting season, nesting activity is intense and nesting females often excavate previous nests with living embryos. To quantify intraspecific nest destruction, we estimated the frequency of females excavating previously laid nests containing living embryos. This parameter was estimated during the 3 main months of the 1994 nesting season and data have been grouped by 15 days interval. The proportion of nesting females excavating previous nests had a maximum at 23%. Leatherback females nesting on the Ya:lima:po beach have been counted or estimated by interpolation during all the 1994 nesting season. Forty-four percent of the season's nests are deposited while the TSP was in a masculinizing period. This value was not used as the primary sex ratio but as an index to calculate the consequences of this destruction by nesting females.

The analytical model is relatively simple and is described graphically in fig. 1. The parameters in the model are: XY, the effective size of the nesting beach, ie. the size of an ideal beach in which females nest with uniform probability along both axes; k, the daily probability that a nest will be destroyed by abiotic or biotic factors, but not including the destruction by nesting females; Dk is the daily change in this parameter and it can be positive or negative; and d is the probability that an excavated nests still contains living embryos.

We fit this function iteratively to find optimal values for the parameters that best explained the observed distribution of intraspecific nest destruction during the nesting season. We used two iterative methods in sequence. First, we used a genetic algorithm to obtain a roughly good estimation of the set of parameters and then used a steepest descent gradient method to search for the optimal combination of fitted parameters around minimum.

RESULTS

We found that the d parameter has so little influence on the distribution of nesting females excavating previous nests that the parameter could not be accurately estimated from the initial model. However, XY, k and Dk could be estimated.

The k parameter was relatively high: more that 3% of the nests are destroyed per day and the rate increases slightly enhanced during the nesting season. The effective size of the beach (= uniform nesting distribution along both axes) is one tenth of the actual size (70,000 m^2). This result is consistent with the observation that nests are grouped near vegetation and the upper region of the beach was far most affected than other regions. We examined the effects of these parameters on those nests which successfully incubated full term. Because the d parameter could not be estimated, for all the further results we varied the parameter from 0 to 1.

In fig. 2 are presented the distributions of intact nests at the end of the incubation for d = O and 1 using the set of parameters minimizing the difference between observed and calculated frequency of females excavating previous nest. As a first approximation, both distributions are very similar. Less than 10% of the nests contain living embryos at the end of the incubation time; this value agrees with previous estimations made in 1979 (Fretey and Lescure, 1979). Moreover, the proportion of intact nests with TSP in a feminizing period is enhanced compared to the distribution of the nest on the beach. This is because the early nests laid within the rain season are more subject to destruction than the late laid nests laid within the dry season. The effect of nesting density was next investigated since this factor varies annually. We compared the frequency of intact and destroyed nests from 3 successive years of varying nesting density concordant with those observed in french Guiana (15,000; 30,000 and 60,000 nests during the season).

The data indicated density-dependence in nest survivorship, i.e., an increasing female density resulted in increased intraspecific nest destruction. Even so, the available space in which to nest is far from be saturated because the number of intact nests continues to increase when the number of nesting females increases (not shown). Thus, surprisingly, this phenomenon did not produce a significant density-dependent regulation of the population size and is contrary to the outcome proposed by (Bustard and Tognetti, 1969).

However, we did find a bias toward feminization of primary sex ratio that was density-dependent. When the number of nesting females is enhanced, the bias is stronger.

In summary, the proportion of intact nests at the end of the incubation is around 10% and the value was density-dependent at this high density beach. Nest-destruction by nesting females is a minor phenomenon compared to the destruction by other abiotic factors (k and Dk). However intraspecific nest destruction did produce a significant bias in primary sex ratio relative to the temporal distribution of nesting females arriving through the season.

LITERATURE CITED

Bustard, H.R. and Tognetti, K.P. - 1969 - Green sea turtles: a discrete simulation of density-dependent population regulation. Science, 163: 939-941.

Desvages, G., Girondot, M. and Pieau, C. - 1993 - Sensitive stages for the effects of temperature on gonadal aromatase activity in embryos of the marine turtle Dermochelys coriacea. Gen. Comp. Endocrinol., 92: 54-61.

Fretey, J. and Girondot, M. - 1989 - L'activite de ponte de la tortue luth, Dermochelys coriacea (Vandelli, 1761), pendant la saison 1988 en Guyane francaise. Rev. Ecol. (Terre Vie), 44: 261-274.

Fretey, J. and Lescure, J. - 1979 - Rapport sur l'etude de la protection des tortues marines en Guyane francaise. Notes sur le projet de reserve naturelle de Basse-Mana. Minist. Environ., Mineogr., 59 pp.

Pieau, C., Girondot, M., Desvages, G., Dorizzi, M., Richard-Mercier, N. and Zaborski, P. 1994. Environmental control of gonadal differentiation. In Short, R.V. and Balaban, E. (eds.), The Differences Between the Sexes. Cambridge Univ. Press, Cambridge, U.K., pp. 433-448.

Rimblot-Baly, F., Lescure, J., Fretey, J. and Pieau, C. - 1986 - Sensibilite e la temperature de la differenciation sexuelle chez la tortue Luth, Dermochelys coriacea (Vandelli, 1761); application des donnees de l'incubation artificielle e l'etude de la sex-ratio dans la nature. Ann. Sc. Natur., 13: 277-290.

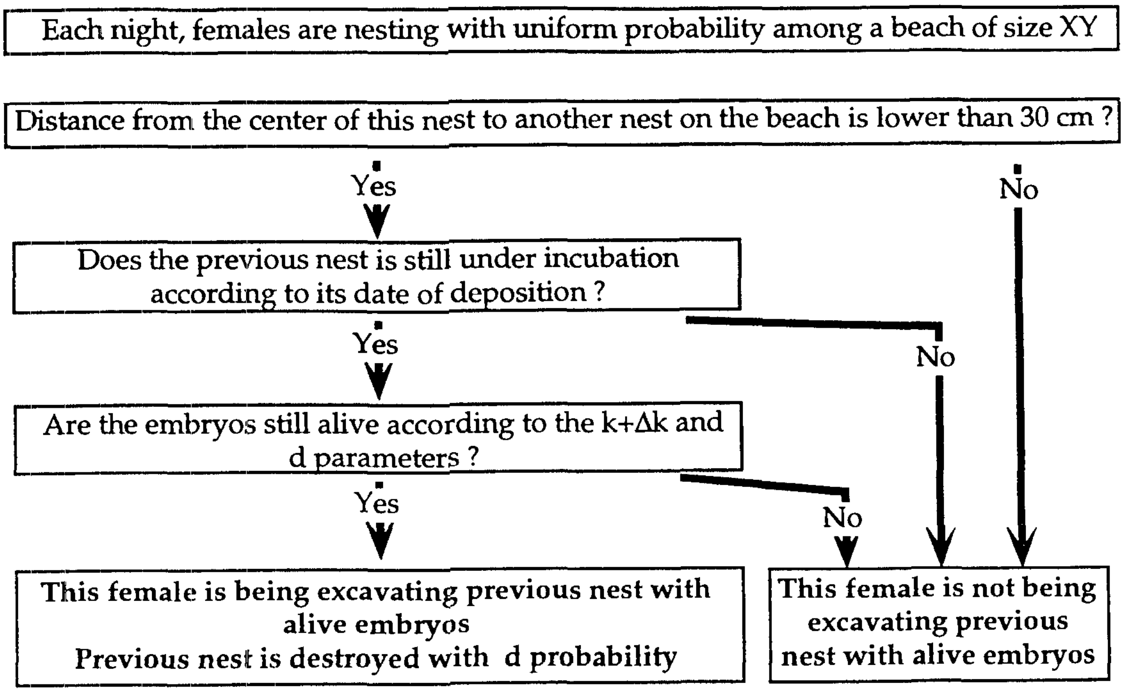

Fig. 1. Organigram of the simulation. See the text for the definition of parameters.

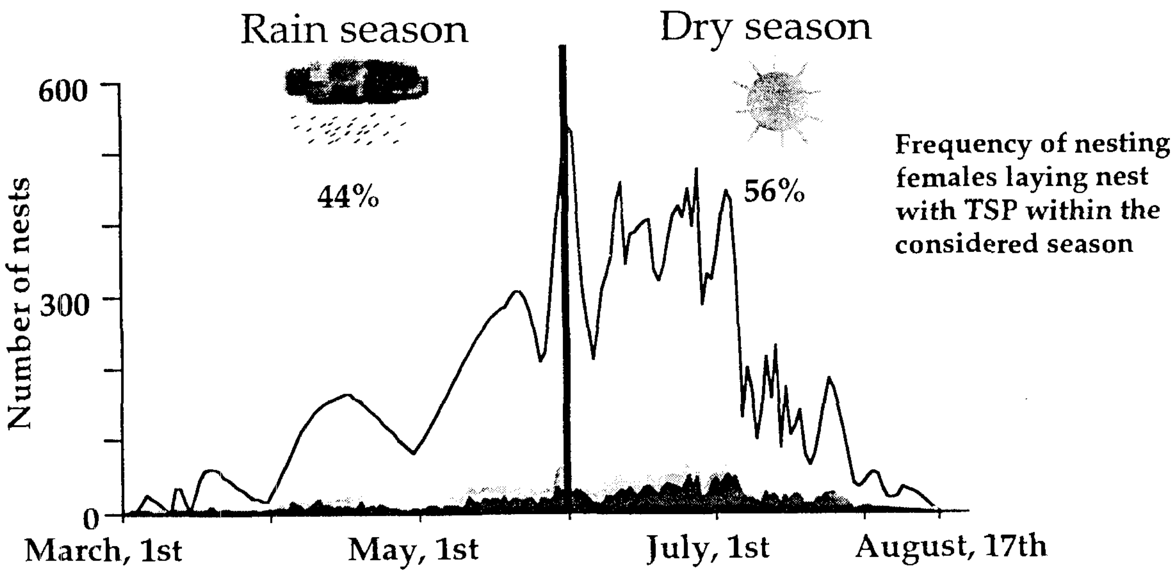

Fig. 2. Distribution of the non-detroyed nests (░ for d=0 and ■ for d=1) in comparison to the distribution of nesting females during the nesting season (‾) for k=0.03225, Δk=0.16 10^{-4}, XY=7 240 m^2. The frequency of non-destroyed nests with TSP within dry season (feminizing season) is 59% and 69% respectively for d=0 and d=1.

THE CONSEQUENCES OF HUMAN MANIPULATION OF THE COASTAL ENVIRONMENT ON HATCHLING LOGGERHEAD SEA TURTLES (Caretta caretta, L)

Lawrence Glenn

Department of Biological Sciences, Florida Atlantic University, Boca Raton, FL 33431

There are many hidden consequences to hatchling sea turtles from human manipulation of the coastal environment. The purpose of this study was to identify the effects of two such manipulations (i) the use of nearshore artificial reefs and (ii) the use of on-the-beach hatcheries on the orientation and survival of hatchlings.

Successful migration to the open ocean requires that sea turtle hatchlings immediately establish an offshore heading. Disorientation in the nearshore environment may compromise hatchling survival by (i) costing additional energy as they swim in inappropriate directions and (ii) delaying their departure from predator rich waters. Therefore, it is essential that hatchlings have proper orientation cues available.

Surface waves are the initial aquatic orientation cue used by loggerhead hatchlings (Salmon and Lohmann 1989; Wyneken et al. 1990). Surface they are refracted and aligned parallel. Waves are slowed due to bottom friction and realigned to approach shore in a parallel manner (Denny 1988). Therefore, swimming into surface waves directs hatchlings offshore. However, the substratum form and type over which water travels can influence the form and direction of surface waves (as an orientation cue). Hence, waves produced over different substrata types may present different orientation information. In the first part of the study, I assessed the effects three different substrata types had upon hatchling orientation.

The second portion of the study focused upon the effects of open beach hatcheries on hatchling survival in the nearshore environment. Hatcheries concentrate large numbers of nests into relatively small areas. This concentration results in abnormally high numbers of hatchlings entering the ocean at the same location. Nearshore predators associated with these areas may become entrained to an area because of the high numbers of hatchlings. These "entrained" predators may then remain in or return to these areas which consistently provide hatchlings.

METHODS

Individual hatchlings were tracked offshore at night in both studies. In the first study, hatchlings were tracked over three substratum types (a nearshore breakwater, a natural patch reef and a natural sand bottom). All sites were located in the Town of Palm Beach, FL. Each trial lasted 15 min. The hatchling's point of entry and its position at 5 min intervals were recorded using a hand-held GPS. Trials were carried out during the week of the full moon to minimize the confounding effects of urban lights on orientation. Hatchlings were recaptured at the end of each trial and released. The direction of wave approach was recorded nightly. Surface currents were measured by tracking a water-filled drift bottle for 20 min.

The second study involved following hatchlings offshore from both high and low nest density sites in Hillsboro Beach, FL. Three hatcheries comprised the high nest density sites (200-700 nests per 0.1 km). Two low density control sites contained naturally deposited nests (90 nests per km). Hatchlings were tracked for 15 min at night as they swam away from hatcheries and control sites. Predation rates were compared between high and low nest density sites and over the course of the hatching season.

RESULTS AND DISCUSSION

Hatchling orientation differed significantly among sites. There was no significant difference between the deviations of (i) individual hatchling headings from directly into oncoming surface waves or (ii) angle of surface wave approach and the angle perpendicular to shore did not differ significantly. These results showed that the type of substratum present in the nearshore environment did not adversely effect the wave cues. The differences in orientation among the three treatment types (sites) were due instead to the direction of beach axis. Background lighting was similar at all treatment sites and had no detectable effect on orientation.

Eleven of the 100 hatchlings followed offshore from hatcheries and natural nest sites were depredated. Predation levels differed greatly with nest density (control sites: 1 of 40 [2.5%], hatchery sites: 10 of 60 [17%]). These results support the hypothesis that predation rates may be linked to the density of hatchlings leaving the beach.

Higher rates of predation occurred at the height of the hatching season than towards the end. Predation rates based on the number of individuals tracked by month reflected this trend (August: 8 of 40 [20%], September: 3 of 50 [6%], October: 0 of 10 [0%]). The large clutch size of loggerheads, seasonal pattern of hatchling densities (low to high to low), and scattering of clutches over time and space by individual females may be adaptations to combat the large loss of hatchlings to congregating fish.

LITERATURE

Denny, M.W. 1988. Biology and the mechanics of the wave-swept environment. Princeton: Princeton University Press.

Salmon, M. and K.J. Lohmann. 1989. Orientation cues used by hatchling loggerhead sea turtles (Caretta caretta) during their offshore migration. Ethology. 83: 215-228.

Wyneken, J., M. Salmon and K.J. Lohmann. 1990. Orientation by hatchling loggerhead sea turtles Caretta caretta L. in a wave tank. J. Exp. Mar. Biol. Ecol., 139: 43-50.

PATTERNS OF MORTALITY IN MARINE TURTLES IN THE EASTERN MEDITERRANEAN

Brendan J. Godley [1&2*], Robert W. Furness [1], and Sally E. Solomon[2]

[1] Division of Environmental and Evolutionary Biology, I.B.L.S., Graham Kerr Building, University of Glasgow, Glasgow, G12 8QQ, Scotland, UK.
[2] Department of Veterinary Anatomy, University of Glasgow Veterinary School, Bearsden Road, Glasgow, G61 1QH, Scotland, U.K.
* Correspondent

Both species of marine turtles that nest in the eastern Mediterranean, (Chelonia mydas and Caretta caretta), are considered as regionally, "Endangered" (Groombridge 1990). In the past 15 years, the location of the major nesting beaches in the region have been identified. However, relatively little research effort has been channeled into trying to understand the distribution patterns and wider ecology of these two populations. This paper outlines preliminary efforts to assess patterns of marine turtle mortality (n= 98 strandings) in the eastern Mediterranean (Turkey and Northern Cyprus).

METHODOLOGY

Data regarding the incidence of marine turtle strandings were collected opportunistically in Northern Cyprus and Turkey between 1992-5. In Northern Cyprus, stranded turtles (n=62) were collected by members of Glasgow University Turtle Conservation Expeditions 1992-95, while monitoring nesting beaches. As an additional part of these studies, curved carapace lengths of nesting females, of both species, were collected at Alagadi, N. Cyprus. This enabled a possible range of adult female size to be generated for both species. In Turkey, 36 strandings were recorded. Surveys of the Goksu Delta and Kazanli, two well known marine turtle nesting sites, were carried out in 1994 and 1995. All study sites are marked in Fig. 1. Additional information regarding strandings from the Goksu Delta was obtained from previous studies (Peters and Verhoeven, 1992; van Pigglen, 1993) and via personal communication with various interested individuals in the region. When a stranded turtle was found, species was ascertained. Only individuals of known species were included in this study. Following this, necropsy was carried out. Curved carapace length was used as the index of size and condition of stranded turtles was scored on an ordinal scale as: 0 - Alive with no visible injuries; 1 - Alive and injured; 2 - Freshly dead; 3 - Moderately decomposed; 4 - Severely decomposed; 5 - Dried carcass; and 6 - Skeleton only. Specific carcass anomalies were recorded in a similar format as in Teas (1993). As an additional part of this initiative, preliminary attempts were made to establish a Mediterranean Marine Turtle Stranding Network (Godley, 1995).

RESULTS

Fig. 1 shows a map of the eastern Mediterranean region illustrating sampling sites. None of the data regarding size class distribution for either species in either Turkey or N. Cyprus are normally distributed (Kolmogorov-Smirnov test, $P>0.05$). Non-parametric statistics were applied (Mann Whitney U-test). There is no significant difference in median size between sites for Chelonia mydas ($U = 312.5$, $p = 0.60$) or C. caretta ($U = 130$, $p = 0.21$). Data were then pooled for each species (Fig. 2 and Fig. 3) and comparison made of median size between species. The difference is highly significant ($U = 183$, $p < 0.0001$). Size ranges of nesting females measured in N. Cyprus are marked on figs. 2 and 3. Size ranges for nesting Chelonia mydas ranged between 77 and 107cm. For C. caretta this range was 64-87cm. Whereas only 4/62, or 6.5% of Chelonia mydas fall within this adult range, 26/36 or 72% of C. caretta would be classed as adult by this method. Fig. 4 illustrates the condition score of those stranded turtles found in N. Cyprus in 1994 and 1995 (n=46). The major carcass anomalies found in comparison to Teas (1993) are shown in table 1.

DISCUSSION

Although both species nest within the study area, there is a marked interspecific difference in the size distribution of stranded turtles. This is consistent with work carried out on a smaller sample size (n =26) by Baran and Kasparek (1989). This difference suggests that either there are different mortality factors acting on the two populations or the relative distribution of size classes is markedly different between the two species. It is more likely that the latter is true and there is a much greater level of dispersal in C. caretta, with juveniles leaving the eastern basin, at least until sub-adulthood.

Carcass anomalies found during this study differ from those found in a more extensive study, with a greater sample size, in the USA (Teas 1993). The N. Cyprus data set shows a greater preponderance of traumatic lesions present (>70% of all turtles). Many of these anomalies are consistent with incidental catch and subsequent slaughter by fishermen. In addition, of all the turtles found in relatively good condition (i.e. score < or = 4), only one was found to be emaciated without a degree of gut fill. This further suggests a high preponderance of sudden death without disease. Groombridge (1988) quotes estimates of the incidental bycatch of marine turtles in N. Cyprus as in the region 10 - 50 annually. Preliminary verbal surveys carried out on fishermen in N. Cyprus, suggest a high level of incidental catch, up to 50 times greater (Godley, unpublished data). The carcass anomalies found in N. Cyprus and survey findings of a high level of incidental catch, with associated mortality, combine to form circumstantial evidence suggesting the major mortality factor experienced is bycatch in fisheries. In addition, if C. caretta juvenile stages were present in significant numbers, it is likely that these would be readily caught as they are on longlines in Greece (Panou et al.,1993). This lends more weight to the hypothesis that these individuals are not present in this area. Unlike a previous study in the central Mediterranean Sea (Gramentz, 1988) where more than 20% of loggerhead turtles were visibly affected by pollutants, there was a low incidence of this with: only one individual being caught up in plastic sacking and 2 entrapped in discarded fishing netting.

Recommendations: This preliminary investigation highlights three targets for those endeavoring to understand and conserve marine turtles in the Mediterranean: (1) The necessity for a communicative marine turtle stranding network; (2) the need for more research into the interaction between marine turtles and fisheries; and (3) the need for a greater research effort to be channeled into understanding the distribution of juveniles and adults outwith nesting periods.

ACKNOWLEDGMENTS

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LITERATURE CITED

Baran, I. and M. Kasparek, 1989. On the whereabouts of immature sea turtles (Caretta caretta and Chelonia mydas) in the eastern Mediterranean. Zoology in the Middle East: 3: 321-36.

Godley, B.J., 1995. Mediterranean Marine Turtle Stranding Network. Marine turtle Newsletter. 69: 21.

Groombridge, B., 1988. Marine Turtle Conservation in the Eastern Mediterranean: Field Survey in Northern Cyprus. WWF Project 3852 Europe. 21 pp.

Groombridge, B., 1990. Marine turtles in the Mediterranean: Distribution, Population status, Conservation. Nature and Environment Series, No. 48. Strasbourg. 98 pp.

Gramentz , D., 1988. Involvement of Loggerhead Turtles with the Plastic, Metal and Hydrocarbon Pollution in the Central Mediterranean. Marine Pollution Bulletin. 19 (1): 11-13.

Panou, A., G. Antipas, Y. Giannopoulos, S. Moschonas, D., G., Ch. Mourelatos, P. Toumazatos, L. Tselentis, N. Voutsinas and V. Voutsinas, 1992. Incidental Catches of Loggerhead Turtles, Caretta caretta in Swordfish Long-lines in the Ionian Sea, Greece. Testudo. 3 (4): 47-57.

Peters, A. and K.J.F. Verhoeven. 1992. Breeding Success of the Loggerhead, Caretta caretta and the Green Turtle, Chelonia mydas, in the Goksu Delta, Turkey. Report 310. Dept. of Animal Ecology, University of Nijmegen, the Netherlands., 26pp.

Teas, W.G., 1993. 1992 Annual report of the Sea Turtle Stranding and Salvage Network : Atlantic and Gulf Coasts of the United States, January - December 1992., NOAA, NMFS, Contribution Number MIA-92/93-73. 43pp.

van Pigglen, D.C.G., 1993. Marine turtle survey in the Goksu Delta, Turkey, June-August, 1991. Report 314. Dept. of Animal Ecology, University of Nijmegen, Netherlands., 33pp.

Table 1: Comparing carcass anomalies from N. Cyprus 1994/95 with those from the US in 1992 (Teas 1993).

STUDY	SAMPLE	ANOMALY
Teas (1993)	(n= 1560)	INCIDENCE (%)
N. Cyprus 94/95	(n=46)	INCIDENCE(%)

Boat related injury	Skull injuries	Skull missing	Skull and flippers missing	Flippers missing	Harpoon wounds
10.3	2.5	3.6	7.8	6.5	not listed
4.3	15.2	6.5	19.6	2.2	4.3

Neck partially severed	Entangled in fishing net	Entangled in fishing line	Entangled in non-fish gear material	Bullet wounds	Tar or oil impact
not listed	0.6	1.5	0.3	0.3	0.2
19.6	10.9	0	2.2	2.2	0

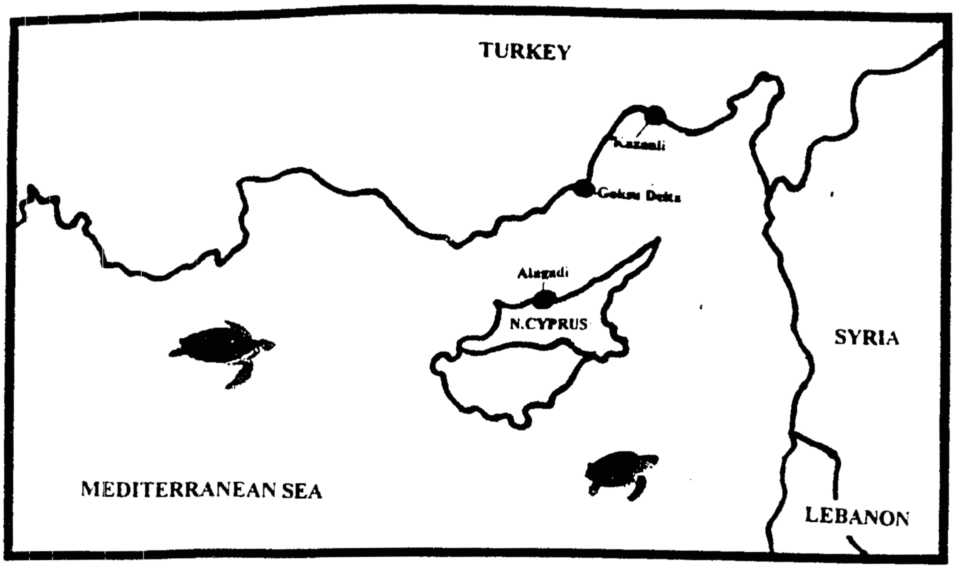

Figure 1. Map of the Eastern Mediterranean region to illustrate study sites.

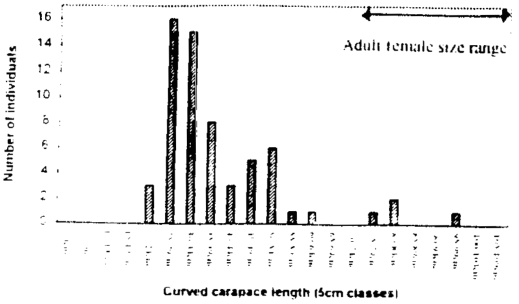

Figure 2. Size distribution of stranded C. mydas in N Cyprus and Turkey 1992-5

STUDY	Teas (1993)	N. Cyprus 94/95
SAMPLE	(n= 1560)	(n=46)
ANOMALY	INCIDENCE (%)	INCIDENCE(%)
Boat related injury	10.3	4.3
Skull injuries	2.5	15.2
Skull missing	3.6	6.5
Skull and flippers missing	7.8	19.6
Neck partially severed	not listed	19.6
Flippers missing	6.5	2.2
Entangled in fishing net	0.6	10.9
Entangled in fishing line	1.5	0
Entangled in non-fishing gear material	0.3	2.2
Tar or oil impact	0.2	0
Bullet wounds	0.3	2.2
Harpoon wounds	not listed	4.3

Table 1. Comparing carcass anomalies from N. Cyprus 1994/95 with those from the USA in 1992 (Teas 1993)

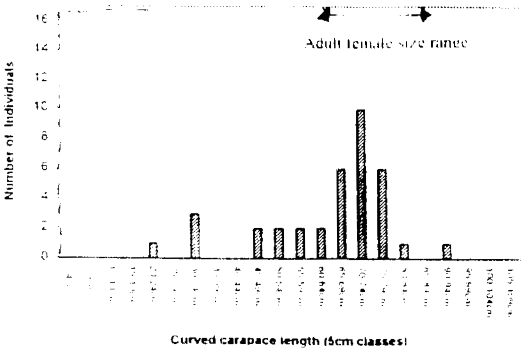

Figure 3. Size distribution of stranded C. caretta in N Cyprus and Turkey 1992-5

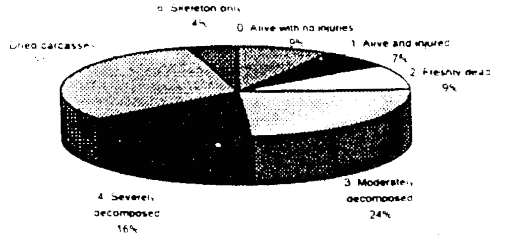

Figure 4. Condition of carcasses of both species found in N.Cyprus 1994/5

EPIZOITES OF GALAPAGOS GREEN TURTLES

Derek Green

Espey, Huston & Associates, Inc., P.O. Box 519, Austin, Texas 78767

During a long-term study on green turtles (Chelonia mydas) in the Galápagos Islands, epizoites encountered on turtles at three nesting beaches (Quinta Playa and Bahía Barahona on Isabela Island, and Las Salinas on Baltra Island) between 1976 and 1978 and at three feeding grounds (Elizabeth Bay, Isabela Island; Punta Espinoza, Fernandina Island; and Turtle Cove, Santa Cruz Island) between 1976 and 1980, were recorded. Nine of the epizoite species were barnacles, of which the most frequently encountered was Cylindrolepasdarwiniana, followed by Platylepas decorata, Chelonibia testudinaria, and Conchoderma virgatum var. chelonophilus. Of the nesting females examined, 68% were infested with C. darwiniana, 60% with P. decorata, 21% with C. testudinaria, and 9% with C. virgatum.

Of the 532 turtles examined at the feeding grounds, only 3% (16 individuals) were free of barnacles; 91% housed C. darwiniana, 78% bore P. decorata, 11% had C. testudinaria, and 2% carried C. virgatum. While C. darwiniana was the most frequently encountered barnacle species, P. decorata was the most abundant; 37% of the turtles studied at the feeding grounds bore more than 50 specimens of this epizoite, compared to 13% for Cylindrolepas darwiniana and 1% for Conchoderma virgatum. There were rarely more than 5 individuals of C. testudinaria per turtle, although I did find 52 large (3 to 7-cm) specimens on a female nesting at Quinta Playa in 1976.

Over half of the occurrences of C. virgatum at the feeding grounds were either on the skin in the shoulder, neck, and throat regions or on the foreflippers. Attachment other than on the skin was usually in small gouges. C. testudinaria was most commonly found on the carapace, followed by the plastron; occasionaslly it appeared on the head or flippers. P. decorata was most frequently found attached to the skin, particularly in the posterior regions of the body. The flippers and plastron were also well used. Only about 1% occurred on the head, of which just a few were on the mouth or on the eyelids. Most of the C. darwiniana occurrences were either on the plastron or on the carapace (especially in the joints between the scutes), although almost 20% were on the flippers -- usually on the leading edges of the foreflippers. Almost 6% of the occurrences were on the head, generally in the upper or lower jaw. In most cases, the number of barnacles within the mouth was restricted to fewer than ten, but occasionaslly the infestation was so severe as to completely deform the mouth. In areas where turtles feed on bushlike algae, these barnacles probably do not seriously affect a turtle's ability to feed. At Elizabeth Bay and Punta Espinoza, however, turtles feed mainly on species of algae such as Ulva that grow to only a few cm from the substrate and must be cropped closely. Severe barnacle infestation of those turtles could possibly lead to death. At Elizabeth Bay I observed several emaciated and near-death turtles, as well as a recently dead turtle, that were smothered in C. darwiniana, especially in the mouth region.

Once a turtle became infested with barnacles, it did not necessarily remain so. On several occasions, turtles recaptured on the feeding grounds bore fewer barnacles than noted previously. Furthermore, several turtles carried scars of both C. darwiniana and C. testudinaria and yet were barnacle-free.

In addition to the four species of barnacle discussed above, several other barnacles were encountered on Galápagos green turtles: Lepas hilli, Balanus trigonus, B. poecilus, and possibly B. calidus and Megabalanus tintinnabulum galapaganus. These species were much rarer and in some cases were found only on one turtle. Apart from C. darwiniana, all other barnacles appeared to use the turtle solely as a substrate; this includes even C. testudinaria and P. decorata, which are both obligate epizoites of marine turtles. C. darwiniana is a burrowing barnacle that bores into the bone beneath the scales. While the pits made by the barnacle were deep, I never saw one that had penetrated the body cavity, even on several skeletons that still showed the pit-holes. Hendrickson (1958), however, observed that the burrowing barnacle Stepahanolepas muricata did penetrate the body cavity of Malaysian green turtles.

Apart from barnacles, several other turtle epizoites were encountered. The marine leech Ozobranchus branchiatus was common. It was usually attached to the corners of the eyes in groups of up to 30, although occasionally it occurred on the skin in the shoulders, neck, and throat and in small gouges on the flippers. On one occasion it was found alongside some specimens of C. darwiniana in the upper jaw. Hydroids, bryozoans, an anemone, and several small crabs hiding among algae were also found. Two Elizabeth Bay subadults each carried a 7-cm specimen of the gastropod mollusk Hexaplex princeps (fam. Muricidae), indicating a sedentary existence. Of almost 7,000 green turtles encountered in Galápagos between 1975 and 1980, only one, an Elizabeth Bay female, had a remora attached to it. In addition to the fauna, it was rare for a turtle, especially at the feeding grounds, not to have at least one species of alga growing on it.

LITERATURE CITED

Hendrickson, J.R. 1958. The green sea turtle, Chelonia mydas (Linn.) in Malaya and Sarawak. Proc. Zool. Soc. Lond. 130:455-535

FEW TURTLES, MANY PROBLEMS: THE DIFFICULTIES FOR THE SEA TURTLE CONSERVATION IN VENEZUELA

Hedelvy J. Guada[1] and Vicente J. Vera[2]

[1]PROVITA. Apdo. 47.552. Caracas 1041-A. Venezuela.
[2]PROFAUNA. Edif. Camejo. Mezzanina. El Silencio. Caracas 1010. Venezuela.

In Venezuelan waters, five species of sea turtles occur: green, loggerhead, hawksbill, olive ridley, and leatherback. With the exception of Aves Island, where the green turtle colony ranges exceeds 300 Chelonia mydas per year, nor other place in the mainland or the islands shows great numbers of nesting sea turtles.

Current information indicates that near of 10 beaches in Venezuela may have nesting 25-30 nesting females per year in good years (including all the species nesting). The estimation of the sea turtle population numbers has been scarcely documented in the feeding areas, being that some of them are very important for other nesting sea turtles in the Caribbean.

Venezuela has a good conjunct of laws, special resolutions and decrets for the protection of the marine turtles in the territory. We may resalt the declaration of Aves Island as Wildlife Refuge since 1972 and, of 11 coastal, marine and coastal-marine National Parks.

However, the law enforcement is irregular. Moreover, the implementation policies toward the sea turtle monitoring and conservation are not well defined within the governmental sector responsible for the wildlife management and protection: the Ministry of the Environment and Natural Renewable Resources (MARNR) and the Fauna Autonomous Service (PROFAUNA).

The more sound efforts of the government about the sea turtle conservation have been realized mainly within the National Parks Service Institute since 1990. INPARQUES have auspiced several training courses in the basic sea turtle monitoring and conservation techniques and it have promulgated special resolutions for protection of the marine turtles. However, the implementation of the monitoring and conservation efforts in the National Parks have been strongly irregular.

At a private level, we may observe some continuos efforts. Los Roques Scientific Foundation (FCLR) initiated in 1976 a headstarting program in the Archipelago Los Roques National Park. However, several years after, the program functions at low levels and fortunately, the head-starting orientation is being changed. The Foundation for Defense of Nature (FUDENA) has been monitoring the green turtle females from Aves Island since 1979 and, since 1987 motivated the initiation of work for national country personnel to establish the status of the sea turtles in Venezuela. However, it must be addressed that although the private conservation efforts may be more continuous, sometimes they are difficult to evaluate and to produce public impact because they are not inserted within the national policies. In this sense, we may restate that although the nesting green turtles are fully protected in the Aves Island Wildlife Refuge, we may not say great things about cooperative efforts with the countries where this population has foraging areas. The number of nesting green turtles in Aves Island converts it in the second nesting beach in the Caribbean but this is not impressive for the common people in the country. For those familiarized with sea turtles as fishermen, beach inhabitants, and illegal traders, to have a real involvement about the continuation of the intentional or incidental killing of sea turtles and robbing of eggs will conduct them to the extinction it is a difficult matter. Many think that there are enough turtles yet it is completely evident that a strong effort must be focused to create public concern (fishermen, tourists, government, NGO's) about the status of the sea turtles in Venezuela.

Summarizing, the governmental efforts to have the better legislation to the protection of the sea turtles and, the non-governmental efforts to realize the sea turtle conservation are not enough to this moment to sure the survival of the sea turtles in Venezuela. The organization of the governmental and private efforts about the sea turtle conservation and research and Venezuela are being auspiced through the Work Group on Sea Turtles of Venezuela (GTTM), through the preparation of the Sea Turtle Recovery Action Plan. The country is participating in this WIDECAST initiative for the different countries represented in the Wider Caribbean area. We hope the document, to be finished this year, addresses the key activities to warrant the improvement of the sea turtle in all their Caribbean distribution range and, that the institutions involved may work really in a cooperative basis.

MONITORING OF WILDLIFE IN THE NATIONAL PARKS OF VENEZUELA: THE SEA TURTLES AS A STUDY CASE

Hedelvy J. Guada[1], Vicente J. Vera[2], Edgard Yerena[3], Pedro Vernet[4], and Hector Cuenca[5]

[1]PROVITA. Apdo. 50.789. Caracas 1050-A. VENEZUELA
[2]PROFAUNA. Edif. Camejo. Mezzanina. El Silencio. Caracas 1010. VENEZUELA
[3]Comisión de Ambiente del Senado. Congreso Nacional. Apdo. 68.409. Caracas 1062-A. VENEZUELA.
[4]Fundación Ecológica Oscar Ochoa Palacios. Apdo. 50.275. Caracas 1050-A. VENEZUELA
[5]INPARQUES. P. N. Morrocoy. Final Av. Principal de Tucacas. Edo. Falcón. VENEZUELA

ANTECEDENTS

Park Rangers made two attempts to do wildlife monitoring 1960's and at the end of the 1980's: in El Avila and the Guatopo National Parks (E. Yerena, pers. comm.). A Wildlife Program was established in 1990 in the National Parks Service (DGSPN) of the National Parks Institute (INPARQUES). One of their main goals was the implementation of wildlife monitoring programs.

The five species of sea turtles in Venezuela (green turtle, Chelonia mydas, loggerhead turtle, Caretta caretta, hawksbill turtle, Eretmochelys imbricata, olive ridley turtle, Lepidochelys olivacea and the leatherback turtle, Dermochelys coriacea) were considered as key species in the Program, since we had information of the problems for their survival along the country coast (Guada y Vernet, 1988a,b).

METHODS

It was considered as a basic strategy the training of the field personnel. Three persons from INPARQUES took the Short Courses on Sea Turtle Conservation of the Caribbean Conservation Corporation in Tortuguero (Costa Rica) in 1990 and 1993, with support of the Wildlife Conservation Society, U.S. National Parks Service, U.S. Fish and Wildlife Service and INPARQUES. These persons and other key personnel worked in the field surveys and, the design and realization of the sea turtle monitoring courses for Park personnel (Park rangers, Area Chiefs, Superintendents) and monitoring programs.

Field surveys and nest protection in some cases were realized in the main nesting and feeding areas within the coastal, coastal-marine or marine national parks.

RESULTS AND DISCUSSION

They were organized 3 courses on sea turtle monitoring for Park personnel in the National Parks for more of 15 persons (near 10 persons more were from NGO's, Army, tourism operators) in the National Parks: Laguna de Tacarigua (1991), Morrocoy (1993) and Archipielago Los Roques (1994). A course on wildlife monitoring for coastal and marine National Parks realized in 1992 in Laguna de Tacarigua included a sea turtle monitoring component for 10 -12 rangers (Guada et al., 1994). They were produced a short guide and a register form for sea turtle observations.

The personnel conducting the monitoring program realized field surveys in 8 National Parks: Medanos de Coro, Morrocoy, San Esteban, Laguna de Tacarigua, Mochima, Peninsula de Paria, Laguna de La Restinga, Archipielago Los Roques (Cuenca, 1995; Guada y Vernet, 1990, Guada and Vernet, 1992, Guada et al., 1994). The main emphasis was realized in Laguna de Tacarigua (1990-1992), Morrocoy (1993), Mochima (1993) and Peninsula de Paria (1990-1993). The Park personnel only conducted periodic monitoring efforts in Laguna de Tacarigua (1992) and in Morrocoy (1993-1994) National Parks. The main results of this work was to get the inventory of the main nesting beaches within the protected areas.

Specific regulations for the protection of the sea turtles feeding and nesting areas were included in the Zoning Plans and Use Regulations (Planes de Ordenamiento y Reglamentos de Uso). They have been published five of these Plans since 1990 for: Archipielago Los Roques, Mochima, Laguna de Tacarigua, Laguna de La Restinga, Morrocoy National Parks.

Because of the information gathered on sea turtle nesting and feeding areas, a marine area was added to 2 National Parks: Laguna de La Restinga (1 nautical mile) and Laguna de Tacarigua (5 nautical miles).

The implementation of the field surveys and regulations it have been extremely difficult. Even with the training and motivation, the sea turtle monitoring through Park rangers has had a lot of problems. In many cases it was not considered important any kind of wildlife monitoring. Although we have good regulations for fauna protection within the National Parks, the lack of definite policies to implement the wildlife management and conservation in these protected areas (even for endangered species) and the low management levels, contributes to a very limited success in the conservation of the sea turtles in the National Parks.

This situation only may be reversed if it is established as a policy of the National Parks, that the wildlife monitoring is important at the same level of other management strategies for the protected areas, such as the environmental education, control of tourism and visitors, promotion of scientific research, between others.

LITERATURE

Cuenca, H. 1995. Programa de seguimiento de las poblaciones de tortugas marinas. Informe interno de INPARQUES. 4 p.

Guada, H. J. y P. Vernet P. 1988a. Situación actual de las tortugas marinas en la costa caribeña de Venezuela. Estado Falcón. Informe interno de FUDENA. 25 p.

Guada, H. J. y P. Vernet P. 1988b. Situación actual de las tortugas marinas en la costa caribeña de Venezuela. Estados Anzoátegui y Sucre. Informe interno de FUDENA. 24 p.

Guada, H. J. y P. Vernet P. 1990. Salida de inspección de campo al P.N. Médanos de Coro y areas adyacentes. Informe interno de INPARQUES. 14 p.

Guada, H. J. and P. Vernet P. 1992. The sea turtle conservation in the Laguna de Tacarigua National Park, Venezuela. Marine Turtle Newsletter 56: 7-8

Guada, H. J. and P. Vernet P. 1994. The sea turtle conservation in the National Parks of Venezuela. pp: 192-195. In: Proceedings of the Twelfth Annual Workshop on Sea Turtle Biology and Conservation. February 25-29, 1992. Jekyll Island, Georgia, USA. J. I. Richardson and T. H. Richardson. NOAA-SEFSC-361.

Guada, H. J., A. Acuña, A. Trujillo, P. Vernet P., D. F. Amorocho and V. J. Vera. 1994. 1993 courses on sea turtle biology and conservation in Venezuela. pp: 232-233. In: Proceedings of the Fourteenth Annual Symposium on Sea Turtle Biology and Conservation. 1-5 March 1994. Hilton Head, South Carolina. K. A. Bjorndal, A. B. Bolten, D. A. Johnson, P. J. Eliazar (comp.). NOAA Tech. Mem. NMFS-SEFSC-351.

Guada, H. J., P. Vernet P., V. J. Vera, A. Quijada, A. J. Martinez, V. Reinoza. 1994. The sea turtle nesting beaches in the Peninsula de Paria, Sucre State, Venezuela. pp: 50-52. In: Proceedings of the Fourteenth Annual Symposium on Sea Turtle Biology and Conservation. 1-5 March 1994. Hilton Head, South Carolina. K. A. Bjorndal, A. B. Bolten, D. A. Johnson, P. J. Eliazar (comp.). NOAA Tech. Mem. NMFS-SEFSC-351.

MOLECULAR BIOLOGICAL EVIDENCE FOR THE INVOLVEMENT OF A UNIQUE HERPES VIRUS IN THE PATHOGENESIS OF GREEN TURTLE FIBROPAPILLOMATOSIS

Lawrence H. Herbst[1,3], Richard L. Garber[2], Luanne Lockwood[2], and Paul A. Klein[1]

[1]Interdisciplinary Center for Biotechnology Research, BEECS Immunological Analysis Laboratory, Box 100275 HSC, University of Florida, Gainesville, FL 32610 USA
[2]PathoGenesis Corporation, 201 Elliott Avenue, West, Suite 150, Seattle, WA 98119 USA
[3]Institute for Animal Studies, Albert Einstein College of Medicine, 1300 Morris Park Avenue, Bronx, NY 10461 USA

Histologic, immunohistochemical, and serologic studies have demonstrated an association between Green Turtle Fibropapillomatosis (GTFP) and infection with a herpesvirus-like agent found in tumor epidermis. Continuing attempts to isolate this virus in vitro have remained unsuccessful. Meanwhile, using sets of degenerate primers, specific for 2 conserved herpes virus DNA sequences, the homologous regions of the GTFP-associated herpes virus genome were amplified by polymerase chain reaction (PCR) and sequenced. Phyllogenetic analysis, using these amplicon sequences, shows that the GTFP-associated herpes virus is a unique alphaherpesvirus that is most closely related to Varicella-Zoster Virus of humans and the Lung, Eye, Trachea (LET) Virus, also found in green turtles. Using the same PCR and sequencing protocol, identical GTFP-associated herpesvirus sequences have been found in all GTFP homogenates used to demonstrate GTFP transmissibilty, in visceral fibromas found in lungs, kidneys, and gastrointestinal tract, but (with one exception) not in normal tissues from the same turtle. Identical viral sequences have also been found in DNA extracted from tumorigenic GTFP-derived fibroblast cultures but not in DNA extracts from non-tumorigenic normal skin-derived fibroblast cultures from the same turtle. Identical viral sequences were found in a fibropapilloma removed from a loggerhead turtle, Caretta caretta. These data strongly support the hypothesis that this herpes virus is involved in the pathogenesis of marine turtle fibropapillomatosis. With a PCR-based test it is now possible to detect active and latent herpes virus infections in vivo and in vitro and to move epizootiologic and pathogenesis studies forward.

1995 - THE HURRICANE SEASON OF THE CENTURY, BUCK ISLAND REEF NATIONAL MONUMENT, ST. CROIX, VIRGIN ISLANDS

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

[1]National Park Service, P.O. Box 160, Christiansted, VI 00821
[2]Vista Mar, Christiansted, St. Croix, VI 00821

Buck Island Reef National Monument, administered by the National Park Service is a 300-acre tropical dry forest island and associated marine system 1.5 miles north of St. Croix in the United States Virgin Islands. Research on the small population of hawksbill turtles (Eretmochelys imbricata) nesting on Buck Island has been the focus of a saturation tagging program since 1988. The program objectives include, the long-term population study of nesting adult and foraging juvenile hawksbill turtles, collection of basic biological data on nesting and foraging behavior, population genetics, nesting beach temperature and hatchling sex ratio studies, and to investigate management concerns and most recently, natural disaster recovery strategies.

The study site consists of four nesting areas. The eastern most nesting area, Turtle Bay, is a narrow beach with low sea grape vegetation located inside the barrier reef. The north and south shorelines are beach forest with narrow coral cobble/sand berms a few meters above the associated shoreline reefs. West Beach, the popular recreational area, encompasses a wide sand beach with vegetated dunes and no near shore reef.

On September 17, 1989, Hurricane Hugo devastated Buck Island Reef National Monument. By 1995 the nesting beaches, vegetation and berms, had begun to recover. The berms along the beach forest edge had mostly disappeared. Beach forest vegetation, manchineel saplings and sea grape, were growing providing cover for hawksbill nesting. Hawksbill nesting activities were again distributed equally between northshore and southshore, with the remainder of the activities split between West Beach and Turtle Bay (Figure 1). Nesting hawksbill turtle's emergence to lay ratio had returned to the pre-Hugo level of two emergences per successful nest.

We began the 1995 season with the largest research team in years anticipating 3½ months of nightly patrols to encounter every nesting hawksbill turtle. To our dismay, we were first hit by Hurricane Luis on September 5, which luckily passed to the north of the island. On September 15, Luis was followed by Hurricane Marilyn, which effectively curtailing further nightly research operations on Buck Island. Marilyn, a Category II hurricane with winds exceeding 150 mph and 20 foot seas, pounded the island for 8 hours. We lost 28 nights of patrol and upon returning to Buck Island, October 6, found the nesting beaches altered beyond recognition.

The north shore nesting area lost 3 m of "permanent" heavily vegetated beach forest, including trees with more than 1 m diameter. Dead, fallen trees and storm washed debris lay parallel to the shoreline blocking turtle's access to prime nesting areas, and hurricane erosion created 1 m high berms along the edge of the beach forest. The south shore nesting area lost 2-5 m of beach forest and created berms more than 1 m high preventing turtle access to nesting areas. The associated shoreline reef was covered less than 1 or more m of replenished sand. West Beach lost up to 12 m of vegetated shoreline. However, below the eroded berm the hurricane had completely removed the beach sand, and then replaced it with more than 2 m of new sand. Turtle Bay lost between 3 to 4 m of vegetated shoreline, and seaward of the vegetation sand was removed down to the rock and replenished with more than 2 m of new sand and debris.

Hurricane Impacts to Nesting Success - We reviewed the nesting activities of the same six hawksbill turtles who were active during the period 25 days before and after the hurricane. We examined what effect the hurricane altered nesting beach had on their nesting behavior and nesting success, including beach debris, eroded berms, and fallen trees.

Beach debris reduced the average distance nesting females were able to crawl beyond the edge of the shoreline vegetation on a successful nesting. Pre-hurricane crawls averaged 6 m into shoreline vegetation. Post-hurricane crawls averaged 3 m into the vegetation. Hurricane eroded berms, fallen trees, and debris prevented access to beach forest nesting areas and hawksbill nesting activities shifted to West Beach. On-hurricane years, West Beach receives less than 15% of all hawksbill nesting activities. This same shift occurred after Hurricane Hugo in 1989, and was witnessed again with Hurricanes' Luis and Marilyn, 1995 (Figure 1).

Emergence to lay ratio, number of emergences for a successful nesting event, was changed by these same obstructions as well. Pre-hurricane the emergence to lay ratio was two emergence to one nest laid. Post-hurricane this increased to five emergences to one nest laid. Debris and steep berms dramatically increased time and energy each female put into laying one clutch.

Hurricane erosion destroyed an estimated six thousand eggs. A total of 27 known hawksbill nests, 4200 eggs counted at egg deposition, were lost to the hurricanes (10 to Luis and 17 to Marilyn). Fourteen suspected nests were also lost to the hurricanes for a possible additional loss of more than 2000 eggs. Seasonally between 6000 to 8000 hawksbill eggs are laid at Buck Island. More than 50% of the seasonal production was lost to the hurricanes.

Seasonal hatch success has been below 70% since Hurricane Hugo in 1989. This is suspected due to loss of vegetative cover, higher temperatures, drought conditions, and rat predation. This year, nests surviving the hurricanes, had higher hatch success possibly indicating the first signs of recovery from Hurricane Hugo. The hatch success of nests surviving hurricanes; N = 69, Mean Hatch Success = 77%, SD = 16, Range 0 to 98%. Unfortunately, when you include nests lost to the hurricane (zero hatch success) the whole beach success drops greatly; N = 96, Mean Hatch Success = 54%, SD = 38, Range 0 to 98%. Recovery is a slow process and it looks like its beginning all over again.

Hurricane Impacts to Research Program - Each night the research team traveled to Buck Island by boat, patrolled the beaches, and left at dawn. Because Buck Island is an offshore island, when weather conditions deteriorate, the research team is unable to get to work. This season, 36 patrol nights were lost to tropical storms and hurricanes. Loss of patrol nights resulted in several gaps in our data, and our saturation tagging goal was not achieved. Due to the large number of nests laid by unidentified females, confirmed post-hatching, we suspect 7 to 9 nesting females were never identified.

Unable to follow our "priority females" consistently, consecutive clutch data was missed. We had also hoped to monitor priority females' change in weight and blood glucose levels through the nesting season. Unable to do this, we collected blood glucose levels on 19 nesting females at different times during the nesting season. Preliminary results indicate nesting female's blood glucose levels do decline through the nesting season. Unfortunately, the research team cannot live on the island, so we will continue to be at the mercy of the elements each season.

How to Better Prepare for the Next Hurricane

Nesting Beach Markers - Most of 1x1x48 in. wooden beach markers used to record nesting distribution were lost in the hurricanes. To replace these, the beach had to be remeasured from a known point. To avoid having to remeasure after every storm, steel "rebar" stakes will be placed deep in beach forest behind shoreline seasonal markers, as permanent reference points.

Baseline Beach Measurements - In many areas, loss of shoreline was so great that all known references were destroyed. No baseline was available from which to accurately measure loss of beach forest and shoreline vegetation, or measure the amount of replenished sand covering the shoreline reef. The "new" steel markers will be used as fixed reference points to measure distance to seaward edge of beach forest vegetation.

Photo Documentation - Quarterly, photographs of the nesting beach shoreline are taken from known points. However, with the possibility of radical changes anytime from storms, it would be better to photo document the nesting beaches monthly. Photos should be taken from select points on each nesting beach that would include a view up and down the beach, and include a photograph to document the condition of the beach forest and shoreline vegetation at that point.

Nest Relocation - Due to our experience with Hurricane Hugo in 1989, we had already modified the nest relocation protocol to account for severe beach loss to storm erosion. Hurricanes Luis and Marilyn have modified this again. Six of 10 nests relocated this year were lost to the hurricanes. In the future, relocations will be made more than 5-8 m from shoreline vegetation into the beach forest and/or further back on West Beach to avoid newly defined hurricane erosion zones.

ACKNOWLEDGMENTS

In no prior year have research personnel, protocol, and equipment been put to greater tests. Volunteers supported through the partnership between the National Park Service, U. S. Fish & Wildlife Service, V.I. Division of Fish & Wildlife, and The Buccaneer Hotel Internship Program did their best to maintain nesting beach coverage for the hawksbill sea turtle studies on Buck Island Reef NM and St. Croix, Virgin Islands. We survived two hurricanes less than two weeks apart, and although it was difficult after the storms everyone was willing to continue the research. Research personnel returned to the beaches as soon as possible and continued to collect data on hurricane damage and hawksbill turtle nesting.

The National Park Service's Buck Island Reef Hawksbill Research Program would like to thank the following team members for their gallant efforts on behalf of the program: Brendalee Phillips, Jennifer Shelby, Kimberly Woody, Anderson Hughes, Claire Prochaska, Amanda Haywood, Michael Dunnington, Amy Denius, Hilary Tudgee, Maria Cochran, America Ayala, Jason Allen, Sarah Peacock, Jason Ransom, Kerry Weymouth, and our research partners Amy Mackay, James Rebholz, and Michael Evans.

ASSESSING NEST PATERNITY AND GENETIC VARIATION IN THE SURINAME OLIVE RIDLEY (Lepidochelys olivacea) AND LEATHERBACK (*Dermochelys* coriacea) POPULATIONS

Willem E. J. Hoekert, Arnoud D. Schouten, Luc H.G. van Tienen, and Mariska Weijerman

Saenredamstraat 1-II, 1076 CA AMSTERDAM, The Netherlands

INTRODUCTION

The surinam olive ridley population is the only significant one in the western Atlantic region. In the late sixties, arribadas were seen regularly at Eilanti beach, Galibi. Due to over-exploitation and erosion of nesting beaches, the number of nesting females declined from ±3,000 in 1968 to less than 300 in 1995. The surinam leatherback population is part of the population in French Guiana that is the largest population in the world. This population is estimated to be 15,000 nesting females.

Using microsatellite analysis, we want to assess:
1. Whether multiple paternity occurs in the olive ridley and leatherback populations.
2. Whether the surinam olive ridley population shows signs of reduced genetic variability.

MULTIPLE PATERNITY

Multiple matings of sea turtles have been observed in Chelonia mydas. Depending on sperm storage and sperm competition strategies it is possible that several fathers sire the offspring in one nest, which makes some of the hatchlings only half siblings. Multiple paternity has been shown in a number of vertebrates, including several reptiles, among others in the: (1) Loggerhead (Caretta caretta); (2) adder (Vipera berus); (3) sand lizard (Lacerta agilis); and (4) green turtle (Chelonia mydas) nest paternity is currently being investigated by N. FitzSimmons amongst others.

GENETIC VARIATION

The surinam olive ridley population is geographically isolated and has suffered a severe bottleneck. These factors may have caused a decline in genetic variation. Microsatellite data can be used to calculate the level of inbreeding, thereby revealing information on genetic diversity. In addition, the level of genetic variability of this population can be compared with other populations that have been studied.

Multiple paternity may influence the genetic variation of a population as it increases the genetic variation in the offspring of a female and could promote gene flow among populations. In addition, multiple paternity may increase female reproductive success by increasing hatching success.

SAMPLING BLOOD

Blood samples from adult olive ridleys were taken from the dorsal cervical sinus. This was very easy after a little practice. Blood samples from adult leatherbacks were taken by making a small incision in the hind flipper. Blood was then collected with a syringe from the resulting incision. Blood from all hatchlings was taken following the protocol of Bennet, 1986. The blood was conserved in lysis buffer following a protocol from BEECS, 1993. This protocol allows blood conservation without refrigeration.

We collected blood samples (0,5 ml) from 12 olive ridley and 15 leatherback adult females. The nests of all these females were transferred to a hatchery. Upon emergence of these nests eight clutches of both species were virtually completely sampled. Of the hatchlings 0,15 ml blood was taken.

MICROSATELLITES

Microsatellites are short tandem repeats of a specific core sequence that appear at many locations throughout the genome. Microsatellites are highly variable in repeat copy number. As a result, many different sized alleles often exist at a specific microsatellite locus. If the flanking sequences of a given microsatellite are known, they can be amplified by a simple PCR reaction. Each set of primers examines a single microsatellite locus. In general, several loci should be examined, depending on the variability of the loci. Sea turtle specific primers for 5 different loci that show high variability in several species have recently been developed by N. FitzSimmons.

Advantages of the microsatellite method are that it is a non-laborious procedure, it's easy to score banding patterns, the data set can be divided into alleles and primers are available. Disadvantages are that alleles of a given microsatellite locus may differ by only two base pairs (if the repeat sequence is a dinucleotide) and therefore high resolution gels (usually sequence gels) are needed to score different alleles. In addition, the appearance of 'stutter bands' may hamper the interpretation of gels.

EPILOGUE

Despite 2 decades of effective conservation measures the surinam olive ridley has not recovered. By studying nest paternity and genetic variation we hope to learn more about the effects of, and reasons for the seemingly unstoppable decline of the surinam olive ridley population.

In contrast, the surinam leatherback population can be considered being large and stable. This gives the opportunity to study nest paternity in a healthy leatherback population. The observed allele frequencies and heterozygosities may be used as a measure of a healthy population for comparison with other populations.

ACKNOWLEDGMENTS

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LITERATURE

BEECS. 1993. BEECS protocol: Blood for Genetic Analysis. B. Bowen, BEECS Genetic analysis core, University of Florida, Gainesville, Florida, USA.

Bennet. J. M. 1986. A method for sampling blood from hatchling loggerhead turtles. Herp. Review 17(2).

FitzSimmons, N.N., C. Moritz and S. S. Moore. 1995. Conservation and dynamics of microsatellite loci over 300 million years of marine turtle evolution. Mol. Biol. Evol. 12(3):432-440.

THE EFFECT OF ANTHROPOGENIC LIGHTING ON MARINE TURTLES IN NORTHERN CYPRUS

Mark S. Irwin [1], Brendan J. Godley [1&2]*, and Annette C. Broderick [1&2]

[1] Division of Environmental and Evolutionary Biology, I.B.L.S., Graham Kerr Building, University of Glasgow, Glasgow, G12 8QQ, Scotland, U.K.
[2] Department of Veterinary Anatomy, University of Glasgow Veterinary School, Bearsden Road, Glasgow, G61 1QH, Scotland, U.K.
* Correspondent

Hatchling behavior is adapted for reaching the sea as quickly and by as short a route as possible. This behavior can be disrupted by the disorientation caused by anthropogenic lighting (McFarlane, 1963; Philisbosian, 1970; Van Rhijn, 1979). Until recently, this phenomenon had been poorly documented in the Mediterranean. Peters and Verhoeven (1994) reported that, on one beach in Turkey, 63% of loggerhead turtle hatchlings were disorientated by man-made light sources. Witherington and Bjorndal (1991) showed that loggerhead hatchlings were attracted to most types of artificial lights, however, low pressure sodium lights (yellow in color) did not attract them, indeed appeared to repel them. No experimental work has been reported regarding this problem in the Mediterranean. The results presented here were part of the first such study (Irwin, 1996). The purpose of this investigation was to determine any effect anthropogenic lighting might have upon the orientation of green turtle and loggerhead hatchlings from Northern Cyprus. The experimental study involved investigating the effect of different colors of artificial light. Possible lunar effects were also considered. A descriptive study of the present degree of impact of anthropogenic lighting in Northern Cyprus was also undertaken.

METHODOLOGY

Experimental study: 162 green turtle hatchlings were tested in groups of 6 in an experimental arena. This consisted of a 5 m diameter circle, marked in the sand of the study beach, divided into 8 equal sectors. The center of the circle was 10 m from the high water mark and 10 m from the artificial light source, a 2 bar fluorescent torch. The colored light sources were created using filters and the effect of white light was investigated using both 1 bar and 2 bars. Hatchlings were released at the center point of the arena and the sector through which they exited the arena was recorded. All hatchlings were tested for each light source and the order of treatments were sequentially rotated to counter any possible order effects.

Descriptive study: There is still relatively little anthropogenic light on beaches in Northern Cyprus. Only 4 beaches with anthropogenic lighting had significant nesting activity. The tracks of hatchlings extending out to 2 m from the epicenter were recorded onto a circle divided into 4 sectors (seaward, landward, left and right). Data for both species were combined due to the small number of nests present on affected beaches. The results from all 4 affected beaches were combined and these were compared with data from a control beach with no anthropogenic lighting.

RESULTS

Experimental study: Fig. 1 shows the number of C. mydas hatchlings orientating in each sector under each light condition. Chi square analysis (Table 1) showed a significant increase in disorientation for all light conditions except 'red light' over control conditions of 'no light' ($p<0.01$). Comparison of 'moon present' and 'absent' (Table 2) showed there was greater orientation toward the artificial light (white, blue and green) and a greater orientation toward the sea under conditions of 'no light' or 'red light' when the moon was absent ($p<0.05$). Similar results were obtained for C. caretta. However, a small sample size precluded statistical analysis. Descriptive study: Fig. 2 shows the number and percentage of hatchling tracks in each segment for beaches with artificial light compared with the control beach with no light. This shows a significant difference in orientation($X2=106.7$, d.f.$=3$ $P<0.01$). Under anthropogenic lighting a greater percentage of hatchlings orientate in a landward direction than when the light is absent.

DISCUSSION

The results show that Mediterranean turtles are also susceptible to the powerful detrimental effect of anthropogenic light. Between 40% and 60% of hatchlings orientated away from the sea toward the artificial light source. It is also shown that hatchlings are less attracted to long wavelength light than they are to light of shorter wavelengths. This is illustrated by the decreasing order of attractiveness of: white 2 bar, white 1 bar, blue, green and red. The decreasing of attractiveness correlates with an increase of wavelength (white lights emit a very broad spectrum encompassing both long and short wavelengths). Under the 'red light' condition there was only a very small, non significant difference in orientation compared to conditions of 'no light.' The reasons for this preference for short wavelength light is probably due to the fact that the sight of marine turtles will be adapted to the marine environment. Light of long wavelengths does not penetrate the sea well. There is little adaptive reason for a marine turtle being able to perceive red light when it constitutes such a small part of the marine spectrum. Study of the neurophysiology of the visual mechanisms in green turtles appears to lend support to this hypothesis (Granada & O'Shea, 1972).

When the moon is present, the attractiveness of anthropogenic lights decreases. Mrosovsky and Carr (1967) found similar results. Also, when the moon is present, the ambient light increases as does the brightness of the sea. These two circumstances combined reduce the relative intensity of the artificial light and so its relative attractiveness. The increase in ambient light may also make other visual cues, such as silhouette and elevated horizon (Salmon et al., 1992), more obvious. It is likely that this attraction is an unavoidable side effect of the hatchlings sea finding mechanisms of hatchlings. This is also the reason for the detrimental attraction toward artificial lighting. The results of the descriptive study comparing beaches subjected to anthropogenic lighting with the control beach, with no light, showed an effect of anthropogenic light. However 61.2% of the hatchlings orientated toward the sea on the affected beaches, which is higher than the 37% reported by Peters & Verhoeven (1994) in Turkey. The reason for this may be the source of the light, restaurants, closing and putting out their lights before some nests hatch. Further evidence for this was shown by the tendency for nests near to lights to either, have all the hatchlings either orientate correctly, or be disorientated, an 'all or nothing' situation. Most of the previous work in this field has been based on Atlantic populations nesting in the Americas, such as the Florida loggerhead populations. This investigation shows that many principles and results from these studies can be directly applied to the Mediterranean turtle populations and protective measures can be taken. The use of long wavelength light sources (e.g., low pressure sodium lights) on beaches appears to have some potential as a compromise between the sea turtle conservation interests and existing human usage. Further, they require more detailed studies.

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LITERATURE CITED

Granda, A.M. & O'Shea, P.J. 1972. Spectral sensitivity of the Green turtle, Chelonia mydas determined by electrical responses to heterochromatic light. Brain, Behaviour and Evolution 5:143-154.

Irwin, M.S. 1996. The effect of anthropogenic light on marine turtles in Northern Cyprus. Unpublished Honours Thesis, University of Glasgow.

McFarlane, R.W. 1963. Disorientation of loggerhead hatchlings by artificial lighting. Copeia. 1: 153.

Mrosovsky, N. and Carr, A. 1967. Preference for light of short wavelengths in hatchling green sea turtles, Chelonia mydas, tested on their natural nesting beaches. Behaviour, 28: 217-231.

Peters, A & Verhoeven, K.J.F. 1994. Impact of artificial lighting on the seaward orientation of hatchling loggerhead turtles. Journal of Herpetology, 28, (1): 112-114.

Philibosian, R. 1976. Disorientation of Hawksbill turtle hatchlings, Eretmochelys imbricata, by stadium lights. Copeia. 4: 824.

Salmon, M., Wynekan, J., Fritz, E. and Lucas, M. 1992. Seafinding by hatchling sea turtles: Role of brightness, silhouette and beach slope as orientation cues. Behaviour. 122: 56-76.

Van Rhijn, F. A. 1978. Optic orientation in hatchlings of the sea turtle, Chelonia mydas. 1. Brightness: not the only optic cue in sea finding orientation. Marine Behaviour and Physiology. 6:105-121.

Witherington, B.E. & Bjorndal, K.A. 1991. Influences of artificial lighting on the seaward orientation of the hatchling loggerhead turtle, Caretta caretta. Biological Conservation. 55: 139-149.

Figure 1: Diagram showing numbers of hatchlings in each sector under each condition. (n = 162)

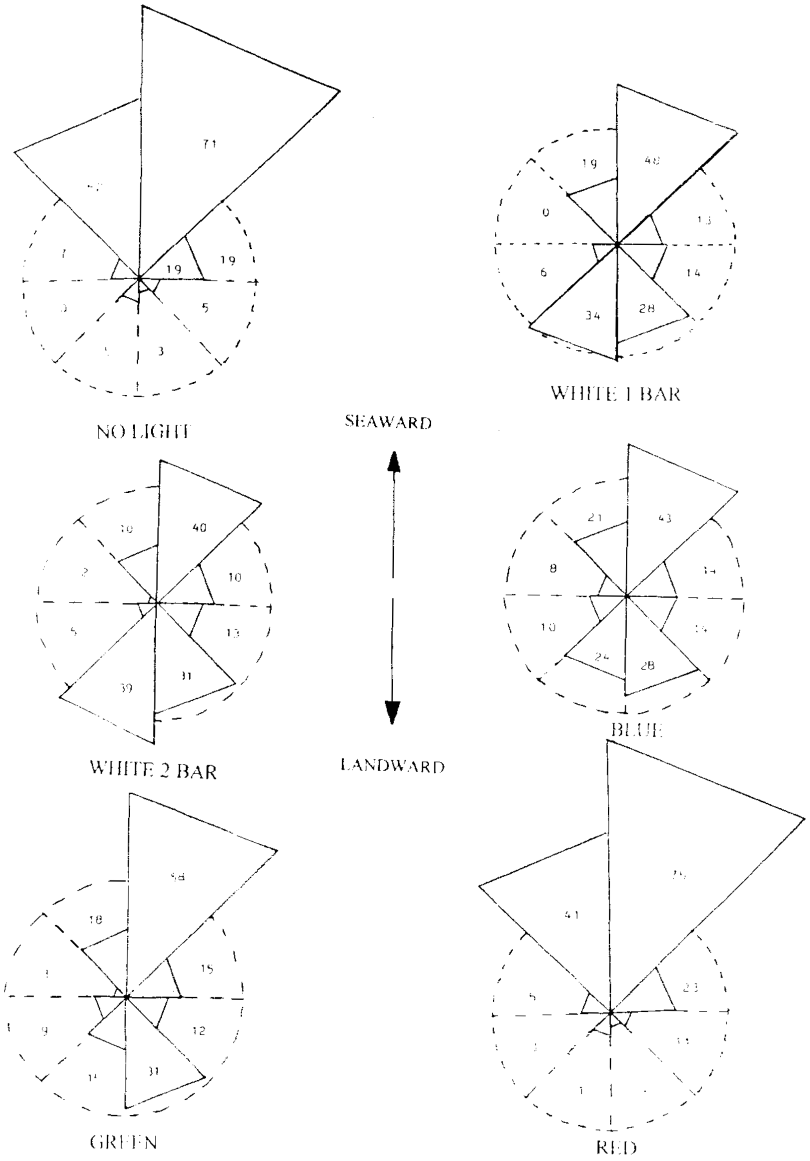
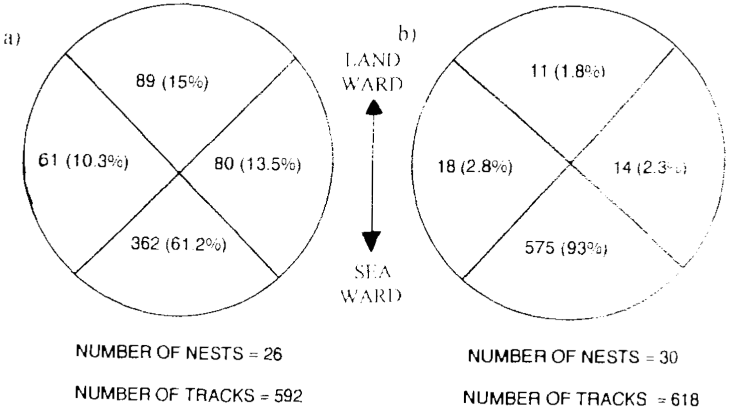


Figure 2: Diagrams showing numbers and percentages of hatchling tracks in each sector for a) affected beaches and b) control beach



Light type v no light	chi-square
White 1	70.921
White 2	80.932
Blue	61.5
Green	49.811
Red	0.927

Table 1: Chi- square results for comparison of hatchling orientation under control (no light) V artificial light sources. (n=162, df=1 at p< 0.01)

LIGHT TYPE	CHI-SQUARE
No. 1 light	34.711
White 1	60.329
White 2	48.347
Blue	43.896
Green	52.056
Red	15.477

Table 2: Chi-square results on orientational differences when moon present / absent, under different light conditions. (moon present n=126, moon absent n=36, df=7 at p<0.05)

LIPID COMPONENTS OF THE YOLK IN LEATHERBACK TURTLE EGGS

Jorge Arturo Juarez[1], Ana Rebeca Barragan[1], Humberto Gomez[2], and Georgina Duarte[2]

[1]Laboratorio de Tortugas Marinas, Facultad de Ciencias, UNAM, Circuito Exterior C.U. Mexico D.F. 04510. Mexico
[2]Laboratorio de Espectrometria de Masas, Facultad de Quimica, UNAM. Edificio "B" Planta Baja, Ciudad Universitaria, Mexico D.F. 04510. Mexico

Studies on the energy contained on sea turtle eggs are of great importance as an indirect way to know quality and quantity of available food for the mother, in preparation for the nesting season, and how this affects the size and strength of the hatchlings. Yolk substances are not just important for the development of the embryo, but in the case of sea turtles they may represent the only source of energy for the hatchlings in their journey from the beach where they were born to areas suitable for their nourishment (Congdon et al., 1983a).

There are few studies on the yolk reserve substances in sea turtle eggs. Vazquez and collaborators (unpublished data) studied the bromatology of the yolk in leatherback eggs, and found 37.3% of lipids from dried samples. The composition of fatty acids on loggerhead, green, leatherback and hawksbill eggs has been characterized in order to provide a technique for species identification, and the relevance for further research of dietary needs of the females and possible dietary deficiencies has been stressed (Seaborn and Moore, 1994). To make possible such studies and comparisons, a complete characterization of the egg lipids of several sea turtle populations is needed. This study describes the lipid contents and kind of molecules present in the yolk of leatherback eggs from a Pacific population, determining the fatty acid profile.

METHODS

Eggs from leatherback (Dermochelys coriacea) nesting females were collected in Playon de Mexiquillo, Michoacan, in the Pacific coast of Mexico, during the conservation activities held in that beach. One egg from each nest relocated in a hatchery was sampled, up to a total of 12 in the season. The eggs were frozen and transported in ice to Mexico City for their laboratory analysis. Chemical procedures consisted in: (1) Separation of the yolk and lysis using anhydrous sodium sulfate as abrasive and extraction of the lipid fraction using hexane. (2) Hydrolysis (saponification) with KOH-methanol 20% weight/volume, in order to separate the fatty acids (aqueous phase) from the triglycerids (organic non-saponifiable fraction). (3) Acidification using HCl and methylation of the fatty acid salts using boron trifluoride/methanol 10%. (4) Hexanic extraction of methyl esters. (5) Separation and characterization of fatty acids using coupled gas chromatography-mass spectrometry (GC-MS).

RESULTS

The chromatograph response allows a graphic description of the fatty acid profile characteristic of the leatherback turtle egg (Fig. 1). The ionic chromatogram of the non-saponifiable fraction of the samples revealed a large spike of cholesterol and an unexpected presence of waxes in which the carbon chains ranged from 17 to 31 molecules (Fig. 2). As a comparison, the same procedure was applied to a hen's egg, in which some waxes were also observed, but with different distribution and ranging only from 15 to 24 carbon molecules.

DISCUSSION

Fatty Acids - This study has rendered new data on the fatty acid analysis of the leatherback turtle egg in a Pacific population, and will provide information useful for further research in the egg biochemistry and bioenergetics of sea turtles. Not all fatty acid molecules appeared in all the samples; we can assume that such differences may be due to possible problems with the extraction procedure or sample handling, since several hours passed between sampling in the beach and extraction in Mexico City. Nevertheless, we expect that the profile presented here is indeed characteristic of the population and will be useful for future species characterization. In order to prove if the differences are due to dietary defficiency, or other variability source, a broader sampling is needed, including other leatherback populations. Likewise, it would be necessary to study the possible effect of such differences in fatty acid composition on the survival of the hatchlings, since these molecules are essential for the development of the embryos and as an energy source for the hatchlings in an early stage (Dial, 1987).

Another aspect interesting to consider regarding the leatherback turtle is the investment of the female in each egg compared with other turtle species, since it is the sea turtle that lays the largest eggs in the smallest clutches, which would mean the largest energy investment per egg. Unfortunately, the data available for freshwater turtles in the literature is not comparable with our kind of analysis, since they only report total lipid contents of the yolk (Congdon, et al., 1983b).

Non-saponifiable Fraction - The presence of highly hydrophobic large carbon chains (waxes) in the non-saponifiable fraction was not previously reported in any reptilian egg. Compared with the avian egg, the waxes found in the leatherback egg are considerably larger and with different distribution as seen with the GC/ME. We don't know the function of these substances in the turtle egg, but the normal distribution shown in the chromatogram (Fig. 2) may be an indication that the biosynthesis of this waxes is random and non-specific; they may act as an energetic molecule but may have some other structural or protective function. Further research on the dietary needs of the leatherback turtle surely will prove some of these assumptions. The non-saponifiable fraction also rendered three different kinds of sterols, which are yet to be analyzed.

LITERATURE

Congdon, J.D.; J.W. Gibbons and J.L. Greene. 1983a. Parental investment in the chicken turtle (Deirochelys reticularia). Ecology. 64(3): 419-425.

Congdon, J.D.; D.W. Tinkle and P.C. Rosen. 1983b. Egg components and utilization during development in aquatic turtles. COPEIA 1983(1): 265-268.

Dial, E.B. 1987. Energetics and performance during nest emergence and the hatchling frenzy in loggerhead sea turtles (Caretta caretta). Herpetologica 43(3): 307-315.

Seaborn, G. and M. Moore. 1994. Unscrambling eggs: a biochemical method of species identification to aid in the prosecution of marine turtle egg poachers. In: Schroeder, B. and B. Witherington (comps.) Proceedings of the XIII Annual Symposium on Sea Turtle Biology and Conservation. NOAA Tech.

Mem. NMFS-SEFSC-341. 162.

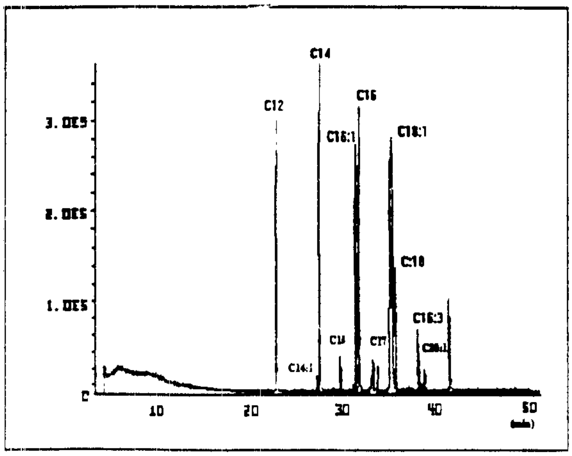


FIG. 1. IONIC CHROMATOGRAM OF METHYL ESTERS IN LEATHERBACK TURTLE EGG
Y axis show the relative response of the chromatograph. X axis is time in minutes

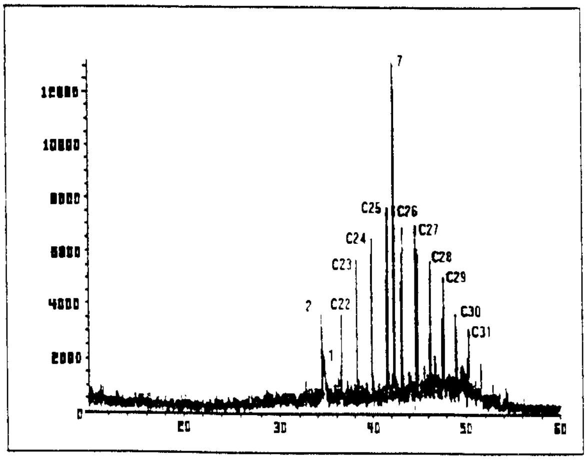


FIG 2. IONIC CHROMATOGRAM OF NON-SAPONIFIABLE FRACTION 1 and 2. unidentified sterols. 7. cholesterol. X axis. time in minutes. Y axis. chromatograph response

INTRA-CLUTCH TEMPERATURE VARIATIONS OF EASTERN MEDITERRANEAN LOGGERHEAD AND GREEN TURTLE NESTS

Yakup Kaska[1&2], Roger Downie[1], and Roger Tippett[1]

[1]Division of Environmental and Evolutionary Biology, University Glasgow, Glasgow G12 8QQ, UK.
[2]Permanent Address: Pamukkale Üniversitesi, Fen Edebiyat Fakültesi, Biyoloji Bölümü, Denizli, TURKEY.

This work aimed to record the intra-clutch temperature differences of two species of turtles nesting in the Mediterranean, and to determine the sex ratio in the different parts of these nests by sexing a sample of hatchlings from each level where temperatures were recorded. Laboratory and field experiments have shown that sex in many turtle species is determined by egg incubation temperature, usually during the middle third of development (Yntema and Mrosovsky, 1980; Morreale et al., 1982; Mrosovsky, 1994). In most of these studies, temperature was recorded at *intervals, not continuously, during incubation, and* related to sand and air temperatures. Temperature and sex ratio differences between different zones and different seasons were reported (i.e., Hays et al., 1995; Mrosovsky et al., 1995) but no data have been reported showing the temperature and temperature differences within the clutch during the whole incubation period.

MATERIALS AND METHODS

Temperature of nest was measured using "Tiny talk" temperature recorders (Orion Components (Chichester) Ltd., UK), which have a 0.35°C resolution. We launched the "Tiny talks" by computer for a recording period of 60 days with readings taken at 48 min intervals. They were placed at three different depths (top, middle and bottom) of the nests, after excavating them on the morning after laying. The nests were then covered and protected with wire mesh against dog and fox predation. A number of hatchlings from each level were sexed. The gonads were sectioned and stained with sex designation based on development of cortical and medullary regions and presence and absence of seminiferous tubules (Yntema and Mrosovsky, 1980).

RESULTS AND DISCUSSION

Between 1300-1700 temperature readings were taken per nest. Our data show that temperature ranged from 24.9 to 34.5°C with rises of up to 9.6 (10)°C in a single nest during incubation. The mean temperature for the whole incubation period was 29.3°C or above for all levels in all nests measured, and the mean for the middle third of the incubation period was 29.7°C or above (Table 1). Marked diel cycles(mean difference between daily maxima and minima) of up to 1.5°C were detected in loggerhead nests during the incubation period, but not in greens. Clutch temperatures have previously been shown to increase during incubation in nests of marine turtles (Hendrickson, 1958; Bustard & Greenham, 1968; *Standora and Spotila*, 1985). *Our data also show that top eggs were warmer and bottom eggs cooler* with the middle ones intermediate in the first third of incubation, but that later in incubation middle eggs became the same as top eggs or even warmer, possibly due to metabolic heat. It is not known whether diel variations (which were quite marked in our loggerhead nests) and temperature differences within a clutch have any influence on turtle development. The temperature of nests laid early in the season were cooler and produced more males than those laid later in the season. The top and middle levels of a clutch produced more females than the bottom level. The nest closer to the vegetation and small clutch size (Chelonia mydas 2), produced more males than the one far from vegetation with a big clutch size(C. mydas 3). The sex ratio for the 5 nests was calculated after sexing 10-17 hatchlings per nest, and the results showed a female biased sex ratio for both species (Table 2), but because of our CITES permit for this season limited us to sampling as few embryos as possible: unfortunately, the numbers were too low, as it turned out, to allow reliable inter-nest comparisons to be made. Similar results have been reported elsewhere (cf. Mrosovsky, 1994).

Mean incubation temperatures may be adequate to predict sex ratios only in sea turtles that have deep nests that experience little temperature fluctuation (Bull, 1980; Morreale et al., 1982). The variety of relationship between pivotal and beach temperatures suggests that diversity of sex ratios in different populations should be expected (Mrosovsky, 1994). We have not attempted to predict the sex ratio of this population, because the pivotal temperature for the two species in the Mediterranean has not been established. Using the mean temperatures we obtained for the middle third of incubation, and the pivotal temperature reported for these species elsewhere (28.8-30.3°C for Chelonia mydas; 28.6-30.0°C for C. caretta, in Mrosovsky, 1994) we would expect to have only females at all levels in all nests. However, as shown in Tables 2, our sex ratios were all female dominated but not for all levels in all nests and we did obtain a significant number of males. This suggests to us that the pivotal temperature in the Mediterranean may be somewhat higher than elsewhere, certainly above 30°C. Mrosovsky (1994) summarized data from many studies and indicated that field pivotal temperatures often different from those calculated from laboratory experiments.

LITERATURE CITED

Bull, J. J.1980. Sex determination in reptiles. Q. Rev. Biol. 55:3-20.

Bustard, H. R. and P. Greenham. 1968. Physical and chemical factors affecting hatching in the green sea turtle, Chelonia mydas L. Ecology 49:269-276.

Hays, C. G., R. C. Adams, A. J. Mortimer, and J. R. Speakman. 1995. Inter- and intra-beach thermal variation for green turtle nests on Ascension Island, South Atlantic. J. Mar. Biol. Assn. U.K. 75:405-411.

Hendrickson, J. R. 1958. The green sea turtle, Chelonia mydas (Linn.), in Malaya and Sarawak. Proc. Zool. Soc., London. 130:455-535.

Morreale, S. J., G. J. Ruiz, J. R. Spotila and E. A. Standora. 1982. Temperature dependent sex determination: current practices threaten conservation of sea turtles. Science N. Y. 216:1245-1247.

Mrosovsky, N. 1994. Sex ratios of sea turtles. The J. Exper. Zool. 270:16-27.

Mrosovsky, N., C. Lavin, and H. Godfrey. 1995. Thermal effects of condominiums on a turtle beach in Florida. Biological Conservation 74:151-156.

Standora, E. A., and J. R. Spotila. 1985. Temperature dependent sex determination in sea turtles. Copeia 1985 (3):711-722.

Yntema, C. L. and N. Mrosovsky. 1980. Sexual differentiation in hatchling loggerhead (Caretta caretta) incubated at different controlled temperatures. Herpetologica 36:33-36.

TABLE 1. The mean nest temperatures for whole and second third of incubation period.

Mean temper./nest	Chelonia mydas 1	Chelonia mydas 2	Chelonia mydas 3	Caretta caretta 1	Caretta caretta 2
Top	29.7	30.2	31.5	30.8	31.7
Top second third	30.3	30.6	31.7	30.8	32.3
Middle	29.8	30.0	31.2	30.5	31.7
Middle second third	30.2	30.3	31.4	30.6	32.3
Bottom	29.3	29.5	31.0	29.9	31.3
Bottom second third	29.7	29.9	31.1	30.1	31.9

TABLE 2. The sex ratios of nests.(* Data for top, middle and bottom levels of the nests respectively)

	Chelonia mydas 1	Chelonia mydas 2	Chelonia mydas 3	Caretta caretta 1	Caretta caretta 2
No of females*	3-3-3	5-4-2	5-7-4	5-2-1	3-3-3
No of males*	2-2-2	0-1-3	0-0-1	0-1-2	0-0-1
Total females-males	9-6	11-4	16-1	8-3	9-1
% F- % M	60-40	73-27	94-6	73-27	90-10

INTRA-CLUTCH TEMPERATURE VARIATIONS OF EASTERN MEDITERRANEAN LOGGERHEAD AND GREEN TURTLE NESTS

Yakup Kaska [1,2], Roger Downie [1], and Roger Tippett [1]

[1]Division of Environmental and Evolutionary Biology, University of Glasgow, Glasgow G12 8QQ, UK.
[2]Permanent Address: Pamukkale Üniversitesi, Fen Edebiyat Fakültesi, Biyoloji Bölümü, Denizli, TURKEY

INTRODUCTION

Laboratory and field experiments have shown that sex in many turtle species is determined by egg incubation temperature, usually during the middle third of development (Yntema and Mrosovsky, 1980; Morreale et al., 1982; Mrosovsky, 1994). In most of these studies, temperature was recorded at intervals, not continuously, during incubation and related to sand and air temperatures. Temperature and sex ratio differences between different zones and different seasons were reported (i.e., Hays et al., 1995; Mrosovsky et al., 1995) but no data have been reported showing the temperature and temperature differences within the clutch during the whole incubation period.

When eggs are incubated at constant temperatures, there is a narrow temperature range (known as the pivotal temperature) over which around 50% of each sex will be produced, and wider ranges above and below this threshold at which only one sex results (Bull, 1980). This pivotal temperature may vary for different species of turtles and for the same species in different parts of the world, but has been measured at around 29°C for sea turtles (Mrosovsky, 1994).

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

Aims - This work aimed to record the intra-clutch temperature differences of two species of turtles nesting in the Mediterranean, and to determine the sex ratio in the different parts of these nests by sexing a sample of hatchlings from each level where temperatures were recorded.

MATERIAL AND METHODS

The beaches on the West Coast of North Cyprus (Figure 1) were patrolled early in the morning between 24 May and 2 October 1995 to locate turtle nests and record any hatching and predation. Temperature was measured using "Tiny talk" temperature recorders [Orion Components (Chichester) Ltd., UK], which have a 0.35°C resolution. They can store up to 1,800 measurements and can be adjusted to 31 measurement frequency settings - between every half a second and once every 4.8 hours, giving them logging durations from 15 min. to 360 days. We launched the "Tiny talks" by computer for a recording period of 60 days with readings taken at 48 min. intervals. They were placed at three different depths (top, middle and bottom) of the nests, after excavating them on the morning after laying. The nests were then covered and protected with wire mesh against dog and fox predation.

A few days before the anticipated date of hatching these "Tiny talks" were taken from the nests and the information offloaded to a computer. Five eggs were also taken from each level together with the "Tiny talks." These eggs were incubated in moist sand for a few days till they hatched; hatchlings were then killed (CITES permit no 81772), dissected and preserved in Bouin's solution for sex determination. The gonads were sectioned and stained with sex designation based on development of cortical and medullary regions and presence and absence of seminiferous tubules (Yntema and Mrosovsky, 1980).

RESULTS

The temperatures of three green turtle nests and one loggerhead nest was recorded on Kirmiziucurum beach and another loggerhead nest on Halk Plaji. Information on nests of which temperatures were recorded is shown in Table 1.

Table 1. Information on the recorded nests (V:vegetation, HW: High water marker, S: Sea, Percent hatch = No of hatchlings emerged/Clutch size x 100)

Nest	Laying date	Position on beach in distance (m.) from V-HW-S	Top & bottom depths of nest (cm.)	Clutch Size	Incubation period	Percent hatch
C. mydas 1	08.6.1995	25-7-2	70-85	118	56	58.5
C. mydas 2	21.6.1995	10-12-6	69-83	78	57	97.3
C. mydas 3	24.6.1995	24-14-2	75-85	109	51	64.2
C. caretta 1	10.6.1995	26-12-4	35-47	95	51	41.1
C. caretta 2	27.7.1995	11-11-7	30-50	77	48	67.5

Our data show that temperature ranged from 24.9 to 34.5°C with rises of up to 9.6 (~10)°C in a single nest during incubation. The mean temperature for the whole incubation period was 29.3°C or above for all levels in all nests measured, and the mean for the middle third of the incubation period was 29.7°C or above (Fig. 2 A, B and Table 2, 3). Marked diel cycles(mean difference between daily maxima and minima) of up to 1.5°C were detected in loggerhead nests during the incubation period, but not in greens. Clutch temperatures have previously been shown to increase during incubation in nests of marine turtles (Hendrickson, 1958; Bustard & Greenham, 1968; Standora & Spotila, 1985). Our data also show that top eggs were warmer and bottom eggs cooler with the middle ones intermediate in the first third of incubation, but that later in incubation middle eggs became the same as top eggs or even warmer, possibly due to metabolic heat. It is not known whether diel variations (which were quite marked in our loggerhead nests) and temperature differences within a clutch have any influence on turtle development.

The temperature of nests laid early in the season was cooler and produced more males than those laid later in the season. The top and middle levels of a clutch produced more females than the bottom level. The nest closer to the vegetation and with the small the clutch size (Chelonia mydas 2), produced more males than the one farther from vegetation with a larger clutch size (Chelonia mydas 3). The sex ratio for the 5 nests was also calculated after sexing 10-17 hatchlings per nest, and the results showed a female biased sex ratio for both species (Table 2, 3). Because our CITES permit for this season limited us to sampling as few embryo as possible, the numbers were too low, as it turned out, to allow reliable inter-nest comparisons to be made. Similar results have been reported elsewhere (cf. Mrosovsky, 1994).

Mean incubation temperatures may be adequate to predict sex ratios only in sea turtles that have deep nests that experience little temperature fluctuation (Bull, 1980; Morreale et al., 1982). The variety of relationship between pivotal and beach temperatures suggests that diversity of sex ratios in different populations should be expected (Mrosovsky, 1994). We have not attempted to predict the sex ratio of this population now, because the pivotal temperature for the two species in the Mediterranean has not been established. Using the mean temperatures we obtained for the middle third of incubation, and the pivotal temperature reported for these species elsewhere (28.8-30.3°C for Chelonia mydas; 28.6-30°C for C. caretta, in Mrosovsky, 1994) we would expect to have only females at all levels in all nests. However, as shown in Tables 2 and 3, our sex ratios were all female dominated but not for all levels in all nests and we did obtain a significant number of males. This suggests to us that the pivotal temperature in the Mediterranean may be somewhat higher than elsewhere, certainly above 30°C. Mrosovsky (1994) summarized data from many studies and indicated that field pivotal temperatures often different from hose calculated from laboratory experiments.

LITERATURE CITED

Bull, J. J.(1980). Sex determination in reptiles. Q. Rev. Biol. 55, 3-20.

Bustard, H. R. and Greenham, P. (1968). Physical and chemical factors affecting hatching in the green sea turtle, Chelonia mydas L. Ecology 49, 269-276.

Bustard, H. R. (1972). Sea turtles: their natural history and conservation. Taplinger, New York. Carr, A. and Hirth, H. (1971). Social facilitation in green turtle siblings. Anim. Behav. 9, 68-70.

Hays, C. G., Adams, R. C., Mortimer, A. J., and Speakman, J. R. (1995). Inter- and intra-beach thermal variation for green turtle nests on Ascension Island, South Atlantic. J. Mar. Biol. Ass. U.K. 75, 405-411.

Hendrickson, J. R. (1958). The green sea turtle, Chelonia mydas (Linn.), in Malaya and Sarawak. Proc. Zool. Soc., Lond. 130, 455-535.

Morreale, S. J., Ruiz, G. J., Spotila, J. R. and Standora, E. A. (1982). Temperature dependent sex determination: current practices threaten conservation of sea turtles. Science, N. Y., 216, 1245-1247.

Mrosovsky, N. (1994). Sex ratios of sea turtles. The J. Exper. Zool., 270; 16-27.

Mrosovsky, N., Lavin, C., and Godfrey, H. (1995). Thermal effects of condominiums on a turtle beach in Florida. Biological Conservation, 74; 151-156.

Standora, E. A., and Spotila, J. R. (1985). Temperature dependent sex determination in sea turtles. Copeia 1985 (3); 711-722.

Yntema, C. L. and Mrosovsky, N. (1980). Sexual differentiation in hatchling loggerhead (Caretta caretta) incubated at different controlled temperatures. Herpetologica 36, 33-36.

ACKNOWLEDGMENTS

We thank the members of Glasgow University Turtle Conservation Expedition (GUTCE 1995) who helped patrol the beaches and collect the data, and Kate Orr for assisting in embryological techniques. Thanks are also to the Mayor and residents of Akdeniz Village for the warmth of their hospitality.

Table 2. The results of temperature and sex ratio of green turtle nests.

	Chelonia mydas 1 Laid on 08.6.1995			Chelonia mydas 2 Laid on 21.6.1995			Chelonia mydas 3 Laid on 24.6.1995		
	top	middle	bottom	top	middle	bottom	top	middle	bottom
Mean temp.±S.E (min.-max.)	29.7±0.05 (25.6-32.5)	29.8±0.05 (25.2-32.9)	29.3±0.05 (24.9-32.5)	30.2±0.03 (26.0-32.5)	30.0±0.04 (26.3-32.1)	29.5±0.04 (26.3-31.8)	31.5±0.05 (27.4-34.5)	31.2±0.06 (26.7-34.5)	31.0±0.06 (26.7-34.1)
Middle third±S.E. (min.-max.)	30.3±0.03 (28.8-31.4)	30.2±0.03 (29.2-31.4)	29.7±0.02 (28.8-30.6)	30.6±0.03 (29.2-31.8)	30.3±0.03 (28.8-31.8)	29.9±0.02 (28.5-31.1)	31.7±0.04 (29.9-33.7)	31.4±0.04 (29.9-33.7)	31.1±0.03 (29.9-32.9)
No. of females	3	3	3	5	4	2	5	7	4
No. of males	2	2	2	0	1	3	0	0	1
Σ Females-Males	9 6			11-4			16-1		
% Females-Males	60-40			73-27			94-6		

Table 3. The results of temperature and sex ratio of loggerhead nests.

	C. caretta 1 Laid on 10.06.1995			C. caretta 2 Laid on 27.7.1995		
	top	middle	bottom	top	middle	bottom
Mean temp.±S.E (min.-max.)	30.8±0.04 (27.0-34.1)	30.5±0.04 (26.7-33.3)	29.9±0.04 (26.0-32.9)	31.7±0.03 (27.4-34.1)	31.7±0.02 (28.8-33.3)	31.3±0.02 (29.2-32.5)
Middle third±S.E. (min.-max.)	30.8±0.05 (27.7-33.3)	30.6±0.04 (28.5-32.5)	30.1±0.03 (28.5-31.8)	32.3±0.02 (31.1-34.1)	32.3±0.01 (31.4-33.3)	31.9±0.01 (31.4-32.5)
No. of females	5	2	1	3	3	3
No. of males	0	1	2	0	0	1
Σ Females-Males	8-3			9-1		
% Females-Males	73-27			90-10		

SEA TURTLE RESEARCH AND MANAGEMENT AND THE YOLNGU PEOPLE OF NORTH-EAST ARNHEM LAND

Rod Kennett

North Australia Research Unit, Australian National University, PO Box 41321, Casuarina, NT 0811
Australia

Arnhem Land is an area of some 97,000 square km in the Northern Territory of tropical northern Australia. Occupation of northern Australia by Aboriginal people dates some 40,000 to 60,000 years and today Arnhem Land remains under traditional Aboriginal management. The Yolngu people inhabit a large area of the coast and inland of north-east Arnhem Land and have strong cultural, spiritual and economic ties to the sea.

The Dhimurru Aboriginal Land Management Corporation is a non-government agency run by Yolngu people and is responsible for land and resource management in north-east Arnhem Land. Harvesting sea turtles and their eggs is an important traditional activity and Yolngu elders have expressed concern that sea turtles may be declining. In response to these concerns a sea turtle research program was commenced in March 1995. The project is jointly funded by the Australian Nature Conservation Agency (Commonwealth government), the (Parks and Wildlife Commission Northern Territory (NT government), the Australian National University and Dhimurru ALMC.

Conservation and management of sea turtles in northern Australia is hampered by a lack of basic biological information. However, Aboriginal people possess a wealth of traditional knowledge about sea turtles. Recording and interpreting this traditional knowledge and combining it with modern biological research methods will be a major focus of the project. Using this approach, the project will document important nesting and feeding grounds for sea turtles in the region and to quantify the level of anthropogenic mortality of sea turtles and eggs.

Ultimately the project aims to develop guidelines for the sustainable use of turtles by Yolngu, and recognizes that without the grass-roots involvement of Yolngu in all stages of the project, such efforts are futile. A community-based program involving schools in isolated communities and has been established to monitor the sea turtle harvest. Traditional knowledge of the biology and cultural significance of sea turtles has been recorded by individual interviews and in a community workshop run by Yolngu. Yolngu Dhimurru rangers are being trained in sea turtle research techniques and a turtle tagging program has started. Dhimurru rangers recently visited the Mon Repos sea turtle research centre (Queensland) for a training visit and cultural exchange with local Aboriginal people. Ownership of the project by, and feedback to, Yolngu people, are paramount.

POPULATION BOTTLENECK: HOW MUCH GENETIC DAMAGE HAS MAN DONE TO THE KEMP'S RIDLEY?

Kristina Kichler[1], David W. Owens[1], Rene Marquez[2], and Scott Davis[3]

[1]Department of Biology, Texas A&M University, College Station, TX, USA 77843
[2]Instituto Nacional de Pesca, Manzanillo, Colima, Mexico
[3]Department of Animal Science, Texas A&M University, College Station, TX, USA 77843

There has been a severe decline in the size of the Kemp's ridley sea turtle population over the past 50 years. There is concern that this bottleneck will result in the loss of genetic variability in the population. The purpose of this study is to compare the level of variability in the Kemp's ridley population with the level found in an olive ridley population. This will provide us with a basis for evaluating the present genetic health of the Kemp's ridleys and to provide a baseline for comparison for future studies. This study makes use of microsatellite markers to estimate the variability of nuclear DNA. These markers are also being used to look at mating behavior and address paternity questions.

METHODS

Samples were collected at the Kemp's ridley nesting beach at Rancho Nuevo, Tamaulipas, Mexico. Blood samples were taken from adult females after they had finished nesting. Tissue samples were salvaged from dead hatchlings and inviable embryos. All samples were taken to Texas A&M University for analysis. DNA was extracted and amplified with PCR (polymerase chain reaction) using microsatellite primers (FitzSimmons et al., 1995) labeled with 32P. Amplified DNA was separated by size on polyacrylamide gels with electrophoresis, visualized with autoradiography and scored.

RESULTS AND DISCUSSION

Samples were genotyped at four polymorphic loci. Preliminary results show that Kemp's ridleys have comparable numbers of alleles and even higher levels of heterozygosity than seen in the olive ridley population being used for comparison. In addition, there were indications of multiple paternity within nearly 50 percent of the nests studied. At this point, the Kemp's ridley population does not appear to have lost variability. Conservation efforts seem to have stabilized the population size, and the population may even be increasing. If the population continues to increase in size, genetic variability will not be lost. Markers targeting more highly polymorphic loci are needed to better evaluate mating behavior. Efforts to find such markers are in progress.

LITERATURE

FitzSimmons, N. N., C. Moritz, and S. S. Moore. 1995. Conservation and dynamics of microsatellite loci over 300 million years of marine turtle evolution. Mol. Biol. Evol. 12(3):432-440.

DISTRIBUTION OF NESTING SITES OF SEA TURTLES IN OKINAWAJIMA AND ADJACENT ISLANDS OF THE CENTRAL RYUKUS, JAPAN

Akira Kikukawa[1], Naoki Kamezaki[2], Koichi Hirate[3], Aiko Nakayama[1], and Hidetoshi Ota[4]

[1]Department of Biology, University of Ryukyus, Nishihara, Okinawa 903-01, Japan
[2]Graduate School of Human and Environmental Studies, Kyoto University, Yoshida, Sakyo, Kyoto 606-01, Japan
[3]Fisheries Improvement and Extension Center Motobu Substation, Ohama 853-1, Motobu, Okinawa 905-02, Japan
[4]Tropical Biosphere Research Center, University of the Ryukyus, Nishihara, Okinawa 903-01, Japan (Fax: 81-98-895-5376)

Three sea turtle species, the loggerhead (Caretta caretta), green turtle (Chelonia mydas), and hawksbill (Eretmochelys imbricata), are known to nest on islands of the Ryukyu Archipelago (123°E, 24°N - 131°E, 31°N) (Kamezaki, 1991). Data for sea turtle nesting have largely been collected from the southern and the northern Ryukyus; very little information is available regarding sea turtle nesting in the Okinawa Islands of the central Ryukyus. We have recently obtained quantitative data for frequency of emergence and species composition of sea turtles nesting on Okinawajima and adjacent islands.

METHODS

A total of 113 beaches on Okinawajima and adjacent islands were investigated from May to October (i.e., nesting season of sea turtles in the Ryukyus) in 1994. On each beach the number of emergence traces (i.e., body pits and/or tracks) were counted. Shore-line length, width, and height of each beach were also measured. In 1995, we collected egg samples from those beaches to obtain hatchlings for species identification.

RESULTS AND DISCUSSION

In 1994, the number of beaches where nesting traces were found is equivalent to 41.6 % of the total number of beaches surveyed. The number of body pits per km shore-line in the northern half of Okinawajima (4.65) was ca 19 times greater than that in the southern half of the island (0.24). The number of body pits per km in the other islands (3.20) was still much higher than that in the southern half of Okinawajima (Kikukawa et al., 1996).

A significant positive correlation was recognized only between the number of body pits per km shore-line and beach width ($r=0.162$, $df=107$, $p<0.05$). This suggests that sea turtles prefer wider beaches in the Okinawa Islands (Kikukawa et al., 1996).

However, there was no significant difference in width between beaches of the northern and the southern regions of Okinawajima. So, one cannot attribute the striking difference in the density of nesting traces between these regions and the difference in beach width between them. Considering that on Okinawajima human population is much larger in the southern region than in the northern region, artificial disturbance to nesting sea turtles should be greater in the southern region, and this may have caused the extremely low nesting frequency there.

In 1995, 33 clutches were found, of which 29 belonged to Caretta caretta, two to Chelonia mydas, and the remaining two were unidentified because of failure of the development. Present results strongly suggest that C. caretta is the dominant nesting species in the central Ryukyus.

LITERATURE

Kamezaki, N. 1991. A preliminary report on the distribution of nesting sites of sea turtles in the Ryukyu Archipelago, and their evaluation. Biol. Mag. Okinawa (29):29-35.(in Japan)

Kikukawa, A., N. kamezaki, K. Hirate, and H. Ota. 1996. Distribution of Nesting Sites of Sea Turtles in Okinawajima and Adjacent Islands of the Central Ryukyus, Japan Chelonian Conserv. Biol. 2(1):99-101

A BIOTELEMETRIC STUDY OF NEAR SHORE MOVEMENTS OF HATCHLING LEATHERBACK TURTLES: DO HATCHLINGS USE GEOMAGNETIC CUES IN ORIENTATION?

Paul A. Kloc II[1], Edward A. Standora[1], and Frank V. Paladino[2]

[1]Biology Department, State University College, Buffalo, NY 14222, USA
[2]Department of Biological Sciences, Indiana-Purdue University, Fort Wayne, IN 46805, USA

In the laboratory, hatchling leatherback turtles (Dermochelys coriacea) have been shown to orient in response to changes in a magnetic field (Lohmann and Lohmann 1993). The goal of this study was to determine if hatchlings were able to use their magnetic sense as an orientation cue during initial near shore movements. Hatchlings received one of three treatments; either a 1.0 gauss or 0.5 gauss magnet, or a neutral rod of equal size and weight. A transmitter/float control was monitored to determine the effect local currents may have had on hatchling movements. Hatchling locations were determined by radio telemetry and GPS.

The high magnet treatment exhibited the highest mean rate of movement, followed by the low, neutral and float groups. Coefficients of variability, standardized by the mean of each treatment group, indicate the amount of variation in movement rate within each group. The high magnet treatment exhibited the highest coefficient of variation.

Orientation angles for each hatchling and a mean orientation heading for each group were determined. The general trend was for mean orientation headings to be to the southwest. The mean orientation heading for hatchlings under the high magnet treatment was 265° while that of the neutral group was 225°. The high magnet treatment exhibited the greatest range of circular variance of all the treatment groups (over 180°), while the neutral group had a range of 125°.

Hatchling orientation behavior was affected by disruptions in the ambient magnetic field caused by the magnet treatments.

LITERATURE

Lohmann, K.J., and C.M.F. Lohmann. 1993. A light-independent magnetic compass in the leatherback sea turtle. Biological Bulletin. 185: 149-151.

SEA TURTLE STRANDING AND SALVAGE NETWORK--LOUISIANA CAJUN STYLE

Bruce Koike

Aquarium of the Americas, New Orleans, LA USA

INTRODUCTION

The Aquarium of the Americas (AOA) is one of several facilities operated by the not-for-profit Audubon Institute. Located in a corner of the historic French Quarter, the AOA highlights aquatic life found in major bodies of waters in North, Central and South America. The AOA has coordinated the Sea Turtle Stranding and Salvage Network (STSSN) in Louisiana since 1992.

METHODS

Reports of strandings were received from National Marine Fisheries Service (NMFS) personnel, Louisiana Department of Wildlife and Fisheries biologists, United States Coast Guard, McNeese State University students, AOA volunteer naturalists and the general public. Reports were checked for redundancy, information clarified, then forwarded to the National STSSN Coordinator in Miami, FL.

RESULTS

Fifty-four sea turtles were reported to the STSSN during 1995. With the exception of the Green sea turtle (Chelonia mydas), all other species of marine turtle that are known to inhabit the Gulf of Mexico were reported stranded. Of the 54 animals, 42 (78%) were Kemp's ridley sea turtle (Lepidochelys kempii), 5 (9%) Loggerhead (Caretta caretta), 1 Hawksbill (Eretmochelys imbricata) and 1 Leatherback (Dermochelys coriacea). Individual reports could not be identified to species in 5 cases (9%) (figure 1).

Most of the strandings (37) occurred in the NMFS fishery statistical zone 17. In addition, 68% of the strandings occurred from July through October. During this time period, all but one of these strandings were reported from Cameron Parish in NMFS zone 17.

DISCUSSION

The report of 54 sea turtles stranded in Louisiana in 1995 is substantially lower than the 179 animals stranded the previous year. The species composition of stranded sea turtles in 1995 is similar for the years 1990-94. Kemp's ridley sea turtles comprised 78% of the strandings in 1995 and 72% for 1990-94 strandings. Loggerheads were the second most frequently observed species for the fifth consecutive year (fig. 2). In an effort to establish consistent monitoring of a beach, approximately 60 individuals including AOA staff and volunteers, were trained this past fall. Grand Isle, though only 10 miles in length, was selected for this pilot project due to its proximity to New Orleans (100 miles) and its walkable beach during all but the highest tides. It is hoped that consistent monitoring may provide a more accurate picture as to the months that strandings occur on a particular beach, and sizes of animals involved.

ACKNOWLEDGEMENT

The author wishes to thank the Audubon Institute for encouraging and supporting involvement in the STSSN and Mr. Chris Schneidau, STSSN/volunteer liaison for his energetic and enthusiastic involvement.

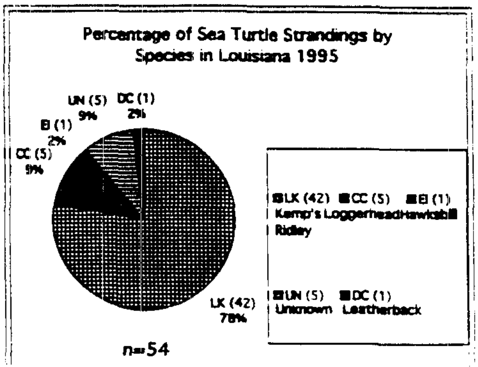


Figure 1.

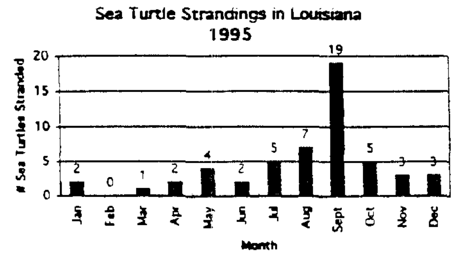


Figure 2.

"LIGHTS OUT FOR TURTLES!" IT CAN BE DONE - BEACH LIGHTING COMPLIANCE AT THE LOCAL LEVEL

Maura C. Kraus, Douglas G. Suitor, and Julia "Kim" Maheuron

Collier County Natural Resources Dept., Naples, FL 33962 USA

Artificial lighting on nesting beaches, as well as, distant sources of illumination (city lights produce a disorienting glow when there is no moon), often discourage a sea turtle from nesting on a developed beach. When nesting does occur on such beaches, hatchling sea turtles may become disoriented by bright lights on the beach. Hatchlings may wander towards the artificial light source leading them away from the water, thereby contributing to higher mortality.

All beachfront developments and land uses can singularly or collectively cause unnecessary illumination of beaches. Common sources of artificial lighting on the beaches in Collier County are from dune crossovers, boardwalks, seawalls, pool and deck lighting, landscape lighting, temporary construction lighting, security lighting, porch lighting, exterior and interior lights from buildings, street and parking lot lighting, and beach access lighting. Most lighting problems start at the beachfront, however, the illumination created by the glow of city lights may also affect nest site selection and cause hatchling disorientation. Resolution of lighting problems must commence at the primary source, direct beachfront lighting.

There are many laws regulating lights on beaches during sea turtle nesting season, however, enforcement has, in the past, been a major obstacle. In 1994, the Collier County Natural Resources Department (NRD) commenced an organized and innovative approach to minimizing the effects of beachfront lighting on a County level. A Beach Lighting Compliance Program was established as part of the Collier County Sea Turtle Protection Plan. The program is a major step toward reducing the effects of beach lighting on sea turtles in Collier County. The program also provides public education and enforcement of the Collier County Land Development Code DIV. 3.10 Sea Turtle Protection Regulations and portions of DIV.3.13 Coastal Construction Setback Line Variances. This paper introduces the methods and results of the Collier County Beach Lighting Compliance Program.

METHODS

A property owner mailing list was created from the Official Records of the Collier County Property Appraisers office. Prior to the onset of sea turtle nesting season, a sea turtle information package is sent (certified mail with return receipts) to beach front property owners. The package includes a general letter of introduction, a colorful flier to post in elevators and on bulletin boards, a copy of the Collier County Land Development Code Div.3.10, "Sea Turtle Protection Regulations" and Div.3.13.7.3 regulating beach furniture, a bumper sticker, Florida Power and Light (FPL) sea turtle brochures, "Lights Out" brochures, and a mail-back request for wall plate stickers. Monthly night inspections are conducted by NRD staff throughout sea turtle hatching season (May 01-October 31). Light sources illuminating the beach or reflective surfaces are considered a violation. To aid in determining this status, staff uses a shadow casting method. If the observer can see his/her shadow, the lights are too intense. The moon may also contribute or cause a shadow to be cast by the observer. Attention to moon phases are taken into account so that moon induced shadows are not confused with shadows produced by artificial lighting. If this is not possible, the inspections are abandoned and rescheduled for another night.

Violations are documented on a NRD "Marine Turtle Lighting Report Form" (MTLRF). The violations are identified by: type of light, number of lights and description of lights. Furniture and other items (i.e., boats) left on the beach are also recorded. Suggestions for correction of the violations are written in the comment section of the form. Suggestions include more than one option such as the following: shield, shade, redirect, reposition, reduce wattage [i.e., five (5) watt yellow bug light], switch to motion detector light and/or turn off the light source. Human safety and welfare is important and must also be recognized when offering lighting change suggestions. A letter of noncompliance and completed copy of the NRD MTLRF are then sent by certified mail to the beachfront establishment. Most establishments contact staff for further clarification, assistance or to notify us that the violation has been corrected. All calls are logged and a copy of the message is attached to the file copy of the violation letter. This procedure alerts staff that the problem has been corrected or an attempt to do so has been made.

Follow-up inspections are conducted 2 weeks after the noncompliance letter has been sent. If the violation remains and no attempt is made to correct the problem, an official "Notice of Ordinance Violation" (NOV) and "Stipulation" is sent to be signed and notarized by the establishment. A carbon copy is also sent to the Collier County Code Enforcement Department. Code Enforcement then sends a NOV and Stipulation followed by a citation to court where fines may be imposed.

RESULTS AND DISCUSSION

In 1995, the NRD mailing list contained 121 beachfront establishments. The list includes 85 condominiums, 9 hotel/motels, 6 timeshares (interval owners), 11 private residences, 5 property owner associations representing more than 1 establishment, and 6 private clubs. Eighteen establishments requested gold "Turn Your Lights Out for Sea Turtles" stickers including 14 condominiums, 2 time shares and 2 hotel/motels. A total of 1,996 stickers were provided to beachfront property owners for light switches.

The first beach lighting compliance inspections commenced in May and continued through September. Although violations occurred throughout the summer, the numbers declined to a manageable few. In most cases, nests did not occur in these areas and the push to turn off lights or change lighting was relaxed. October inspections were canceled due to nest loss from tropical disturbances occurring throughout the summer and the nests still on the beach were in non problem areas.

One establishment refusing to comply with Collier County Sea Turtle Protection Regulations was issued a citation to appear in court and was subsequently fined $125 plus court costs. A second establishment, the Marriott Marco Island Resort and Gulf Club, established a successful public awareness campaign of their own. Their efforts included a compliance program with specific lighting requirements for all buildings, pools, the putt-putt golf course, tennis courts, beach parking lot, beachfront walkways, and restaurant. An employee training program was also established. Handouts were created for all employees in the Recreation, Catering and Convention Service to educate them on sea turtles, and in return they kept guests informed. Public education pamphlets including "Switch Off Unnecessary Lights," "For the Residents of Collier County," "What You Can Do to Protect Sea Turtles" and "Sea Turtle Alert" were placed in all guest rooms. During an unannounced inspection by NRD staff, hotel guests cheered as the lights went out at 9 p.m. Positive results like these brought the total violations from 152 in 1994, to 92 in 1995. Figure 1 shows the 1994/1995 lighting violations per month. Disorientations were reduced 74%, 23 were recorded in 1994, and reduced to 6 in 1995.

CONCLUSION

The Collier County Beach Lighting Compliance Program has been in the development stages for the last 2 years. It will take another season weeding out problems and working with establishments on an individual basis. We feel the reduction of violations and disorientations throughout the County is proof of success of the program. In addition to reduction of the harmful effects of beachfront lighting on sea turtles, the program has brought positive public awareness and education to the residents and visitors of Collier County.

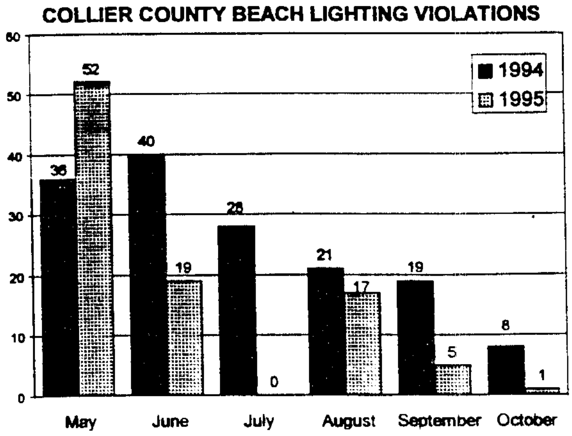


Figure 1

THE SEA TURTLE HOSPITAL AS A TOOL FOR ENVIRONMENTAL EDUCATION

Anna Kremezi-Margaritouli

The Sea Turtle Protection Society of Greece, Solomou 35, GR-106 82 Athens, Greece

The Sea Turtle Protection Society of Greece (STPS) conducts an Environmental Education Programme since 1986. The Programme is carried out either by STPS presenters visiting the schools or by the teachers themselves after borrowing a portable module, especially designed by the STPS (Kremezi-Magaritouli, 1992). Each year more than 500 presentations are conducted at schools throughout Greece. The Programme presents the sea turtle as a symbol of the vanishing wildlife in Greece, contributing positively to conservation efforts.

Every year, several sea turtles are found stranded along the shoreline of Greece. Reports of strandings seem to increase from year to year, apparently due to the increased awareness level of the public and the authorities. In 1991, a Sea Turtle Rescue Network was launched by the STPS.

After some preparatory actions, cooperation has been established with the Port Police stations and Fisheries Departments around Greece. All sea turtle strandings that come to the knowledge of the above agencies are reported to the STPS.

The ever increasing number of turtle strandings and the growing public demand for prompt and appropriate collection, treatment and rehabilitation of the injured or sick animals, made apparent the need for the creation of a Sea Turtle Hospital in Greece.

The greater Athens area was selected as the desired location of the turtle hospital, mainly because of the availability of public transportation means that would carry turtles from various parts of Greece. An STPS proposal was promptly accepted by the Municipality of Glyfada, a large seaside peripheral town, about 20 km from Athens centre.

Two old train wagons, donated by the State Railways, were repaired and installed on seaside land provided by the Municipality. Three polyethylene tanks, one of 5-m diameter and two of 2-m, were constructed in situ and are functioning with a continuous flow of seawater through a system of pumps and filters. One train wagon was transformed to an exhibition area where visitors and especially children would see a photographic display and attend a slide projection. The Hospital is open to the public since 5, June 1995, there is no admission fee and accepts organized groups of people and school children for a guided presentation.

Although not yet completely finished, the Turtle Hospital receives and treats injured or sick turtles since the beginning of 1995. During 1995, 84 turtles were reported dead and 29 injured from various parts of Greece. Of the injured turtles, 23 were brought to the Hospital. Turtles were treated by experienced volunteers under the supervision of a veterinarian; 12 of the 23 animals were released after their treatment, 10 died, and 1 is still under treatment. Rehabilitated animals were released preferably at the locations where they were collected.

From the turtles that were brought to the Hospital, 5 bore injuries inflicted deliberately by humans, presumably fishermen. It must be noted that 7 turtles (of the 23 brought to the Hospital) were found by fishermen who then reported to the Port Authorities.

The Turtle Hospital is an ideal place for sensitizing children. Also, it triggers the social need for active participation in nature conservation and care for animals. We organized, with the approval of the Ministry of Education, guided visits of groups of schoolchildren. Groups consist of no more than 25 children to be tight enough and fit in the small space of the exhibition and the facilities.

Up to the end of 1995, more than 35 school visits have been effected at the Hospital and about 1,000 pupils from the wider Athens area have been awarded. Children are impressed by the turtles and the turtles become angry with people that might deliberately hurt them.

The Sea Turtle Hospital in Greece, besides its main role in the rehabilitation of inured turtles, contributes to public awareness and especially to younger generations.

Much of the work done at the Hospital was carried out by volunteers whom we would like to thank.

LITERATURE CITED

Kremezi-Margaritouli, A. 1992. Sea turtles stimulate environmental education in Greece. Marine Turtle Newsletter 57:21-22.

CHARACTERIZATION OF FIBROPAPILLOMA OCCURRENCE IN A NICARAGUAN GREEN TURTLE FISHERY

Cynthia J. Lagueux[1], Cathi L. Campbell[1], and Lawrence H. Herbst[2,3]

[1]Department of Wildlife Ecology and Conservation, 303 Newins-Ziegler, University of Florida, Gainesville, FL 32611
[2]Program in Biotechnologies for the Ecological, Evolutionary and Conservation Sciences, University of Florida, Gainesville, FL 32610
[3]Institute for Animal Studies, Albert Einstein College of Medicine, 1300 Morris Park Avenue, Bronx, NY 10461

Since the first description of the disease fibropapillomatosis by Smith and Coates (1938) and Lucké (1938), the occurrence of fibropapillomas on green turtles, Chelonia mydas, has been reported worldwide. The prevalence of cutaneous and visceral green turtle fibropapilloma (GTFP) in the green turtle foraging population off the northeast coast of Nicaragua has not been studied. Green turtles are legally harvested by Miskitu Indians who use the turtles for personal consumption and local trade. This fishery provides an excellent opportunity to examine apparently healthy animals externally and internally. Size and prevalence of tumors observed suggest that the harvested turtles may not be seriously affected by GTFP. However, the true magnitude and severity of the disease may be underestimated because turtlemen may be selecting only the healthiest, most marketable animals. In-water studies are needed to more accurately evaluate the prevalence of GTFP in this foraging population.

ACKNOWLEDGMENTS

We would like to thank the marine turtle butchers for their cooperation and allowing CJL access to their turtles. This study was funded by the Wildlife Conservation Society, New York Zoological Society; Inter-American Foundation; Chelonia Institute; The Nature Conservancy; and a Grant-in-Aid of Research from Sigma Xi. We thank the invaluable assistance of Jay Harrison, Institute of Food and Agricultural Sciences, University of Florida, for statistical advice. The views presented are those of the authors and not necessarily those of the funding agencies.

LITERATURE CITED

Lucké, B. 1938. Studies on tumors in cold-blooded vertebrates. Annual Report of the Tortugas Laboratory of the Carnegie Institute, Washington, DC. 1937-1938:92-94.

Smith, G.M and C.W. Coates. 1938. Fibro-epithelial growths of the skin in large marine turtles Chelonia mydas (L.). Zoologica, NY 23:93-98.

DEMOGRAPHY OF MARINE TURTLES HARVESTED BY MISKITU INDIANS OF ATLANTIC NICARAGUA

Cynthia J. Lagueux

Department of Wildlife Ecology and Conservation, 303 Newins-Ziegler, University of Florida, Gainesville, FL 32611

What is probably the largest green turtle foraging population in the western Hemisphere is off the east coast of Nicaragua in Central America. In addition to the green turtle, Chelonia mydas, hawksbill, Eretmochelys imbricata, loggerhead, Caretta caretta, and leatherback, Dermochelys coriacea, turtles also use the seagrass beds, coral reefs and offshore cays. For more than 400 years, Miskitu Indians have harvested green turtles from these foraging grounds for subsistence use and for local and international trade. Currently, the harvest of green turtles is primarily for local trade in meat, organs, and other tissues. The only parts of the animal not consumed or sold are the carapace and plastron. Most green turtles harvested are females and large juveniles. Hawksbill turtles are also consumed but are harvested primarily for their scutes. Loggerhead and leatherback turtles are not targeted in the turtle fishery but are captured incidentally in nets set for green turtles. These data are important for the development of a management strategy for the marine turtle fishery in Nicaragua.

ACKNOWLEDGMENTS

I would like to thank the Miskitu Indian turtlemen and turtle butchers for their cooperation and assistance in data collection and allowing me access to their turtles. This study was funded by the Wildlife Conservation Society, New York Zoological Society; Inter-American Foundation; Chelonia Institute; The Nature Conservancy; and a Grant-in-Aid of Research from Sigma Xi. Community data collection was funded by the Caribbean Conservation Corporation. Jay Harrison, Institute of Food and Agricultural Sciences, University of Florida, provided statistical advice. The views presented are those of the author and not necessarily those of the funding agencies.

EFFECTS OF OFF-SHORE FEATURES ON THE EMERGENCE POINT OF MARINE TURTLES IN NORTHERN CYPRUS

David A. Le Vin[1], Annette C. Broderick[1&2*], Brendan J. Godley[1&2]

[1] Division of Environmental and Evolutionary Biology, I.B.L.S., Graham Kerr Building, University of Glasgow, Glasgow, G12 8QQ, Scotland, U.K.
[2] Department of Veterinary Anatomy, University of Glasgow Veterinary School, Bearsden Road, Glasgow, G61 1QH, Scotland, U.K.
* Correspondent

It is likely that among the basic requirements for a good nesting beach, for marine turtles, is accessibility from the sea. However, it is not usually obvious why individuals emerge at one point of the beach rather than another. The aims of this project were to investigate factors that might influence the emergence site of Mediterranean loggerhead and green turtles (Le Vin, 1996). A summary of this work is presented here. A previous similar study was carried out on Ascension Island by Mortimer (1981).

METHODOLOGY

An extensive comparison of offshore substratum parameters was undertaken on nesting beaches around N. Cyprus. Data on the number of emergences for both species were recorded for 50 beaches. Each of the beaches was assigned an arbitrary rank reflecting the off-shore substratum type: 1 (All rock), 2 (Mostly rock), 3 (Half rock, half sand), 4 (Mostly rock), and 5 (All sand).

Data were augmented by emergence data from the seasons 1992-94 (Godley and Broderick, 1992; 1994; Broderick and Godley, 1993). An intensive study of offshore gradient and substratum types was undertaken on seven nesting beaches. Data on position of emergence point were recorded by triangulation with markers at the back of all beaches. Contour maps were created by plotting 50 cm increments of depth offshore from markers to a maximum of 3 m depth. From these, gradients offshore from each zone of the beach could be calculated. The predominant substratum type was recorded every 5 m for a distance of 60 m offshore. This allowed a picture of the off-shore substratum to be created.

RESULTS

The beach type with the greatest density of emergences was found to be that of rank 4 (mostly sand). This was true for both species separately and for pooled data. The median densities of emergence were found to be significantly different (Kruskall Wallis, $H = 10.85$; $df = 4$; $P = 0.029$). Following a non-parametric multiple comparison test the only significant difference was found to be between ranks 1 and 4 for loggerhead turtles.

A goodness of fit Chi2 test revealed that for both species, there was a significant non-random emergence pattern present on 4 out of the 7 beaches profiled. Spearman's rank correlation test showed no significant correlation between densities of emergence and the offshore gradient. Maps of the substratum were created and "hot spots" or areas of high turtle emergence corresponding to breaks in obstructing substratum identified on 4 of the beaches (Fig. 1-4).

DISCUSSION

There was a general trend in the data regarding offshore substrate type. It may be that the classification system used was not sufficiently elegant to illustrate differences or, that other confounding variables exist. This data does suggest that turtles are not simply choosing beaches to avoid rocks and mechanical damage. It has been suggested that loggerheads seem to prefer beaches adjacent to outcrops of rock or subtidal reefs (Hughes, 1974). These outcrops of rock, it has been proposed, might be used for orientation to sites of emergence onto nesting beaches, possibly explaining the apparent preference for rank 4 beaches. Therefore, a balance might exist between the need for orientational cues and some risk of mechanical damage.

Nesting females appear to be emerging at non-randomly selected positions on some beaches. No correlation between offshore gradient and density of emergences was found. These findings are contrary to those described by Mortimer (1981). Within the confines of this study, it was only possible to map to 3m depth. This may have confounded any comparison with the previous data set.

From the detailed substratum maps, the clear "hot spots" observed on four of the beaches profiled support this aspect of the data from Ascension Island (Mortimer, 1981). Turtle experience may also play an important part in beach choice and emergence point selection, perhaps making avoidance of rocks less vital. Also, relative proximity to appropriate feeding or sheltering grounds may play an important role in beach suitability. It is likely that any selection of emergence point is a complex process with many factors exacting an influence. From these results, only substratum type was indicated to play a part in emergence site selection.

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LITERATURE CITED

Broderick, A.C. and Godley, B.J. (eds.). 1993. Glasgow University Turtle Conservation Expedition to Northern Cyprus 1993 - Expedition Report. Dept. Vet. Anat. Glasgow University Vet School, Bearsden, Glasgow G61 1QH., U.K.

Godley, B.J. and Broderick, A.C. (eds.) 1992. Glasgow University Turtle Conservation Expedition to Northern Cyprus 1992 - Expedition Report. Dept. Vet. Anat. Glasgow University Vet School, Bearsden, Glasgow G61 1QH., U.K.

Godley, B.J. and Broderick, A.C. (eds.) 1994. Glasgow University Turtle Conservation Expedition to Northern Cyprus 1994 - Expedition Report. Dept. Vet. Anat. Glasgow University Vet School, Bearsden, Glasgow G61 1QH., U.K.

Hughes, G.R., 1974. Sea turtles of S.E. Africa I: Status, Morphology and Distribution.Oceanographic Research Institute, Investigation Report 35, 144pp.

Le Vin, D.A. 1996. An investigation into the possible effects of off-shore features on the emergence point of marine turtles, Chelonia mydas and Caretta caretta, onto nesting beaches in Northern Cyprus. Unpublished Honours Thesis, University of Glasgow.

Mortimer, J.A. 1981. Factors influencing beach selection by nesting sea turtles. In: Biology and Conservation of Sea Turtles. (Proceedings of the World Conference on Sea Turtle Conservation. Washington D.C. 26-30th Nov. 1979), Smithsonian Institute Press, Washington D.C.

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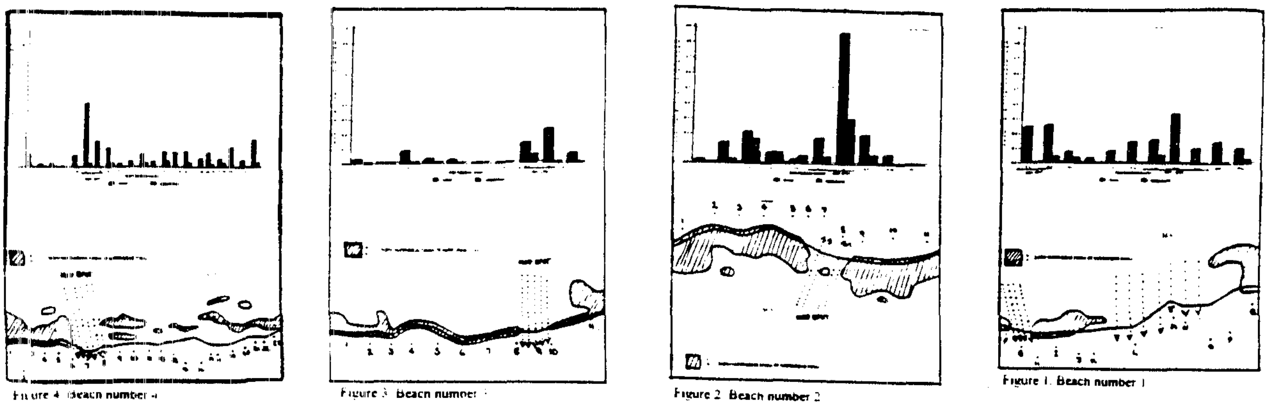

Figure 4 Beach number 4

Figure 3 Beach number 3

Figure 2 Beach number 2

Figure 1. Beach number 1

Figures 1-4. Showing the composite offshore beach maps with histogram of density of emergence in 1995.

SERUM TESTOSTERONE LEVELS FROM HAWKSBILL TURTLES, Eretmochelys imbricata, NESTING ON MILMAN ISLAND, AUSTRALIA

Kirstin A. Loop[1,2], Jeffrey D. Miller[2], Andre M. Landry, Jr.[1], David W. Owens[3] and Rhonda Patterson[3]

[1] Department of Wildlife and Fisheries Sciences, Texas A&M University, 4700 Ave. U., Bldg.303,
Galveston, TX 77551 USA
[2] Queensland Department of Environment and Heritage, PO Box 5391, Townsville, Qld. 4810, Australia
[3] Department of Biology, Texas A&M University, College Station, TX 77843 USA

Serum testosterone (T) levels were analyzed from hawksbill turtles, Eretmochelys imbricata, nesting on Milman Island, Australia. Within a season, T-levels peaked after the second and third nesting and decreased thereafter. The proportion of turtles beginning their nesting season (T-levels: 200-399 pg/ml) decreased steadily from December (71%) through March (26%). Conversely those finishing their nesting season (T-level <50 pg/ml) increased gradually from December (0%) through March (45%). Turtles in the middle of their nesting cycle (T-level: 50-199 pg/ml, >400 pg/ml) were sampled every month.

SEA TURTLE INTERACTIONS WITH INANIMATE OBJECTS: AUTOGROOMING OR PLAY BEHAVIOR?

Martha A. Mann and Roger L. Mellgren

Department of Psychology, Box 19528, University of Texas at Arlington, Arlington, TX 76019-0528

Adult green sea turtles (Chelonia mydas) have been observed at "cleaning stations" where fish remove ectoparasites and debris from body surfaces (Balazs, Miya and Finn, 1994). Our informal observations suggest that captive turtles appear to groom themselves. Grooming behaviors include the use of foreflippers to clean the carapace (i.e., autogrooming), gliding against the surfaces of conspecifics and swimming in close contact with floating objects (i.e., allogrooming) or allowing their surfaces to be cleaned by caretakers. We examined the response of young sea turtles to novel, inanimate objects in two preliminary studies, one conducted in October of 1995, another in January of 1996.

METHODS

At Tortugranja (turtle farm) of Isla Mujeres, Q. Roo, Mexico, a mixed group of green (Chelonia mydas) and loggerhead (Caretta caretta) turtles (8-13 months old) were evaluated in their home tank, measuring approximately 6 m in diameter. First, we presented the group of 45 turtles with a disk-shaped rubber object (a piece of tire, 42 cm O.D., 22.5 cm I.D.) by suspending it in the water so that all but the outer portion of the tethered ring was submerged. We counted each min for 10-20 min periods the numbers of turtles that entered a 1m space encircling the tire. We also noted the responses of individual turtles toward the tire. Observations were made for 4 consecutive days: Day 1: tire presented for 20 min, then removed; Day 2: tire again presented for 20 min, removed for 2 hr then re-presented; Day 3: tire was reintroduced for 10 min observation period and left suspended for 24 hr; Day 4: 10 min test was conducted following the 24 hr period of habituation, tire removed for 2 hr then re-presented. Other novel items were presented on subsequent tests, including plastic bottles. (Further research, however, was rudely interrupted by Hurricane Roxanne.)

In January of 1996, preliminary observations were also made on 4-month-old green sea turtles held at the Acuario of Parque Xcaret, Q. Roo, in rectangular tanks measuring 1X2 m. Two groups of turtles (6/tank) were habituated to their tanks for 24 h. A small "reef" was constructed from coral rocks (a courtesy delivery from Roxanne) to form a short underwater underpass. Each group was observed continuously for 1 hr following presentation, then periodically over the next 3 days.

RESULTS AND DISCUSSION

The figure shows the results of our October study. The average number of turtles per minute in the vicinity of the tire on each of 4 test days is plotted for green (top panel) and loggerhead (bottom panel) sea turtles. Initial tire presentations of DAYS 1 and 2 led to avoidance of the tire's vicinity, suggesting a neophobia, i.e., fear of a novel stimulus. When the tire was removed on Day 2, more turtles of each species visited the area. When the tire was reintroduced on Day 3, one-third of the green turtles approached and/or contacted the tire; almost one-third of loggerhead sea turtles swam in the vicinity but contact with the tire was never observed. Following 24 hr of tire presentation, i.e., on Day 4, about half the green turtles contacted or swam on, through or around the tire. Fewer loggerheads did so and were apt to remain in the area for shorter durations. When the tire was removed for 2 hr and then re-presented, 50% of the green and 42% of the loggerhead juveniles spent time in contact with or in the vicinity of the tire. The data suggest recognition of the object and habituation to it.

Other items, such as a clear plastic bottle, produced no neophobia. Green and loggerhead juveniles immediately approached the bottle (but not a green plastic bottle), gaped and made feeding attempts. Of course, the popular notion is that certain plastic items resemble jellyfish, so avoidance of such items is unlikely. Nevertheless, the specific stimuli (color, shape, size) that invite feeding attempts and those that deter contact could be explored further in captive populations.

Finally, our observations of 4-month-old green sea turtles exposed to an artificial reef indicate that initial presentation of the structure resulted in neophobia as indexed by frenzied swimming. Such swimming subsided within 30 min and at that time 1 of 6 green sea turtles began swimming repeatedly under the rocks, using the rocks to rub its carapace and plastron. Within the hour, 6 of 6 turtles had contacted the reef, swam through the underpass or over it, flippering the rocks in their transit. These observations were confirmed in a second group of 6 green turtles that exhibited a period of neophobia and a delay to habituation that were nearly identical to those of the first group. The responses of the two groups suggest autogrooming or possibly play behavior.

Taken together, the two studies provide preliminary evidence for some behavioral propensities of developing sea turtles. Play during the juvenile period of many mammalian species is well documented (Bekoff, 1972) yet little is known about the topography or significance of object play for reptilian species. With respect to captive situations, it may be especially important to provide objects to developing turtles that stimulate their visual and motor systems. While we are only beginning to understand the biological significance of grooming behavior, placement of inanimate objects in the home tanks of turtles may facilitate their grooming response.

LITERATURE CITED

Balazs, G.H., Miya, R.K. and Finn, M.A. 1994. Aspects of green turtles in their feeding, resting and cleaning areas off Waikiki beach. Proceedings of Thirteenth Annual Symposium on Sea Turtle Biology and Conservation, NOAA Technical Memorandum NMFS-SEFSC-341.

Bekoff, M. 1972. The development of social interaction, play and metacommunication in mammals: An ethological perspective. Quarterly Review of Biology 47:412-434.

Neural Mechanisms and Biological Significance of Grooming Behavior. The Annals of the New York Academy of Sciences. Vol. 525

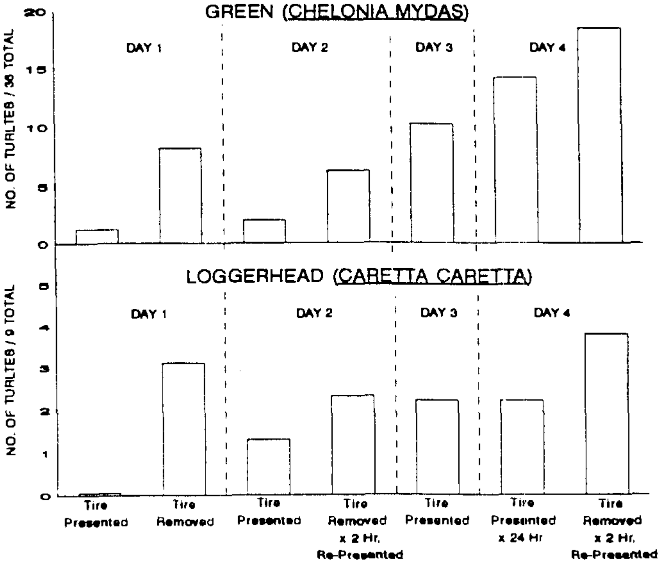

Fig 1 The average number of turtles per minute in the vicinity of the tire on each of 4 test days.

NESTING BIOLOGY OF THE SEA TURTLE Caretta caretta AT PRAIA DO FORTE, BAHIA, BRAZIL

Maria Angela Marcovaldi[1] and Paulo C.R. Barata[2]

[1]Fundacao Pro-TAMAR, C.P. 2219, Salvador-BA, 40210-970, Brazil. e-mail: tamar@ufba.br
[2]Fundacao Oswaldo Cruz, r. Leopoldo Bulhoes 1480 - 8 andar, Rio de Janeiro - RJ, 21041-210,
Brazil

Praia do Forte (12 35'S, 38 00'W) is a beach located about 80 km north of Salvador, the capital of the state of Bahia, on the northeastern coast of Brazil. It is about 13 km long and is a nesting ground to four species of sea turtles: Caretta caretta, Eretmochelys imbricata, Chelonia mydas and Lepidochelys olivacea. Projeto TAMAR - IBAMA, the Brazilian Sea Turtle Conservation Program, has its national headquarters at Praia do Forte, where it has been working since 1982. Projeto TAMAR's activities at this beach include protection of nests and hatchlings, tagging of nesting females and environmental education aimed at fishermen, schoolchildren, tourists and the communities of the nearby villages in general.

The nesting season for all four species of sea turtles is generally from September to March. The loggerhead sea turtle, C. caretta, is the most common species nesting on Praia do Forte. The nestings recorded at Praia do Forte since the season 1987-88 through the season 1994-95 are distributed according to species as follows: 83% belong to C. caretta, 15% to E. imbricata, 1% to Chelonia mydas and 1% to L. olivacea. This paper presents data about C. caretta nesting on Praia do Forte between the seasons 1987-88 and 1994-95.

METHODS

Every night from late August to the end of March the beach is patrolled by a team of biologists on a four-wheel-drive-vehicle, during a variable period. Each turtle found on the beach is identified to species, measured (curved carapace length and width) and double tagged with monel tags (National Band and Tag Co., #681), one tag on each fore flipper. Early every morning, the beach is patrolled on foot by two experienced fishermen, former turtlers who are hired by Projeto TAMAR. These fishermen locate every nest placed on the beach the preceding night. All nests have their exact location marked by Projeto TAMAR's biologists by means of numbered stakes. Nests at risk either by natural or human caused factors were, up to 1993-94, transferred to a beach hatchery. Since 1994-95, nests considered to be threatened are transferred to suitable locations on the beach itself, to incubate under natural conditions. In situ, nests are excavated within 24 hours of hatchling emergence to get a count of the clutch size. All nests are excavated after emergence to identify the species, in case the turtle itself was not observed while nesting. Species identification is made by examination of dead hatchlings or embryos. A more detailed description of Projeto TAMAR's field methodology may be found in Marcovaldi and Laurent (1996).

At Praia do Forte, South American gray foxes (Dusycion vetulus) are strong predators of sea turtle nests. All predated nests were excluded from clutch size, hatchling success and emergence period calculations. A small number of nests with less than 40 eggs (4 nests in 1993-94, 3 in 1989-90 and 2 or less in the other seasons) were excluded from calculations because were believed to have undergone predation, even if this putative predation was not recorded in the data file.

The emergence period for each nest is calculated as the period between oviposition and time of emergence (when most of the hatchlings emerged from the nest onto the sand surface). Hatchling success is calculated as live hatchlings divided by clutch size.

For the calculation of the average curved carapace length, turtles that were found on the beach more than once in a season had only the first measurement made in the season included in the calculations.

To know the new and remigrant turtles for each season we use data gathered in the seasons 1982/1983 through 1994-95. In 1982-83, 3 new Caretta caretta turtles were tagged, 9 in 1983-84, 8 in 1984-85, 3 in

1985-86 and 11 in 1986-87. These turtles were included in the calculation of the number of remigrant turtles in the seasons 1987-88 through 1994-95.

The frequency distribution of the remigration intervals was calculated using data for all turtles tagged since the 1982-83 season.

An "observed turtle" is a turtle found on the beach while nesting. An "observed nest" is a nest whose mother-turtle is known, that is, this nest can be identified with a particular turtle, which is only possible if the turtle was found while nesting.

RESULTS AND DISCUSSION

Peak nesting for loggerhead turtles at Praia do Forte occurs between October and December. There is not much variation in the number of nests laid each season (maximum of 149 nests in a 1987-88 season; minimum of 113 nests in the 1991-92 season) unlike what is observed for other populations of the loggerhead sea turtle (Richardson 1982, Limpus 1985).

Since 1988-89 most nests have been kept in situ. Projeto TAMAR's objective is always to keep the nests in as natural a condition as possible. However, the necessity of transferring nests laid nearby the village, where there is a great movement of people, and nests laid in naturally risky locations place an upper limit (about 65-80%) on the proportion of nests that can be left to incubate in situ.

Clutch size, which averages 123.8 eggs (maximum of 198 and minimum of 40), is within the range reported for other Caretta caretta populations (Hirth 1980, Limpus 1985, Dodd 1988).

Mean curved carapace length (measured over the curve from the precentral scute in the carapace midline to the posterior margin of the postcentrals) for the loggerhead turtles at Praia do Forte is 1.03 m (maximum 1.14 and minimum 0.87 m), and it seems to be somewhat greater than the means generally reported for other populations of this species, although the observed range of carapace length (1.03 + or - 0.05) is within the range usually reported for this kind of measurement (Dodd 1988).

Hatchling success for in situ nests (average of 73.5%) is also within published limits for Caretta caretta sea turtles (Hirth 1980, Dodd 1988). An analysis of variance shows a significant difference among the season means of hatchling success ($p<0.01$). The emergence period for in situ nests (average of 52.6 days) is also within published limits (Dodd 1988), and the mean emergence periods are also significantly different among the seasons (analysis of variance, $p<0.01$). It would be interesting to correlate hatchling success and emergence periods with temperature and other climatic data.

The distribution of "observed turtles" according to the number of "observed nests" varies somewhat (maximum of 5 observed nests/turtle, only happened twice, in the 1987-88 and in the 1989-90 seasons). The turtle that had 5 observed nestings in 1987-88 can be inferred to have laid at least 6 nests, if we accept, as loggerhead researchers usually do (Richardson 1982, Limpus 1985), that there was a non-observed nesting between two observed nestings within a 25-day interval, which is about twice the estimated mean internesting interval for Caretta caretta turtles on Praia do Forte. If we accept that intervals greater than 18 days are composites of lesser intervals, the mean internesting interval (mean of intervals less than or equal to 18 days) is estimated to be 14.9 days. The tagging survey coverage of Projeto TAMAR at Praia do Forte, as measured by the proportion of Nests related to an individual turtle relative to the total number of nests laid in the season, has been typically low, ranging from about 35% in 1987-88 and 1990-91 to as low as about 10% in 1991-92 and 1992-93. Given this low tagging survey coverage, it is to be expected a high proportion of turtles with only one observed nest (109 turtles in a total of 147), since rarely is a turtle observed on the beach more than once.

Remigrant turtles are a relatively small proportion of the turtles observed arriving each season (average of 0.31 remigrant turtles/season). One possible reason for this low proportion of remigrant turtles is tag loss, which has not been evaluated at Praia do Forte. Another possible reason is mortality at sea, either by natural or human caused factors, but there is no data about this subject in Brazil. The relatively low tagging survey coverage may also contribute to the observed small proportion of remigrant turtles. Low remigration rates are also found in other sea turtle populations, a phenomenon that is not completely understood (Carr et al. 1978, Carr 1980, Hughes 1982, Limpus 1985).

One year remigration intervals are a relatively common feature of the Caretta caretta population nesting on Praia do Forte (11/54 = 20.4% of the recorded intervals). This observed percentage of 1-year intervals is greater than the percentages presented in Dodd (1988) for other C. caretta populations. The percentage of 1-year remigration intervals found at Praia do Forte may be an artifact of the low tagging survey coverage, besides the omnipresent problem of tag loss. The highest proportion of remigration intervals occur at 2 years (22/54 = 40.7%), a characteristic also found in other C. caretta populations (Dodd, 1988).

ACKNOWLEDGMENTS

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LITERATURE CITED

Carr, A. 1980. Some problems of sea turtle ecology. American Zoologist 20:489-498.

Carr, A., M.H. Carr e A.B. Meylan. 1978. The ecology and migrations of sea turtles, 7. The West Caribbean green turtle colony. Bulletin of the American Museum of Natural History 162:1-46.

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

Hirth, H.F. 1980. Some aspects of the nesting behavior and reproductive biology of sea turtles. American Zoologist 20: 507-523.

Hughes, G.R. 1982. Nesting cycles in sea turtles - typical or atypical? Pages 81-89. In K. Bjorndal (edit.). Biology and conservation of sea turtles. Smithsonian Institution Press, Washington, DC

Limpus, C.J. 1985. A study of the loggerhead sea turtle, Caretta caretta, in eastern Australia. Ph.D. thesis, University of Queensland, St. Lucia, Australia.

Marcovaldi, M.A. & Laurent, A., 1996. A six-season study of marine turtle nesting at Praia do Forte, Bahia, Brazil, with implications for conservation and management. Chelonian Conservation and Biology 2: 55-59.

Richardson, J.I., 1982. A population model for adult female loggerheads sea turtles (Caretta caretta) nesting in Georgia. Ph.D. thesis. University of Georgia-Athens, Georgia.

IN THE ISLAND OF CRETE: A NEW NESTING AREA OF THE LOGGERHEAD TURTLE IN THE MEDITERRANEAN

Dimitris Margaritoulis

The Sea Turtle Protection Society of Greece, Solomou 35, GR-106 82 Athens, Greece

INTRODUCTION

The loggerhead sea turtle, a circumglobal species, has evolved local populations in the Mediterranean Sea. Colonization o the Mediterranean by loggerheads, occurred at the end of the last glacial period, about 12,000 years ago, probably by animals originating from Florida (Bowen et.al., 1993).

Loggerhead populations in the Mediterranean nest mainly in the Cental (Greece, Libya) and eastern basins (Turkey, Cyprus). In Greece, the main nesting areas of Caretta caretta (i.e., Zakynthos, Kiparissia Bay, Lakonikos Bay), totaling about 2,800-3,000 nests per season, are monitored each year by the Sea Turtle Protection Society of Greece (Fig. 1). At the same time, management measures in the form of nest protection, public awareness, and local participation are taken.

Recently, in a rapid assessment study that covered about 7,000 km of coastline in Greece (Margaritoulis et. al., 1992) new nesting areas were discovered on the island of Crete, three areas were considered as important. These areas, (i.e., Rethimnon, Bay of Hania, and Bay of Messaras), total about 37 km in beach length, 31.8 of which is suitable for nesting and used by turtles (Fig. 1).

Preliminary work conducted before 1995, has shown that sea turtles on Crete are subject to heavy human pressure mainly because their traditional nesting areas are also tourist areas. This implies that many nests are destroyed during the 2-month incubation period by intensive beach use and vehicular traffic. Even when eggs succeed to hatch, hatchlings get disoriented by bright artificial lights.

Another serious problem on Crete is the high rate of nest destruction by sea water, due to narrow beach width (caused by human interventions along the coast) and the predominant winds during the summer.

Nevertheless, as it was seen during the preliminary work, both the above major threats might change for the benefit of the sea turtle.

The loggerhead turtle is considered an endangered species in the boundaries of the European Union and is protected through international conventions (e.g., Bern Convention), European Commission directives (e.g., Habitats Directive), and national legislation. A 3-year project for the recovery of the turtle populations nesting on Crete, was designed and undertaken by the STPS with 75% financial assistance from the European Commission.

The specific objectives of the project are the following:

1. To protect as many nests as possible and thereby increase the hatching rate of the nesting populations.
2. To raise public awareness (of both inhabitants and visitors) on the need to protect these sites, providing also specific guidelines for such protection.
3. To produce Management Plan proposals, in cooperation with local communities, and submit them to competent authorities for implementation.

Nesting Activity and Protection of Nests - Nesting activity on Crete during 1995 started on 4 June and ceased on 30 August. During this period, 3,357 emergences were recorded, of which 780 resulted in nests (Table 1).

Rethimmon area is the most important area on Crete with 511 nests over 10.8 km of nesting beaches (nesting density: 47.3 nests/km). These data rank Rethimnon as the third most important area in Greece after Zakynthos and Kiparissia Bay, featuring average nesting densities of 400 nests/km and 80 nests/km, respectively (Arapis and Margaritoulis, 1994; Margaritoulis, 1988).

The Bay of Hania and the Bay of Messaras host a much less nesting potential. However, the prospects of conservation work at these sites are very encouraging as local authorities, communities, and hotel owners express a genuine interest to help sea turtles while protecting the beaches from erosion and degradation by appropriate management measures.

Out of the 780 recorded nests, 162 nests (20.8%) were considered "doomed" and moved to 6 beach hatcheries constructed at appropriate locations. During 1995, clutches moved to hatcheries produced more hatchlings than clutches left in situ (Table 2).

Most of the nests, left in situ, were fenced with special cages against intense beach-use by humans, including vehicles. Nest cages proved a successful management technique for the physical protection of nests and an important public awareness tool. Each caged nest featured a conspicuous sign in three languages, explaining the reason of the caging.

Conservation and Management - Public awareness efforts were addressed to the general public through the mass media (both national and local) and to specific target groups, i.e., authorities, tourists, and schoolchildren.

Authorities were informed by frequent visits and by their involvement in providing permits for information stations and camps. Local communities were generally very helpful; two of them provided direct support to the project by offering office and store space and community provided free accommodation for project volunteers at the community camping site.

Inhabitants and visitors were sensitized through specially constructed Information Stations erected at the waterfront promenade in the town of Rethimnon, at the old harbor of the town of Hania and at Matala, the main tourist village in the Bay of Messaras. Another means of public education, aimed at tourists, was carried out through slide shows organized in hotels along the nesting areas. A total of 246 slide shows were conducted during the summer of 1995 in hotels and hostels of Rethimnon, Hania Bay, and Messaras Bay.

A leaflet in three languages (Greek, English, and German) provided guidelines and instructions for the protection of turtles and their nests. Another leaflet explained the problem of artificial lights along the beaches. The leaflets were widely distributed and generally accepted by the local community and the tourist and industry.

Raising awareness among schoolchildren was done through the STPS Environmental Education Programme (Kremezi-Margaritouli, 1992). Besides the standard presentations at schools, four specially designed traveling kits on sea turtles were given to the Education Departments of Crete to be used in the schools of each area. As a follow-up action to environmental education activities, a group of 16 children with 2 teachers from Rethimnon came to Athens for a 4-day trip as guests of the STPS.

Date for the elaboration of the three Management Plans started to be collected during 1995. The main abiotic, biotic, and anthropogenic parameters influencing nesting/hatching were documented per beach sector. A draft Management Plan for each area will be presented to the authorities by the end of 1996.

Crete presents a unique opportunity of working with local communities and tourism for the benefit of the sea turtle. The interest shown by local people, visitors, and hoteliers can establish the much needed compromise. The tourist industry in Crete has seized immediately the offered prospects of having a "popular" endangered species nesting on the beaches of Crete.

LITERATURE CITED

Arapis, T. And D. Margaritoulis. 1994. Sea turtle conservation and sustainable tourism for the proposed maring park on Zakynthos Island, Greece. In: Proceedings of the Thirteenth Annual Symposium on Sea Turtle Biology and Conservation. NOAA Technical Memorandum NMFS-SEFSC-341, p. 6-10.

Bowen, B.W., J.I. Richardson, A.B. Meylan, D. Margaritoulis, S.R. Hopkins-Murphy, and J.C. Avise. 1993. Population structure of loggerhead turtles (Caretta caretta) in the West Atlantic Ocean and Mediterranean Sea. Conservation Biology 7(4):834-844.

Kremezi-Margaritoulis, A. 1992. Sea turtles stimulate environmental education in Greece. Marine Turtle Newsletter 57:21-22.

Margaritoulis, D. 1988. Nesting of the loggerhead sea turtle Caretta caretta on the shores of Kiparissia Bay, Greece. Mesogee 48: 59-65.

Margaritoulis, D., A. Kotitsas, and M. Dretakis. 1992. Discovering new nesting areas of Caretta caretta in Greece. In: Proceedings of the Twelfth Annual Workshop on Sea Turtle Conservation and Biology. NOAA, NMFS, SFSC, p. 214-217.

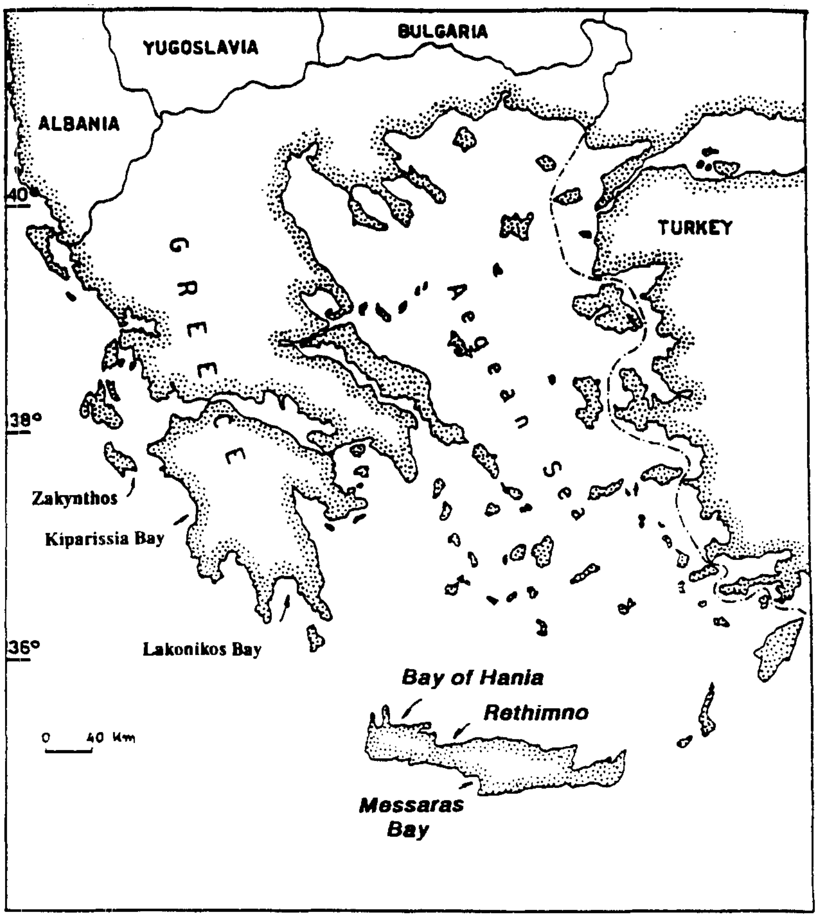


Fig. 1. Sketch map of Greece showing position of Crete and important nesting areas

TABLE 1. DISTRIBUTION OF EMERGENCES, NESTS, NESTING SUCCESS AND NESTING DENSITY ALONG THREE NESTING AREAS ON CRETE DURING 1995.

Nesting area	Length (km)	Emergences (include nests)	Number of nests	Nesting success (%)	Density (nests/km)
RETHIMNON	10.8	2.262	511	22.6	47.3
HANIA	13.0	752	192	25.5	14.7
MESSARAS	8.0	343	77	22.4	9.6
Total	31.8	3.357	780	23.2	24.5

TABLE 2. COMPARISON OF HATCHING SUCCESS BETWEEN NESTS *IN SITU* AND HATCHERY NESTS ON CRETE DURING 1995.

Nesting area	Hatching Success	
	Nests *in situ*	Hatchery nests
RETHIMNON	57.6	71.9
HANIA	62.5	73.9

ESTIMATION OF SEX RATIO OF LOGGERHEAD TURTLES HATCHING ON THE SENRI-COAST IN JAPAN

Yoshimasa Matsuzawa[1], Katsufumi Sato[2], Hideji Tanaka[3], Takeharu Bando[1], Wataru Sakamoto[1], and Kiyoshi Gotou[4]

[1]Department of Fisheries, Faculty of Agriculture, Kyoto University, Kyoto 606-01, Japan
[2]National Institute of Polar Research, 1-9-10 Kaga, Itabashi, Tokyo 173, Japan
[3]Grad. Univ. Advanced Studies, National Institute of Polar Research, 1-9-10 Kaga, Itabashi, Tokyo 173, Japan
[4]278 Higashiyoshida, Minabe-town, Wakayama 645, Japan

Mrosovsky et. al. (1984) and Mrosovsky and Provancha (1989, 1992) reported about sex ratios of loggerhead hatchlings by checking their gonads histologically. Nevertheless, we ought to establish a useful way to survey the sex ratio without any sacrifice. This paper documents field surveys and laboratory experiments made to quantify the effects of temperature on hatching success, emergence success, incubation length, and sex ratio. Then data sets of sand temperature, number of nests and clutch size were substituted into these function to estimate the number of emerging hatchlings and the sex ratio in Senri-coast of Wakayama prefecture, Japan.

METHODS

In 1993 and 1995, the number of nests was counted every day and a sand temperature at the depth of 50 cm was measured every hour with date logger in Senri-coast of Wakayama prefecture, Japan. Throughout the nesting seasons, 1 clutch of eggs was reburied almost every 10 days to open hatchery settled on the same beach. Each operation of transplantation was finished within 3 hours from oviposition. Then each clutch was monitored for hatching success, emergence success, and incubation length.

To survey the effect of constant temperature on hatching success and incubation length, eggs from 5 clutches were incubated at 7 constant temperatures ranging from 24°C to 32°C. Each incubator was filled with 30 eggs from the 5 clutches.

To localize the thermosensitive period, upward temperature shifts during incubation were made. After 220 eggs from the 5 clutches were kept at 25°C for 27 days, 10 of the eggs were removed to another warmer incubator maintained at 32°C every 2 days. An egg was opened to check the developmental stage reached at that time. Sex was determined from examination of sections of the gonads.

To get an equation about relationship between incubation temperature and sex ratio of hatchlings, 7 incubators were kept at constant temperatures ranging from 27.5°C to 30.5°C. Each was filled with 40 eggs from 4 clutches.

In this paper, hatching success is defined as the ratio of hatching eggs to all eggs. Emergence success means the ratio of emerging hatchlings to hatching eggs. The date of incubation length in the field include the time between hatching and emergence above ground.

RESULTS AND DISCUSSION

Hatching success did not vary with temperature, except at 24°C. All of the eggs incubated at this temperature died just before piping, while hatching success of field clutches that were laid in early nesting season to be exposed to lower temperature were ordinary level. Thus, it could be concluded that 24°C is too cool for embryo to pip and hatch out, while this temperature is not lower lethal temperature in any other developmental stages.

Emergence success decreased with increasing of mean sand temperature for 3 days around the first emergence (t). Following regression was obtained: $E=100/[1+\exp(2.0T-63.2)]$, with E denoting the percentage of emergence success. The dramatic decrease occurred between 31°C to 32°C. This result consists with other studies that reported no or few hatchling obtained from incubator at 35°C (McGehee 1979), 34°C (Yntema and Mrosovsky 1979, 1980), and the temperature of the egg mass rises from 1.8°C to 2.3°C during development (McGehee 1979, Kraemer 1979).

Both in the field and laboratory, incubation length is inversely correlated with temperature significantly. According to the law of total effective temperature, following regressions were obtained: $Df=66.3/(T-18.3)$, Df denoting incubation length (days) in the field and T is mean temperature during the period; and $Dl=483.8/(T-19.8)$, here Dl denotes mean incubation length and T is constant incubation temperature.

Former equation indicates that hatchlings emerge from each egg chamber just when the value of the integral of the sand temperature above 18.3°C reaches 600.3.

The pivotal temperature is 29.7°C. The following regression indicates the relationship between percentage of female hatchlings (F) and temperature (T): F=100/[1+exp(-2.26T+6.71)].

Experiments with alterations of temperature localized the thermosensitive period to somewhere between state 23 and 26 of embryonic development. This period is from when eggs finish to receiving about 40% of total effective temperature for hatching to the time when they do about 55%.

Substituting the data sets of sand temperature, number of nests per day, and clutch size: mean clutch size is 115 (N=96) in the beach, into above results, we computed the estimated number of emerging hatchlings per day with their sex ratio. In 1993, there were 18,766 (82.4% of this year) males and 4,008 (17.6% of this year) females supposed to emerge, while in 1995, there were 960 (18.8% of this year) males and 4,142 (81.2% of this year) females supposed to emerge.

LITERATURE CITED

Kraemer, J.E. 1979. Variation in incubation length of loggerhead sea turtle, Caretta caretta, clutches on Georgia coast. Unpubl. M.S. Thesis. University of Georgia, Athens.

McGehee, M.A. 1979. Factors affecting the hatching success of loggerhead sea turtle eggs (Caretta caretta caretta). Unpubl. M.S. Thesis. University of Central Florida, Orlando.

Mrosovsky, N., Hopkins-Murphy, S.R., and Richardson, J.I. 1984. Sex ratio of sea turtles: Seasonal changes. Science, 225:739-741.

Mrosovsky, N. and Provancha, J. 1989. Sex ratio of loggerhead sea turtles hatching on a Florida beach. Can. J. Zool., 67:2533-2539.

Mrosovsky, N. and Provancha, J. 1992. Sex ratio of hatchling loggerhead sea turtles: Data and estimates from a 5-year study. Can. J. Zool., 70:530-538.

Yntema, C.L. and Mrosovsky, N. 1979. Incubation temperature and sex ratio in hatchling loggerhead turtles: preliminary report. Mar. Turtle Newsletter. 11:9-10.

Yntema, C.L. and Mrosovsky, N. 1980. Sexual differentiation in hatchling loggerheads (Caretta caretta) incubated at different controlled temperatures. Herpetologia, 36:33-36.

USE OF PIT TAGS AND PHOTOIDENTIFICATION ON LEATHERBACK TURTLES IN ST. CROIX, USVI

Donna L. McDonald and Peter H. Dutton

Ocean Planet Research, Inc., 2025 32nd Street, San Diego, CA, 92104
NOAA - National Marine Fisheries Service, Southwest Fisheries Science Center, P.O. Box 271,
La Jolla, CA, 92038

We used Passive Integrated Transponder (PIT) tags and photoidentification of pink spots to re-examine flipper tag data for leatherback turtles (Dermochelys coriacea), providing more accurate information on numbers of individuals and proportion of remigrants nesting on the Sandy Point National Wildlife Refuge, St. Croix, USVI (see McDonald and Dutton, in press). We estimate the actual number of individual females seen in St. Croix to be 18.9% fewer than indicated by flipper tags alone. Between 1989 - 1995, the seasonal proportion of remigrants averaged 48.5%, over 10% higher than indicated by flipper tags (35.1%). In some years, over half the turtles nesting were remigrants. Of the turtles tagged from 1987-1991, 58.6% have returned through 1995. Since flipper tag retention is low for leatherbacks, PIT tags and photoidentification can be valuable supplements to flipper tags, and should be used when developing life history profiles and size estimates of nesting populations.

LITERATURE

McDonald, D., and P. Dutton. in press. Use of PIT tags and photoidentification to revise remigration estimates of leatherback turtles (Dermochelys coriacea) nesting in St. Croix, U.S. Virgin Islands. Chelonian Conservation and Biology.

NEST SITE SELECTION IN MEDITERRANEAN MARINE TURTLES AT CHELONES BAY, NORTHERN CYPRUS

Richard J. Mellanby [1], Annette C. Broderick [1&2] *, Brendan J. Godley[1&2]

[1] Division of Environmental and Evolutionary Biology, I.B.L.S., Graham Kerr Building, University of Glasgow, Glasgow, G12 8QQ, Scotland, U.K.
[2] Department of Veterinary Anatomy, University of Glasgow Veterinary School, Bearsden Road, Glasgow, G61 1QH, Scotland, U.K.
* Correspondent

The aim of the study was to describe the nest site selection of both green and loggerhead turtles nesting on Chelones Bay in 1995 and to investigate the hatchability of nests relative to their position on the beach. Because plastic pollution so severely affected this beach, the possible effects of this factor were also investigated. A fuller report is found in Mellanby (1996).

MATERIALS AND METHODS

The study site was a bay situated on the north coast of the Karpaz Peninsula, Northern Cyprus. Locally, the bay is known as "Chelones," signifying the historical importance of this area to nesting turtles. The bay was subdivided along it's length into sections of approximately 40 m. The beach was then mapped with respect to markers, vegetation line and the high water mark. The amount of plastic debris present was visually assessed on each section according to a 6-point ratio scale: 0 indicated that no debris was present on the section and 5 indicated 81-100% coverage by plastic debris. Nesting, hatching and predation activities were recorded twice weekly during daytime surveys according to an established protocol (Broderick and Godley, 1993).

RESULTS

Of the 78 nests laid on Chelones Bay, 71 were Chelonia mydas nests and seven were laid by Caretta caretta. Emergence position was non random as certain sectors were strongly favored (X2 =82.9, df=19, $p<0.01$). In the zones where nesting was favoured there was a smaller relative proportion of false crawl attempts and false crawl U turns. Nests tended to be laid in the middle parts of the beach width and no nests were laid above the vegetation line (fig. 1). Nests laid in the central region had no increased hatching rate, hatching success or lower predation rate than nests laid in lower or higher regions of the beach.

False crawl attempts tended to occur further up the beach than successful nesting attempts. There was no significant difference in the width of beaches where false crawl attempts and successful nesting attempts were made. Thirty-eight percent of the nests hatched.

The incubation periods, clutch sizes and egg chamber depth (table 1) were in the normal ranges for loggerhead and green turtles nesting in Northern Cyprus (Godley and Broderick, 1994). The depth of the green turtle egg chambers was significantly deeper than loggerhead egg chambers. There was a significant correlation between incubation period and date of lay ($r=-0.365$; $N=24$; $p>0.05$) and between length of incubation and the depth of the middle of the nest ($r=0.626$; $N=12$; $p>0.025$). There was a weak correlation between hatching success and clutch size ($r=0.541$; $N=24$; $p>0.025$). Nests were predated by foxes and dogs. Nest predation was greatest in sectors with high nest densities. All sectors had some plastic debris coverage. Turtles showed a tendency to nest on sectors with a moderate coverage of plastic (fig. 2). The extent of plastic coverage did not appear to affect hatching rate (fig. 3) or hatching success.

DISCUSSION

Chelones Bay is the most important green turtle rookery in Northern Cyprus and is a very important nesting site in the Mediterranean. A trend was observed for loggerhead turtles to nest earlier in the season than green. This has also been observed in other studies in the Mediterranean (Peters and Verhoeven, 1992). The clumped distribution of nests along the length of the beach was also in agreement with many other studies of Mediterranean turtles (Brown and Macdonald, 1995).

The green turtles had a much larger clutch size than loggerheads. Loggerhead turtles nesting on Northern Cyprus often have smaller clutches than other loggerheads that nest in the Mediterranean (Godley and Broderick, 1992). The incubation period of green nests tended to be greater than that of loggerhead nests. This is likely to be at least in part due to the greater depth of green nest. Higher temperatures tend to decrease incubation periods (Bustard and Greenham, 1968) and so nests on Chelones Bay had a shorter incubation period than nests laid on beaches in southern Turkey (van Piggelen, 1993; Peters and Verhoeven, 1992). The effect of temperature on the incubation period may account for the correlation between depth of nest and incubation length.

The fact that turtles often lay more nests on moderately polluted areas of the beach may be coincidental or dependent upon a third related variable such as a current or wave pattern that affects both turtles and litter. The finding that pollution did not appear to affect the hatching rate or hatching success should also be interpreted with care. Twice, plastic was found above the egg chamber obstructing the passage of hatchlings to the surface.

ACKNOWLEDGMENTS

The initial project was supervised by Dr. R. Tippett; travel to the symposium was possible due to an overseas student travel grant. Many members of Glasgow University Turtle Conservation Expedition assisted with this work, all sponsors of the expedition are acknowledged in the annual report.

LITERATURE CITED

Broderick, A.C. and Godley, B.J. (eds.), 1993. Glasgow University Turtle Conservation Expedition to Northern Cyprus 1993 - Expedition Report. Dept. Vet. Anat. Glasgow University Vet School, Bearsden, Glasgow G61 1QH.

Brown, L. and Macdonald, D.W. (1995). Predation on Green Turtle Chelonia mydas nests by wild canids at Akyatan Beach, Turkey. Biological Conservation, 71: 55-60.

Bustard, R.H. and Greenham, P. (1968). Physical and chemical factors affecting hatching in the green sea turtle, Chelonia mydas. Ecology, 49(2): 269-276.

Godley, B.J. and Broderick, A.C. (eds.) 1994. Glasgow University Turtle Conservation Expedition to Northern Cyprus 1994 - Expedition Report. Dept. Vet. Anat. Glasgow University Vet School, Bearsden, Glasgow G61 1QH.

Mellanby, R.J., 1996. An investigation into factors affecting reproductive success of marine turtles nesting on Chelones Bay, Northern Cyprus, 1995. Unpublished Honours Thesis, University of Glasgow.

Peters, A. and K.J.F. Verhoeven. 1992. Breeding Success of the Loggerhead, Caretta caretta and the Green Turtle, Chelonia mydas, in the Goksu Delta, Turkey., Report 310, Dept. of Animal Ecology, University of Nijmegen, the Netherlands., 26pp.

van Pigglen, D.C.G., 1993. Marine turtle survey in the Goksu Delta, Turkey, June-August 1991, Report 314, Dept. of Animal Ecology, University of Nijmegen, Netherlands., 33pp.

	Chelonia mydas Mean ± S.E	*Caretta caretta* Mean ± S.E
Mean clutch size	122.07 ± 9.6 (15 nests)	66.3 ± 16.0 (3 nests)
Mean incubation length / ± 7 days	54.9 ± 1.1 (24 nests)	50 ± 1.0 (2 nests)
Mean depth to top of egg chamber (cm)	67.2 ± 3.1 (14 nests)	50.3 ± 7.3 (3 nests)
Mean depth to bottom of egg chamber (cm)	84.4 ± 3.5 (14 nests)	59 ± 7.5 (3 nests)

Table 1 : Summary of incubation period, clutch size and egg chamber position

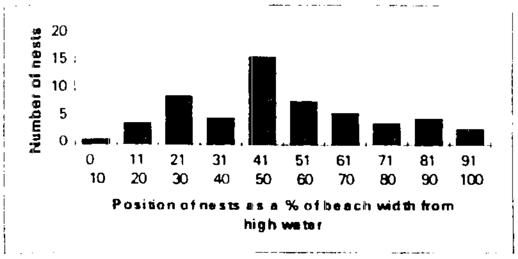


Figure 1 : Distribution of nests as a % of beach width from high water

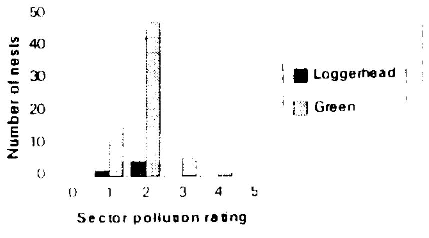


Figure 2 : Distribution of nests relative to plastic debris distribution

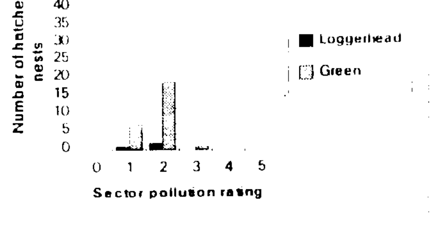


Figure 3 : Distribution of hatched nests relative to plastic debris covering

LEARNING TO ASSOCIATE ENVIRONMENTAL STIMULI WITH FOOD IN YOUNG GREEN SEA TURTLES (Chelonia mydas)

Roger L. Mellgren[1], Martha A. Mann[1], and Alejandro Arenas[2]

[1]Department of Psychology, University of Texas at Arlington, Arlington, TX 76019-0528, USA
[2]Acuario, Parque Xcaret, Carretera Chetumal Pto. Juarez Km282, Quintana Roo, Mexico

One of the most basic proximate mechanisms used by animals to adapt to their environment is the ability to learn about cues or events that signal food availability. The Russian Nobel-prize winner, Ivan Pavlov (1927), was one of the first to study this ability in a systematic way using the procedure that has come to be known as "classical conditioning." Recent research has shown that simply presenting a discrete signal such as turning on a signal light on a plastic disk and following it by a piece of food will result in the subject approaching and contacting the signal. The approach and contact behavior to a cue that signals food is called "autoshaping" (Locurto, Terrace and Gibbon, 1981), and has been studied in a variety of species. Autoshaping represents the basic ability of an animal to associate one environmental event (the cue) with another (food), and associations of this kind are one of the most basic mechanisms of adaptation. An animal that can predict where and when food will occur will have an obvious advantage over an animal who is unable to do so.

Methods

In this experiment, 10-month-old green sea turtles (Chelonia mydas) were presented with two discrete environmental events: (1) the tip of a piece of PVC pipe being placed in the water and (2) a piece of raw fish being presented for the turtle to consume. The relationship between the pipe and fish was systematically varied to evaluate the condition that would control the approach and contact behavior of the turtle to the pipe. In the paired condition, the pipe was placed just under the surface of the water and 15 seconds (sec) later, a piece of fish was extended into the water through the pipe. In the unpaired condition the pipe was also presented for 15 sec, but it was then removed and 20-40 sec later, the fish was presented in the same location that the pipe had previously occupied. In the near condition, the pipe was presented for 15 sec followed immediately by the fish, but the fish was presented approximately 18 cm away from the pipe. Finally, in the far condition, the pipe was presented for 15 sec followed immediately by the fish, but the fish was presented approximately 200 cm away from the pipe.

Thus, the four conditions of the experiment represent varying degrees of togetherness, or contiguity in both time and space, between pipe and fish. In the paired condition pipe and fish are associated in both time and space while in the unpaired group they are associated in space (they occur at the same location) but not in time. In the near and far conditions the pipe and fish are contiguous in time, but not in space.

To begin the experiment all turtles received 10 presentations of the pipe alone (baseline) followed by 20 presentations (trials) with the appropriate arrangement of pipe and fish. We recorded two behaviors as indices of association; approach to the pipe (moving to within one head length of the pipe with direct eye contact) and contact with the pipe (biting the end of the pipe). These behaviors were scored when they occurred during the first 15 sec of the pipe being put into the water.

Results and Discussion

Figure 1 shows the results of the 10 baseline and 20 experimental trials in blocks of 5 trials. The figure shows that turtles in the four conditions start out being not different on block 1 but by blocks 3 and 4 there are significant differences among the conditions. Statistical analysis was done using a mixed-model analysis of variance and differences were considered significant if p was less than .05. These analysis confirmed that there were no differences between the experimental conditions during baseline. However, there were significant effects for trials in both behavioral measures reflecting the decrease in responding from the first to the second block of baseline trials. During the 4 blocks of experimental trials the experimental conditions produced significant differences in both approach and contacts. There were no significant differences due to blocks of trials, but there was a significant interaction of blocks x conditions for the approach behavior. Separate analysis of variance on each block of trials confirmed what can be seen in the figure.

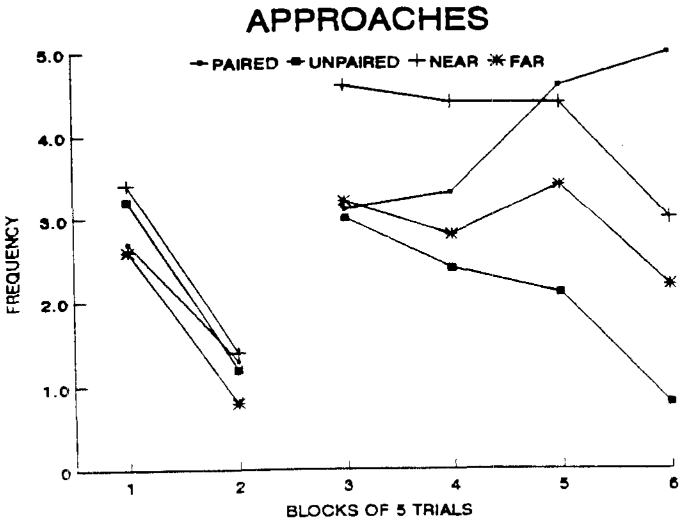
The pattern of results shows that both the time relationship and the spatial relationship between events are important for maintaining behavior directed at the pipe. However, the results also suggest that the timing between events is more important in controlling approach and contact behavior than is spatial contiguity. When pipe and food were presented in the same place, but separated in time (unpaired condition), responding to the pipe dropped rapidly. Temporally contiguous, but not spatially contiguous conditions (near and far conditions) maintained a higher level of behavior than the unpaired condition.

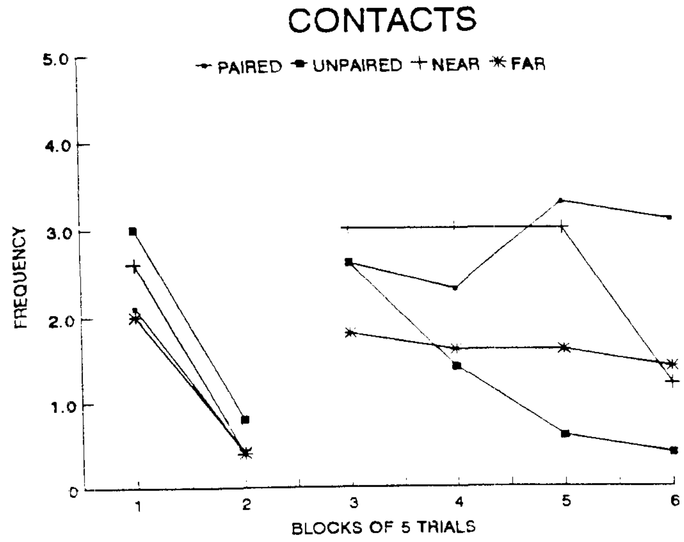
These results indicate that young green turtles are capable of rapidly learning to associate environmental events and that the learned association follows general principles shown by a wide variety of both reptilian and mammalian species under analogous conditions. This procedure can also be useful in research that evaluates the sensory capacities of turtles (e.g., visual discriminations, color sensitivities, etc.).

Literature Cited

Locurto, C.M., Terrace, H.S., and Gibbon, J. (Eds.). 1981. Autoshaping and conditioning theory. Academic Press, New York.

Pavlov, I. 1927. Conditioned reflexes. Translated by G.V. Anrep. Oxford University Press, New York.





THE EFFECTS OF NEST RELOCATION ON HATCHING SUCCESS AND EMERGENCE SUCCESS OF THE LOGGERHEAD TURTLE (Caretta caretta) IN FLORIDA

Karen Moody

Department of Environmental Protection, Florida Marine Research Institute, 100 8th Avenue SE,
St. Petersburg, Florida 33701 USA

INTRODUCTION

Florida's Department of Environmental Protection (DEP) maintains an extensive statewide marine turtle nesting database, and issues permits to a wide range of individuals and organizations to manage nesting areas and collect data on nesting activity in Florida. The state's management policy is to protect nests from both natural and man-made disturbances using the least manipulative conservation strategy possible. However, about 4% of nests in the state have been relocated in recent years. This study compares the hatching success and the emergence success of loggerhead turtles in relocated nests with those of loggerhead turtles in nests left in situ on Florida's beaches.

METHODS

To evaluate nest success, nest contents were inventoried by permit holders either 72 hours after hatchling emergence or at least 70 days after egg deposition to determine the number of eggs hatched (number of eggshells), the number of live hatchlings found in nest, the number of dead hatchlings found in nest, the number of pipped eggs (both live and dead) in nest, and the number of unhatched eggs (including depredated eggs). The number of hatchlings emerged was calculated by subtracting the number of live and dead hatchlings in the nest from the number of eggshells. The total number of eggs laid was either counted during relocation, or was calculated by adding the number of eggshells, the number of pipped eggs, and the number of unhatched eggs. Permit holders report the total numbers in each category to DEP for each beach surveyed.

I analyzed data from all beaches surveyed in Florida in 1993 and 1994 that met the following criteria: (1) Presence of at least 20 relocated nests and 20 in situ nests; and (2) no unresolved discrepancies on the permit holder's reporting form. When individual nest data from several sites were made available by the permit holders, I conducted statistical tests to determine if nest success rates were different in relocated nests versus nests left in situ.

RESULTS AND DISCUSSION

Due to Florida's low nest-relocation rate (4%), many of the nesting beaches did not have enough nests in each category to be included in the analysis. Of those beaches with 20 or more nests in each category, several had to be excluded due to unresolvable discrepancies in the data. As a result, of the beaches surveyed in 1993 and 1994, six were included in each year in the preliminary analyses (Figure 1). In these analysis, hatching and emergence success rates for each site were based on numbers from all nests combined. On 9 of the 12 beaches evaluated, hatching success was lower in relocated nests, and on 10 of 12 beaches, emergence success was lower in relocated nests. However, using statistical tests on these combined data is not appropriate because there is no measure of the variability of success among individual nests within a site. Mote Marine Laboratory, The South Volusia Sea Turtle Protection Society, and the Volusia Turtle Patrol provided their individual nest data for further analysis (Table 1). Hatching and emergence success rates were tested with a Mann-Whitney Rank Sum Test for significance. Hatching success rates were significantly lower for relocated nests in only two of the six beaches evaluated; however, emergence success rates were significantly lower for relocated nests in six of the eight beaches evaluated. None of the sites had significantly higher hatching or emergence success rates for relocated nests. This suggests that for these sites, there may or may not be a difference in the percentage of eggs that hatch; however, fewer hatchlings are emerging from relocated nests.

These analysis were conducted to determine if differences existed in hatching and emergence success rates of Caretta caretta in relocated versus in situ nests on Florida beaches. More sites should be evaluated to determine if these differences exist for beaches other than those included in these analysis. Further research should focus on determining what factors (biotic, abiotic, and anthrogenic) may cause these differences.

ACKNOWLEDGMENTS

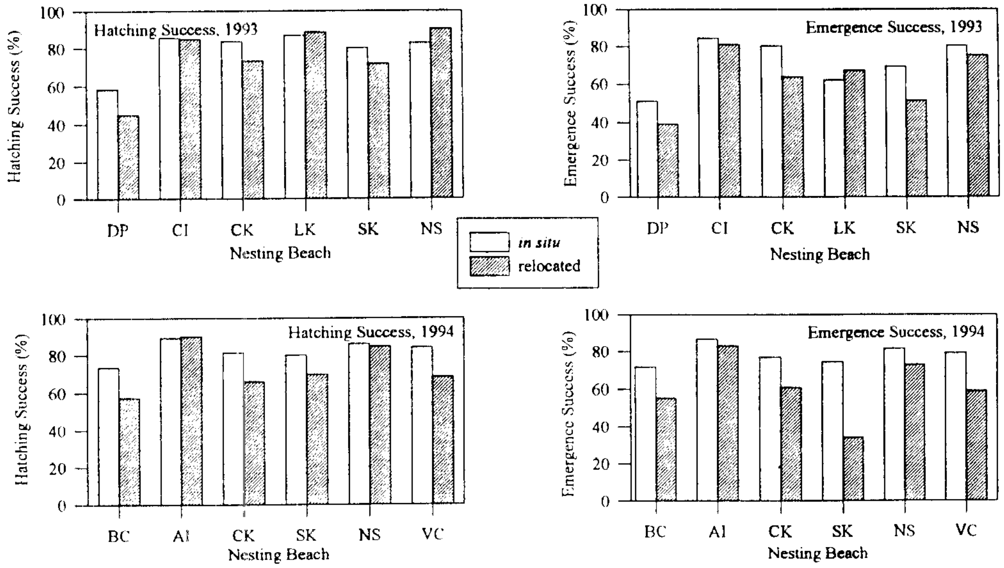
I am indebted to the state's permit holders and DEP staff for the collection and collation of the nesting data (from the marine turtle nesting database) that I used in this study. In addition, I thank Jerris Foote (Mote Marine Laboratory), Beth Libert (South Volusia Sea Turtle Protection Society), and Marye Marshall (Volusia Turtle Patrol) for allowing me access to their raw data. I also thank Joseph O'Hop (DEP) for statistical advice, and Anne Meylan and Allen Foley (DEP) for comments on the analysis.

Table 1. Statistical evaluation of hatching success and emergence success in relocated versus in situ nests of <u>Caretta caretta</u> in Florida for which individual nest data were available.

Location	Hatching Success		Emergency Success	
	<u>In situ</u> vs. relocated	P value	<u>In situ</u> vs. relocated	P value
Casey Key 1993	I>R	n.s.(0.0541)	I>R	*(<0.0001)
Longboat Key 1993	R>I	n.s.(0.6871)	R>I	n.s.(0.7126)
Siesta Key 1993	I>R	n.s.(0.1213)	I>R	*(<0.0001)
New Smyrna 1993	R>I	n.s.(0.0655)	I>R	n.s.(0.1081)
Casey Key 1994	I>R	n.s.(0.0787)	I>R	*(0.0223)
Siesta Key 1994	I>R	*(0.0036)	I>R	*(<0.0001)
New Smyrna 1994	R>I	n.s.(0.2458)	I>R	*(0.0039)
Volusia Co. Beaches 1994	I>R	*(<0.0001)	I>R	*(<0.0001)

Figure 1. Hatching success and emergence success in *in situ* versus relocated nests of *Caretta caretta* on Florida beaches in 1993 and 1994.

AI=Amelia Island, BC=Broward Co. Beaches, CI=Captiva Island, CK=Casey Key, DP=Don Pedro Island, LK=Longboat Key, NS=New Smyrna Beach, SK=Siesta Key, VC=Volusia Co. Beaches



MAPPING MARINE TURTLE SATELLITE TELEMETRY DATA USING A GEOGRAPHIC INFORMATION SYSTEM (GIS)

Andrea E. Mosier and Timothy J. Leary

Florida Department of Environmental Protection, Florida Marine Research Institute, 100 8th Avenue SE, St. Petersburg, Florida 33701, USA

The number of researchers employing satellite telemetry to track marine turtle movements is rapidly increasing. Florida Marine Research Institute (FMRI) staff have attached satellite transmitters to female green turtles departing from a Florida nesting beach and to adult male green turtles intercepted in Panama along their migratory route. Future telemetry projects are planned for Florida Bay and Bermuda. Signals received from UHF transmitters provide turtle location data to the Service ARGOS receivers on the NOAA TIROS satellites. Once the signals are downloaded to ground-based computers, SAS, DBASE III, and ARC/INFO software programs are used to process latitude and longitude coordinates and to produce preliminary maps for detailed analysis.

Researchers' use of Geographic Information System (GIS) software to graphically represent and analyze these data reduces the potential for errors introduced by more traditional methods. Although telemetry data are routinely used by researchers to map the migrations and distributions of many animal species, the magnitude of marine turtle migrations can preclude the use of common mapping procedures. Small- and large-scale GIS basemaps were created for the Caribbean region from the available navigational charts. Charts were scanned, rectified, and mosaiced using ERDAS Imagine and ARC/INFO software. Small-scale basemaps are useful for plotting turtles along their long migratory routes, whereas co-registered large-scale basemaps are useful for localized basins and for coastal regions.

By creating basemaps of various scales, FMRI staff have begun to create a GIS that facilitates the process of verifying, updating, and analyzing satellite telemetry data, as well as enhances the presentation of this information. Eventually, the integration of additional associated environmental data layers, such as benthic habitats, current patterns, and bathymetry, will allow researchers to better understand the behavioral patterns of different species of sea turtles through the use of GIS queries and spatial analysis.

THERMAL PROFILES OF TURTLE HATCHERIES AND NESTING AREAS AT PRAIA DO FORTE, BRAZIL

Eugênia F.S. Naro[1], N. Mrosovsky[2], and Maria Ângela Marcovaldi[3]

[1]191 Waverly Place, New York, NY 10014
[2]Department of Zoology, University of Toronto, 25 Harbord St., Toronto, Ontario, M5S 1A1 Canada
[3]Fundação Pró-TAMAR, Caixa Postal 2219, Salvador, Bahia, Brazil CEP 40.210-970

Sand temperatures at sea turtle nest depth were taken in both open-air hatcheries and natural nesting areas at Praia do Forte, Bahia, Brazil. The aim of this study was to determine if incubating these turtle eggs in hatcheries was likely to affect the local population's sex ratio. The mean sand temperatures at 30 and 60 cm. depths in the hatcheries were not significantly different from those in natural areas with similar characteristics. The slightly higher ranges in temperature in one hatchery that was irrigated were unlikely to have had major effects on sex ratio. Nest transferal off the beach into open-air hatcheries at Praia do Forte probably have very minor effects on the sex ratios of the hatchlings.

PRELIMINARY ASSESSMENT OF LOGGERHEAD TURTLE (Caretta caretta) NEST SEX RATIOS OF NESTS INCUBATED IN ARAGONITE SAND

David A. Nelson[1], Stephen Blair[2], and Tim S. Gross[3]

[1]USAE Waterways Experiment Station, Vicksburg, MS 39180
[2]Dade County Department of Environmental Resources Management, Miami, FL 33130
[3]University of Florida (BEECS), Gainesville, FL 32511

A hatchery study was conducted on the use of historical, present, and potential sand types useful for the nourishment of Dade County beaches. The field portion of the study was conducted at Miami Beach, Florida beginning in July 1995 and ending in October 1995. The sex ratios of loggerhead sea turtle (Caretta caretta) nests incubated in four sand types was determined for a Dade County turtle hatchery. The four sand types were Bahaman aragonite (calcium carbonate)sand, renourished sand from nearshore borrow areas (calcium carbonate), native sand (quartz), and a aragonite-renourished 50-50 mix of sand.

METHODS

Field Sampling: Loggerhead Sea turtle nests were moved from Dade and Broward County, FL beaches to a Miami Beach, FL hatchery. Nests were placed sequentially in four sand types: calcium carbonate (aragonite), native, renourished, and mixed (50% calcium carbonate and 50% renourished). Each sand type was 20 ft by 20 ft by 5 ft (depth). Approximately, 7 to 10 days prior to anticipated emergence eggs were removed from the hatchery and placed into an incubator until they hatched (Figure 2). Seven eggs were taken from each of the top, center, and bottom portion of the nest. Eggs were incubated individually into cups in a temperature and humidity controlled incubator (Figure 3 and 4). Upon hatching the egg fluids remaining in the cup were pipetted into a cryovial, frozen, and stored for later estrogen/testosterone (E/T) analysis by the BEECS Reproductive Analysis Laboratory. Eggs were removed for sex ratio determination from a total of 53 nests (aragonite sand - 13, native sand - 13, renourished sand - 13, and mixed sand - 14).

Laboratory Analysis: The Biotechnologies for the Ecological, Evolutionary, and Conservation Sciences (BEECS) Program Reproductive Analysis Laboratory, developed a relatively non-invasive procedure for sex identification of neonatal sea turtles. This technique requires the collection of egg fluids (chorioallantoic/amniotic fluid; CAF) at hatching and the analysis of estrogen and testosterone metabolites in this fluid. This method produces and estrogen/testosterone ratio that is nearly 95% effective in identifying hatching sex for loggerhead sea turtles.

Data Analysis: Data were analyzed using SPSS-PC+ 6.1 for windows. Nest with results from less than 2 eggs were excluded from the analysis. The percent males was calculated for each nest. Percent data were transformed using the arcsine transformation prior to analysis (Zar, 1984). Means were tested using analysis of variance (ANOVA) with alpha set at 0.05. Tukeys-B multiple comparison tests were used to test significant differences between different sand types and different nest locations (p = 0.05). Levenes tests were used to test homogeneity of variance (Norusis, 1993).

RESULTS

Sex was determined for 903 total eggs from 47 different nests (aragonite sand - 13, native sand - 13, renourished sand - 7, and mixed sand - 14). The percent males for each nest were predominantly between 35% and 70% with very few values outside this range. The mean percent males for the four sand types ranged from 41.9% to 53.0% (Table 1) which approaches a 50:50 sex ratio. The mean percent males for nests incubated in aragonite sand was lower than nests incubated in the other three sand types for eggs. However, the difference was not significant (p = 0.05). Examination of the distribution and scatter of the data from the four sand types suggests that the lower mean percent males for the aragonite data was probably not genuine. The sex ratios relative to position in the nest, all sand types combined and for nests incubated in the native sand, showed that the top portion of the nest had a significantly lower percent males than the bottom and middle portions. A lower number of males may be expected for top portions of the nests since these eggs are nearer to the beach surface where sand temperatures are warmer and more variable. No significant differences were found for percent males of eggs from the three portions of the nests incubated in aragonite and mixed sand. No significant differences were found for percent males between the middle and bottom portions of the nests incubated in the four sand types or for nests from all sand types combined. However, sex ratios determined for nests by combining eggs taken from the different layers in the nest should be viewed with caution since equal partitioning of the samples among the three layers may not represent the correct stratification of samples. For example, if eggs from the top layer, which tended to be female biased, represent only 10% of the eggs rather than the 33.3% sampled in this study then the nest sex ratio has been biased toward females by the sampling regime.

CONCLUSIONS

The mean nest sex ratio for nests of the four sand types was close to 50:50 (42% to 53%). However, this sex ratio may have been influenced by equal partitioning rather than randomizing of eggs sampled within the nest. No significant differences in percent males were found for nests incubated in the four different sand types. Within nest variability of hatchling sex was high. Sex of hatchlings is likely influenced by the eggs position within the nests during incubation with eggs near the sand surface tending toward the female. The combination of egg position in the nest, nest location on the beach, and variation of temperatures over the nesting season are likely to produce variable sex ratios.

ACKNOWLEDGMENTS

This survey was funded by the US Army Engineer District, Jacksonville and Dade County.
Mr. Steve Traxler was the Jacksonville District Project Manager. Mr. Steve Blair was the Dade County Project Manager. The study was a combined effort of Florida Atlantic University (FAU), University of Florida (UF), Dade County Department of Environmental Resource Management (DERM), Dade County Department of Parks and Recreation (DCParks), US Army Engineer District, Jacksonville and the USAE Waterways Experiment Station (WES). The overall study effort consisted of three primary areas of research: (1) nest success data (Mr. Jim Hoover and Mr. Steve Blair, DERM); (2) nest and temperature data (Dr. Peter Lutz, Dr. Sarah Milton, and Ms. Rebecca Cheeks, FAU); and (3) nest sex ratios (Mr. Dave Nelson, WES; Dr. Tim Gross, UF, and Mr. Steve Blair, DERM). Field work was conducted by Ms. Rebecca Cheeks (FAU) , Dr. Sarah Milton (FAU), Ms.Sabeena Beg (FAU), Mr. Chris McFadden (FAU), Ms. Rene Varelay (FAU), Mr. Steve Blair (DERM), Mr. Joe Hibler (DCParks), Mr. Jim Hoover (DCParks), Ms. Sue Kim (DERM), Mr. Tony Way (DCParks), Mr. Paschual Alverez (DCParks), Mr. Bill Ahern (DERM) and Mr. Bill Margolis (Broward County). Dr. Tim Gross (BEECS) provided laboratory analysis of samples and guidance on sampling techniques.

LITERATURE

Norusis, M. J. 1993. SPSS for Windows: Base system and user's guide, release 6.0. SPSS, Inc. Chicago, IL. 828 pp.

Zar, J. H. 1984. Biostatistical analysis. 2nd ed., Prentice-Hall, Englewood Cliffs, NJ. 718 pp.

Table 1. ANOVA and Tukey-B multiple range test (p = 0.05) for percent males in all portions of the nests combined for the four sand types (none was significantly different).

Sand Type	n	Mean	SD	SE	95% Conf	Min	Max
Aragonite	13	41.9	18.0	5.0	31.0 to 52.7	4.8	71.4
Mixed	14	52.3	16.0	4.3	43.0 to 51.5	19.1	83.3
Native	13	53.0	15.0	4.2	43.9 to 62.1	30.0	72.2
Renourished	7	50.5	12.9	4.9	38.6 to 62.4	35.0	71.4

F-ratio 1.35, F-probability 0.271

Table 2. ANOVA and Tukey-B multiple range test (p = 0.05) for percent males in each depth portions of the nests combined for the four sand types (Top eggs had significantly lower percent males than the middle and bottom incubated eggs).

Location the Nest	n	Mean	SD	SE	95% Conf	Min	Max
Top	45	38.8	16.7	2.5	33.8 to 43.8	0.0	85.7
Middle	43	52.4	23.9	3.7	45.0 to 59.8	0.0	100
Bottom	45	57.6	20.1	3.0	51.6 to 63.6	0.0	100

F-ratio 10.2, F-probability 0.000

Figure 1. Mean + 95% confidence intervals for percent male for eggs from all layers combined of the nests for each of the sand types.

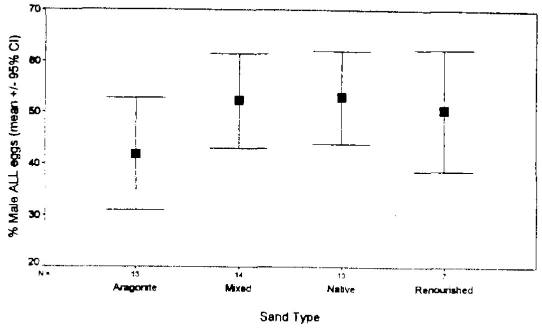
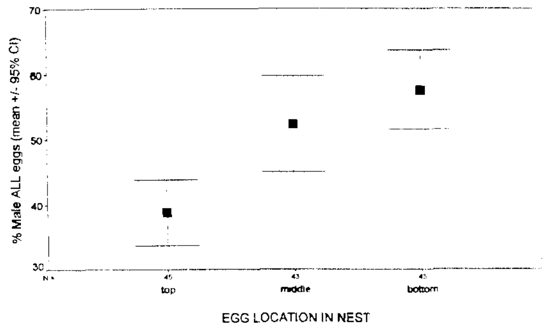


Figure 2. Mean + 95% confidence intervals for percent male for eggs from the top, middle, and bottom layers of the nests for all of the sand types combined.



NESTING SEA TURTLE RESPONSE TO BEACH SCARPS

David A. Nelson[1] **and Boyd Blihovde**[2]

[1] USAE Waterways Experiment Station, Vicksburg, MS 39180
[2] University of Central Florida, Orlando, FL 32816

One concern associated with beach nourishment is the response of nesting sea turtles to scarps which often form as a result of the nourished sand and wave interaction. A preliminary study was conducted to examine nesting turtle response to scarps and refine methods for studying this issue.

METHODS

False crawls and nesting crawls for Chelonia mydas and Caretta caretta turtles were measured on beaches in south-central Florida. A range of variables were measured to determine the conditions which may cause a nesting turtle to reject or traverse a scarp. The parameters that were measured included: species, crawl width, crawl length, elevation (slope), scarp height, scarp angle, and distances to the wrack and dune line. Distances were measured using a rolatape measuring wheel, meter stick, and measuring tape. Angles were measured with a protractor. Elevation was determined by measuring height (rise)for a given distance (run) (0.3 - 1 m) (e.g., 1 m rise for a 3 m distance produces a 1 on 3 slope). Each of the measurements were made on crawls that traversed a scarp and crawls that did not traverse (rejected) a scarp for both species. A variety of scarp heights and slopes were measured to determine rejection and selection criteria.

RESULTS

The turtles were capable of traversing a wide range of scarp heights up to 127.0 cm (Table 1, 2). Greens and loggerheads were inhibited by a wide range of scarp heights as little as 16.5 cm. Turtles were capable to traversing a wide range of scarp angles including 90° angles (Table 3, 4). But were inhibited by a wide range of scarp angles, 90° to 160°. Predicting a turtles response to a scarp appears to be combination of height and angle. As the scarp angle approaches 90° and the height 20 cm then the turtle is more likely to be inhibited. Green turtles appear to be capable of traversing a higher scarp than loggerheads. This may be due to their habit of nesting very close or into the dunes and their longer flippers. Since these data were collected in a non-random manner in order to document the full range of values statistical comparisons would not be valid. The next phase of this work will sample with a statistically valid design.

ACKNOWLEDGMENTS

This survey was funded by the US Army Engineer District, Jacksonville and Dade County. Mr. Steve Traxler was the Jacksonville District Project Manager.

Table 1. Scarp height (cm) for nesting crawls for green turtles (Cm) and loggerhead turtles (Cc) that traversed (T) or were inhibited (I) by a scarp.

Activity	n	Mean	SD	SE	95% Conf	Min	Max
Cm-T	7	40.7	31.5	7.6	24.6 to 56.9	1.8	110.5
Cc-T	21	35.7	17.8	3.9	27.6 to 43.8	12.7	71.1
Cm-I	8	41.1	18.0	6.4	26.1 to 56.2	19.1	69.9
CC-I	12	67.2	28.4	8.2	49.2 to 85.2	27.9	129.5

Table 2. Scarp height (cm) for false crawls (crawl) for green turtles (Cm) and loggerhead turtles (Cc) that traversed (T) or were inhibited (I) by a scarp.

Activity	n	Mean	SD	SE	95% Conf	Min	Max
Cm-T	11	33.7	15.7	4.7	23.2 to 44.3	10.2	64.8
Cc-T	8	51.0	39.1	13.9	18.2 to 83.7	12.7	127.0
Cm-I	9	51.9	40.9	13.6	20.5 to 83.4	16.5	147.3
CC-I	9	65.6	37.1	12.4	37.1 to 94.1	30.5	152.4

Table 3. Scarp angle (degrees) for nesting crawls (nest) for green turtles (Cm) and loggerhead turtles (Cc) that traversed (T) or were inhibited (I) by a scarp.

Activity	n	Mean	SD	SE	95% Conf	Min	Max
Cm-T	16	140.3	23.3	5.8	127.9 to 152.8	90.0	165.0
Cc-T	21	149.2	20.3	4.4	139.9 to 158.4	90.0	170.0
Cm-I	8	130.6	24.0	8.5	110.5 to 150.7	90.0	160.0
CC-I	12	134.6	19.1	5.5	122.4 to 146.7	90.0	155.0

Table 4. Scarp angle for false crawls (crawl) for green turtles (Cm) and loggerhead turtles (Cc) that traversed (T) or were inhibited (I) by a scarp.

Activity	n	Mean	SD	SE	95%Conf		Min	Max
Cm-T	11	154.1	9.2	2.8	147.9 to 160.3	135.0	165.0	
Cc-T	8	147.5	11.3	4.0	138.0 to 157.0	135.0	170.0	
Cm-I	9	145.0	10.9	3.6	136.6 to 153.4	120.0	155.0	
CC-I	9	116.4	21.9	7.3	99.6 to 133.2	85.0	148.0	

NESTING CORRELATES OF THE BLACK TURTLE (<u>Chelonia</u> <u>agassizi</u>) AT PLAYA COLOLA, MICHOACAN, MEXICO

Kevin S. Palmer, Carlos Delgado[2], David C. Rostal

[1]Dept. of Biology, Georgia Southern University, Statesboro, GA
[2]Dept. of Biology, Universidad de Michoacan, Morelia, Michoacan, Mexico

INTRODUCTION

The Eastern Pacific represents a unique environment for large ectothermic herbivores, such as the black turtle, <u>Chelonia</u> <u>agassizi</u>. Resource availability is highly variable and patchy, possibly causing female turtles to vary energy allocation during reproduction. Female turtles can modify the amount of energy invested into reproduction in one of three ways: (1) number of clutches; (2) clutch size; and (3) egg size. A pilot study was conducted during the 1995 season to identify which reproductive parameters should be measured to begin a detailed study of the black turtle.

METHODS

Data was collected on nesting turtles from early October through late December 1995, a period encompassing the peak nesting season. Straight carapace length (SCL), straight carapace width (SCW), and body depth were measured for 122 first time nesters (multiple clutches were not included). Clutch size (# of eggs) and the egg diameter and egg weight for 20 eggs from each clutch were recorded. Straight carapace length, width, and depth and the weight of 20 hatchlings from 25 clutches were also taken. The data was compiled and analyzed using the SigmaStat and SigmaPlot statistical programs.

RESULTS AND DISCUSSION

Evidence suggests that a variety of reproductive parameters should be measured over a long period to better understand the reproductive strategies of the black turtle in the Eastern Pacific. Clutch size did not correlate with female carapace length, width or depth (Fig. 1a). Other parameters such as egg size were more influenced by female size yielding Rsqr values of 0.240 and 0.118 (regression analysis) for egg weight versus female SCL and egg diameter versus female SCL, respectively. Both clutch size and egg size are indirect measures of energy investment and thus suggest a role of environmental factors in reproductive output (i.e., food availability, water temperature). Analysis of clutch size and its effects on egg size and hatchling size did not show a correlation (Fig. 2a). Egg size and hatchling size were relatively constant. This relationship is also evident in the comparison of mean egg weight versus mean hatchling weight. Correlations were seen for hatchling weight and hatchling SCL vs. egg weight (Rsqr values of 0.257 and 0.223) (Figs. 1b and 2b) and for hatchling weight and hatchling SCL vs. egg diameter (Rsqr values of 0.256 and 0.191). Mean egg diameter, however, showed a greater variability in size classes than did mean hatchling SCL. These data support the conclusion that a specific egg size and hatchling size are being selected for and that clutch size is more variable in response to environmental variables.

ACKNOWLEDGMENTS

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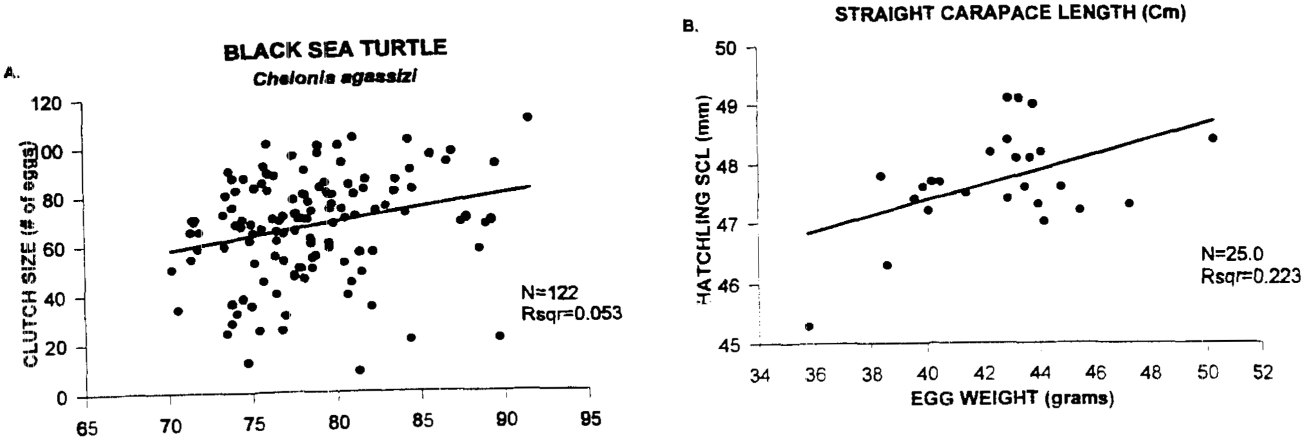

Figure 1. (A) Graphs showing mean clutch size versus curved carapace length for 122 female black turtles and (B) egg weight versus hatchling SCL (B)

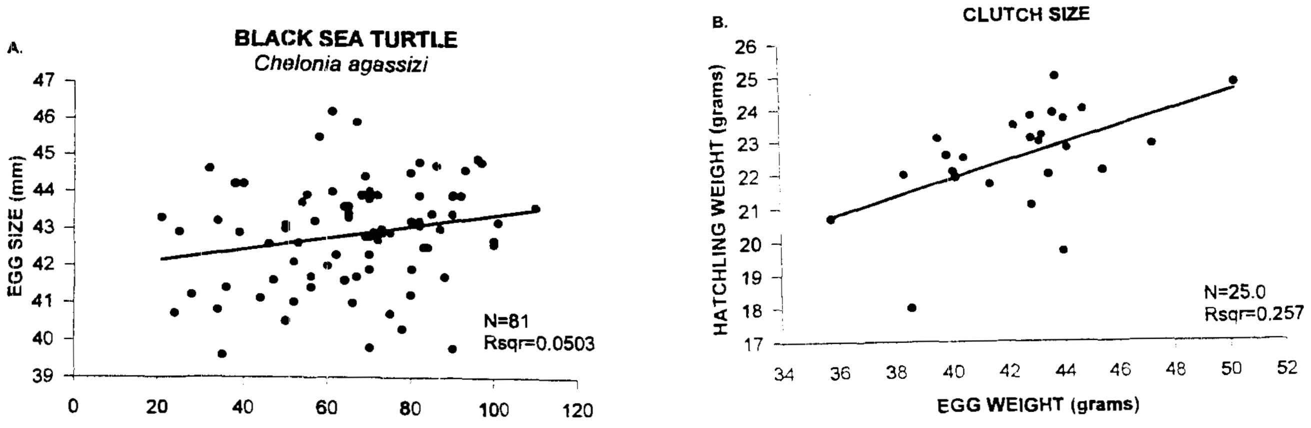

Figure 2. (A) Graphs showing mean clutch size versus egg size and (B) egg weight versus hatchling weight

PATERNITY ANALYSIS IN THE GREEN SEA TURTLE

Tigerin Peare[1], Patricia G. Parker[1], and Mark E. Irwin[2]

[1]Department of Zoology, Ohio State University, Columbus, Ohio 43210
[2]Department of Statistics, Ohio State University, Columbus, Ohio 43210

Since small or declining populations tend to lose genetic variation most rapidly, it is important to gain information about the maintenance of variation in these populations. One feature influencing the amount of genetic diversity is the mating system. The number of males a female mates with directly impacts the number of genotypes that will be represented in subsequent generations.

The intractable life history of marine turtles prevents direct evaluation of fertilization events, but high resolution genetic tools can reveal the genetic consequences of breeding behavior and indirectly provide information about the prevalent mating system of different rookeries. We are using single locus microsatellite technology to analyze paternity in clutches of green turtles (Chelonia mydas) to determine the mating system of green turtles by examining whether nests are characterized by single or mixed paternity.

METHODS

Small blood samples (10-50 microliters) were collected from adult nesting green turtles and their hatchlings. Microsatellite regions of the DNA extracted from these samples were amplified using PCR in combination with primer sets developed by Nancy FitzSimmons. The products of these amplifications were separated by size along an electrical gradient in a 7.5% polyacrylamide gel, stained with ethidium bromide, and visualized through UV illumination.

We compared each hatchling with its mother, and identified paternally-derived alleles among nestmates as those that were not found in the mother's lane. For each family, we then counted the total number of paternally derived alleles distributed among nestmates. Because a male can contribute at most two alleles to a given clutch, the appearance of more than two paternal alleles among nestmates was considered evidence that the female had used sperm from at least two males to fertilize her clutch.

The number of males represented within these clutches was then estimated by a computer program (Irwin) which generates likelihood values associated with the number of fathers for a given clutch. The program is provided with the potential number of fathers to be considered, the allele frequency information from the population, and the genotypes of family members. It determines the probability of observing family allele data assuming a certain number of fathers and then identifies the number of fathers of maximum likelihood.

RESULTS AND DISCUSSION

We first ran a group of adult females to characterize alleles in the Tortuguero population. For 31 females, we found a total of 12 alleles for CC 117 that ranged in frequency from about 2% to almost 20%. For CM 3 we have found eight alleles among 29 females. These alleles ranged in frequency from about 2% to more than 40%.

We have examined eight families from Tortuguero, Costa Rica using two primer sets (Cc 117 and Cm 3) developed by FitzSimmons et al. (1995). Of these eight, five have more paternally derived alleles than were expected if only one father was represented. The other three are consistent with single paternity. These initial results suggest that multiple paternity is probably a common occurrence among green turtles from Tortuguero.

So far, four of the eight Tortuguero families have been analyzed by using the Irwin program. Of these, one clutch was likely fertilized by only one male, two males probably fertilized two clutches each, and at least three fathers fertilized the last clutch.

The results from this single locus microsatellite approach reveal multiple paternity in most the clutches we have examined, and suggest that the prevalent mating system of the Tortuguero rookery may be promiscuity. For threatened populations, a promiscuous mating system offers a mechanism that can contribute to the maintenance of genetic diversity by increasing the number of genotypes represented in subsequent generations. For the Tortuguero nesting population, evidence of multiple paternity among nests is a hopeful sign. However, this optimism should not be generalized to other marine turtles since promiscuity may not occur in all species and may not even be characteristic of green turtle populations.

LITERATURE

FitzSimmons, N. N., C. Moritz and S. S. Moore. 1995. Conservation and dynamics of microsatellite loci over 300 million years of marine turtle evolution. Molecular Biology and Evolution, 12 (3) 432-440.

OCCURRENCE AND FEEDING OF SEA TURTLES IN SOUTHERN BRAZIL

M. Cristina Pinedo, Ricardo Capitoli, Andre S. Barreto, and Ana L. V. Andrade

Departamento de Oceanografia, Fundacao Universidade do Rio Grande - FURG, Caixa Postal 474,
96201-900, Rio Grande RS, Brazil

INTRODUCTION

Spawning areas of marine turtles in Brazil are restricted to latitudes north of 19°38'S (Marcovaldi, 1991). Studies on population characteristics, feeding area, displacement patterns, and mortality causes of marine turtles on non-breeding areas are urgently needed, been recommended as research priorities (Ogren et al., 1989). This work presents information on species composition, mortality and feeding habits of sea turtles in southern Brazil.

MATERIAL AND METHODS

Systematic beach surveys were conducted in southern Brazil, along the coast of Rio Grande do Sul state, from Torres (29°20'S) to Chuφ (33°45'S), from January 1992 to November 1995. Species identification and external measurements were based on Márquez (1990). In Caretta caretta, straight-line carapace length (SLCL) was measured from the anteriormost edge of the carapace to the notch between the rearmost marginal scutes. All measurements were done with calipers, and read to nearest mm. Digestive tracts (stomachs and/or large intestines) were collected and food items analyzed, based mainly on reference collections of otoliths and crustaceans.

Two hundred twenty dead sea turtles of five species were recorded: loggerhead, Caretta caretta (n= 91); leatherback; Dermochelys coriacea (n= 58), green turtle, Chelonia mydas (n= 24); hawksbill Eretmochelys imbricata (n= 2) and olive ridley, Lepidochelys olivacea (n=1). Forty-four specimens were not identified.

RESULTS

The geographic distributions of the former four species have been previously mentioned to occur in southern Brazilian waters (de Menezes, 1972; Frazier, 1984; Márquez, 1990). Most of the strandings occurred on the spring and summer, being mainly represented by C. caretta and D. coriacea (Fig. 1). Seasonal distribution of the SLCL is shown on Fig. 2. Twenty-two of the 28 digestive tracts analyzed contained food items. They indicated that C. caretta consumes bentonic and demersal preys, mainly the crustaceans Libinia spinosa, Dardanus arrosor and Loxopagurus loxochelis, which are found up to 50 m in the southern Brazilian shelf (Table 1).

Algae, fragments of phanerogams and planktonic tunicates occurred mainly in Chelonia mydas (Table 2) and Pyrosoma atlanticum in D. coriacea (n=3). The gastropod mollusk Buccinanops gradatum was found in the digestive tract of E. imbricata (n= 1) and L. olivacea (n= 1), together with cirriped crustacean (Balanus sp.) in the former, and fishes (Trichiurus lepturus, Paralonchurus brasiliensis) in the latter species. Plastic material was found in one stomach of D. coriacea and Chelonia mydas (Table 2).

From 167 individuals examined, seven showed signs of fishery interactions, as net filaments or jute string attachments on neck or flippers. This evidence together with the presence of food items on most digestive tracts examined indicated that incidental catches in fishing nets appear to be the principal cause of mortality along the coast of the state of Rio Grande do Sul.

LITERATURE CITED

de Menezes, M.F. 1972. As tartarugas marinhas do Brasil. Arq. Cienc. Mar. 12(1):17-20.

Frazier, J. 1984. Tortugas marinas en el oceano Atlantico sur occidental. Asso. Herp. Arg. Serie Divulgacion 2:2-21.

Marcovaldi, M.A. 1991. Sea turtle conservation program in Brazil expands activities. In:. Marine Turtle Newsletter, K.L. Eckert and S.A. Eckert (eds), 52: 2-3

Marquez, M.R. 1990. FAO species catalogue. Vol 11: Sea Turtles of the World. An annotated and illustrated catalogue of sea turtle species known to date. FAO Fisheries Synopsis, vol. 125, n 11, Rome, FAO.

Ogren, L., F. Berry, K. Bjorndal, H. Kumpf, R. Mast, G. Medina, H. Reichart and R. Witham. 1989. Proceedings of the Second Western Atlantic Turtle Symposium. NOAA Technical Mem. NMFS-SEFC-226.

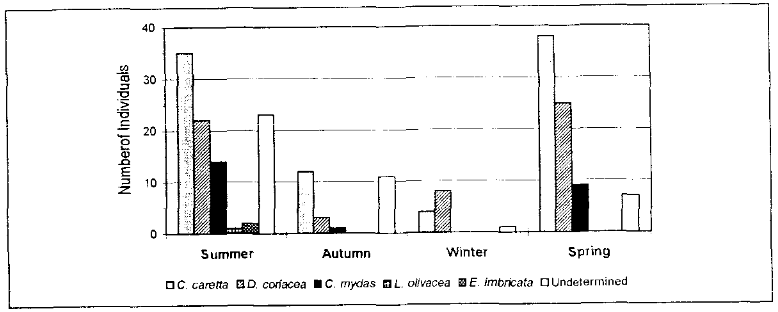

Figure1: Seasonal distribution of sea turtles strandings (n=220) in southern Brazil (29°20'S - 33°45'S) January 1992 - November 1995

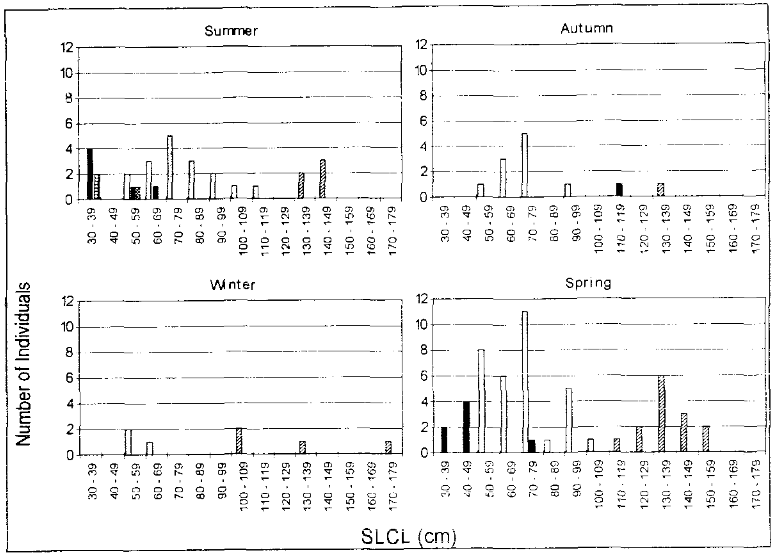

Figure 2: Seasonal distribution of straight-line carapace lengths of Caretta caretta (n=52), Dermochelys coriacea (n=24), Chelonia mydas (n=14), Eretmochelys imbricata (n=2) and Lepidochelys olivacea (n=1) found stranded in southern Brazil, January 1992 - November 1995

Table 1. Food items found on digestive tracts of Caretta caretta (n=11) stranded in southern Brazil. "Ocurrence" is the number of times that a particular food item appeared in all digestive tracts. "Num. of Ind." is the number of individuals that were found of that particular food item in all digestive tracts.

FOOD ITEMS		OCURRENCE	NUM. of IND.
CRUSTACEA		**9**	**50**
PENAEIDEA	Artemesia longinaris	1	2
ANOMURA	Dardanus arrosor	4	15
	Loxopagurus loxochelis	3	7
BRACHYURA	Libinia spinosa	5	8
	Portunidae und.	2	2
	Pseudorombila octodentata	1	1
	Ovalipes trimaculatus	1	4
	Hepatus pudibundus	1	1
	Undetermined	2	2
CIRRIPEDIA	Balanus sp.	1	8
MOLLUSCA		**6**	**14**
GASTROPODA	Odontocymbiola brasiliensis	1	1
	Buccinanops lamarcki	2	6
	Undetermined	3	5
PELECYPODA	Mactra isabelleana	1	2
PISCES		**5**	**10**
Condrichthyes	Sympterygia sp.	1	1
Osteichthyes	Paralonchurus brasiliensis	1	1
	Micropogonias furnieri	1	2
	Umbrina canosai	1	1
	Cynoscion guatucupa	1	1
	Trichiurus lepturus	1	3

Table 2. Food items found on digestive tracts of Chelonia mydas (n=6) stranded in southern Brazil. "Ocurrence" and "Num. of Ind." are the same as in table 1.

FOOD ITEMS		OCURRENCE	NUM. of IND.
ALGAE		**3**	
Rodophyta	Gelidium sp.	1	
Clorophyta	Ulva sp.	2	
FANEROGAMAE		**2**	
BRYOZOA	Membranipora sp.	**1**	**1**
MOLLUSCA	(shells)	**2**	**2**
TUNICATA		**3**	
Ascidiacea	Undetermined	1	1
Thaliacea	Iasis zonaria	1	1
	Salpa sp.	1	1
PISCES		**2**	**1**
Osteichthyes		1	1
Eggs		1	undet.
OTHERS		**2**	
Polyethylene bag		1	
Polyester plastic		1	
Naylon string		1	
Jute string		1	
Solid petroleum		1	

RADIO AND SATELLITE TRACKING OF SEA TURTLES IN THE GULF OF MEXICO, 1995

Maurice L. Renaud, Jo A. Williams, and James A. Carpenter

National Marine Fisheries Service, Southeast Fisheries Science Center, Galveston Laboratory, 4700
Avenue U, Galveston, TX 77551

During June and July 1995, one loggerhead (Caretta caretta) and five Kemp's ridley (Lepidochelys kempii) sea turtles were radio-tracked in conjunction with a population assessment study by the National Marine Fisheries Service (Pascagoula and Galveston Labs) and Texas A&M University (Institute of Marine Life Science). Radio-tracking did not extend beyond 22 days, the length of the assessment study. The loggerhead moved westward from Barataria Pass, Louisiana, traveling approximately 70 km in 48 hours. Its last known location on day three of tracking was by triangulation, in the southern region of Terrebonne Bay. Three of four Kemp's ridleys tracked from Sabine Pass, Texas for 22 days, remained within 8 km of the jetties. The fourth ridley moved 100 km eastward, in 18 days, to the Calcasieu Pass jetties in Louisiana. Nearshore coastal movements of juvenile Kemp's ridleys and their associations with jetties is a behavior seen in previous research projects (Renaud et al. 1994, 1995). Five Kemp's ridley turtles were released during the same time with satellite transmitters. Three were released at Calcasieu Pass and two at Sabine Pass. During a 35-day period turtle 8003 moved 220 km in a southwesterly direction from Calcasieu Pass to near Freeport, Texas and then 90 km back to the northeast near Bolivar Peninsula, Texas. Turtle 8004 swam 220 km from Sabine Pass to near Marsh Island, Louisiana in 47 days. Turtle 8008 was tracked approximately 700 km from Sabine Pass to just south of the Texas-Mexico border. Last location, after 107 days, was just north of the Texas-Mexico border. Turtle 8002, released at Calcasieu Pass, still being monitored after 184 days (through 2/21/96). It has moved approximately 2300 km from the Gulf of Mexico into the Atlantic and was last located in the southern reaches of the Indian River, Florida. The last Kemp's ridley was tracked for 287 days (13 August 1994 - 16 May 1995) from Calcasieu Pass to Rancho Nuevo, Tamaulipas, Mexico (Renaud et al. 1996). It nested twice, first on 23 April, then 19 May 1995. A total of 121 eggs were deposited in the first nest; 103 (85%) successfully hatched on 14 June 1995 (52 days). One-hundred twenty-nine eggs were laid in the second nest; 98 (76%) hatchlings emerged from the nest on 5 July 1995 (47 days).

LITERATURE CITED

Renaud, M. L., J. A. Carpenter, J. A. Williams and A. M. Landry, Jr. 1996. Kemp's Ridley Sea Turtle (Lepidochelys kempii) Tracked by Satellite Telemetry from Louisiana to Nesting Beach at Rancho Nuevo, Tamaulipas, Mexico. Journal of Chelonian Conservation and Biology. In Press.

Renaud, M. L., J. A. Carpenter, J. A. Williams and S. A. Manzella. 1994. Telemetric tracking of Kemp's ridley sea turtles (Lepidochelys kempii) in relation to dredged channels at Bolivar Roads Pass and Sabine Pass, TX and Calcasieu Pass, LA, May 1993 through February 1994. Final Report Submitted to U.S. Army Corps of Engineers, 76 p.

Renaud, M., J. Carpenter, J. Williams, D. Carter and B. Williams. 1995. Telemetric tracking of Kemp's Ridley sea turtles (Lepidochelys kempii) in relation to dredged channels at Bolivar Roads Pass and Sabine Pass, TX and Calcasieu Pass, LA May 1994 Through May 1995. Final Report Submitted to the U.S. Army Corps of Engineers, Galveston and New Orleans Districts, 74 p.

THE MATING SYSTEM OF THE LEATHERBACK TURTLE: A MOLECULAR APPROACH

Julie P. Rieder[1], Patricia G. Parker[1], James R. Spotila[2], and Mark E. Irwin[3]

[1]Department of Zoology, Ohio State University, Columbus, OH 43210
[2]Department of Bioscience and Biotechnology, Drexel University, Philadelphia, PA 19104
[3]Department of Statistics, Ohio State University, Columbus, OH 43210

Leatherback turtles (Dermochelys coriacea) have been experiencing severe declines in population size and are now considered endangered worldwide. Nesting leatherbacks at Las Baulas de Guanacaste National Park, Costa Rica, the area of study, have declined from 1600 in 1988-1989 to only 469 females in 1994-1995 (Steyermark et al., in prep). They are in dire need of conservation efforts.

Populations in decline or in small numbers are vulnerable to random loss of genetic variation. When long-term survival of a population is the goal, genetic diversity must be maintained so that evolution can occur. Among the most important factors influencing the maintenance of genetic diversity is the effective size of the population (Ne). The estimation of Ne requires many demographic parameters including the variance in reproductive success for each sex (Nunney and Elam, 1994).

Mating systems are a function of the distribution of the reproductive success between males and females in a population. Despite the inability to sample males, we are describing the mating system of leatherback turtles with the use of microsatellite techniques. This information may allow a more critical evaluation of the effective size of leatherback populations and may consequently provide us with knowledge of the genetic resources of this species.

MATERIALS AND METHODS

We collected blood samples from adult females nesting at Las Baulas (thanks to Dr. David Rostal). When hatchlings emerged from these nests, we took blood (20-60ul) from the dorsal cervical sinus, and allowed the hatchlings to crawl to the sea. We obtained additional samples from embryos that were being maintained in incubators in the lab for temperature dependent sex determination studies conducted by Chris Binckley. Finally, some nests perished before the estimated emergence date. We salvaged embryos and dead hatchlings from these nests and took blood, liver, and flipper samples.

We used microsatellite sea turtle primers (FitzSimmons et al., 1995) to obtain allelic information from two loci for each hatchling and their respective mothers representing four families. An additional 28 adult females were screened to provide background allelic information for the population.

We scored hatchlings against nestmates and their respective mother for both loci. We identified paternally derived bands and used them to construct potential paternal genotypes. The genotypes at both loci for mothers and hatchlings in each family were used to calculate likelihood values for each possible number of fathers.

RESULTS AND DISCUSSION

Among 32 females, we observed 3 alleles for locus Cm3 and 7 alleles for locus Cc117 (Alleles F and G at locus Cc117 were found only once within a single individual). For 15 globally distributed leatherbacks, FitzSimmons et al. (1995) found 6 alleles for Cm3 and 11 alleles for Cc117. In comparison, the seemingly low level of polymorphism at Las Baulas should receive more attention to determine if this population is genetically depauperate. The possible lack of genetic diversity could be associated with single paternity (reducing the level of genetic mixing) and/or population size fluctuations and declines.

No evidence for multiple paternity existed in any of four clutches when information from two primer sets was considered. The likelihood for a single father ranged from 2.12 to 32.29 times larger than the likelihood for two fathers to describe the distributions of genotypes within a clutch. Single paternity within clutches eliminates polyandry as a possible description of the mating system. However, these results prevent us from distinguishing between polygyny and the possibility of sequential monogamous pairings.

Genetic studies on single populations, like this one, can provide estimates of additional demographic parameters, such as adult sex ratios, that may further facilitate estimation of the effective population size. Estimation of other important parameters will require sampling other populations to assess the distribution of genetic variation among beaches and the degree of genetic mixing between beaches. In our study population, all of the paternally derived hatchling alleles were represented in the sample of adult female genotypes. This may support the idea that these males are from the same population as the females sampled.

By incorporating this characterization of the mating system with the current and accumulating knowledge of life history traits for leatherbacks, we can develop a more accurate estimation of the effective size of this population and may provide assistance in conservation efforts for this endangered species.

WHAT NEXT?

1. Compare paternity within a single female's series of clutches.
2. Compare paternity between multiple female's clutches to determine whether a given male genotype is represented in more than one nest. This would enable us to distinguish between various mating systems such as monogamy and polygyny and provide evidence of internesting matings and/or sperm storage. For example, females 9125 and 9192 potentially mated with the same male with the deduced genotype LL(Cm3), DE(Cc117). Based solely on allelic information the probability of this paternal genotype occurring is less than 1%, supporting the possibility that these two females mated with the same male.
1. Sample turtles from other populations to provide estimates of genetic variation among beaches and genetic mixing between beaches.

ACKNOWLEDGMENTS

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LITERATURE

FitzSimmons, N. N., C. Moritz, and S. S. Moore. 1995. Conservation and dynamics of microsatellite loci over 300 million years of marine turtle evolution. Molecular Biology and Evolution. 12(3):432-440.

Nunney, L., and D. R. Elam. 1994. Estimating the Effective Population Size of Conserved Populations. Conservation Biology. 8(1): 175-184.

Steyermark, A. C., K. Williams, J. R. Spotila, F. V. Paladino, D. Rostal, S. Morreale, M. T. Koberg, and R. Arauz. In Prep. Learning How to Count: Nesting Leatherbacks at Las Baulas de Guanacaste National Park, Costa Rica.

TRAUMA TO STRANDED SEA TURTLES BEFORE AND DURING REQUIRED TED USE

Carol A. Ruckdeschel[1] and Robert Shoop[2]

[1]Cumberland Island Museum, P.O. Box 796, St. Mary's, Georgia 31558, USA
[2]Department of Biological Sciences, University of Rhode Island, Kingston, Rhode Island 02881, USA

In the 1989 proceedings of this symposium, we reported the frequency of trauma observed on sea turtles stranded on Cumberland Island, Georgia, for 1986 and 1987 (Shoop and Ruckdeschel, 1989). Cumberland Island, being only 27 km long, has one of the highest stranding rates in the country with a 17-year average of 2.7 strandings per km or 75 turtles per year. In 1986-87, 71% of the stranded turtles had suffered some type of trauma. Antemortem trauma was observed in 44% of strandings, while trauma judged as postmortem or inflicted near the time of death (lethal wounds) were found in 65% and 4% of the stranded animals, respectively. A third of all carcasses had limbs removed postmortem by sharks. Fractures and lacerations (28.6%) were the next most frequent type of trauma. We suggested, at that time, that a comparison of trauma frequency when the use of turtle excluder devices (TED) was mandated might show a change in frequency of some types of trauma, especially those types that could be human-inflicted. We assumed that there would be less opportunity for human contact since TED would presumably release trapped turtles, thus stranded animals would have different frequencies of trauma types. We report herein that follow-up study, based on sea turtles stranded on Cumberland Island in 1994 and 1995 when TED use was required in the shrimp trawl fishery.

The study area, Cumberland Island, Georgia, was surveyed at least weekly, frequently daily, and we responded to strandings immediately when notified by daily National Park Service patrols or other individuals. With the exeception of a single carcass, we probably examined every stranded sea turtle on the island. Notes and photographs of stranded animals, necropsy results, and examinations of the prepared specimens (mainly skeletal material) were used for this study. Prepared material was deposited in the collections of Cumberland Island Museum.

To determine if trauma was antemortem, postmortem, or probably occurred near the time of death (lethal trauma) for both studies, we examined tissues for signs of healing or scarring, hemorrhaging or bruising that would indicate antemortem damage. Fresh fractures or lacerations without association of those conditions were interpreted as occurring postmortem. An individual might have sustained trauma at all three times. Amount of fat, food in the gastrointestinal tract (when present), and barnacle loading (especially on skin) all provided indications of physical condition before death. Probably causes of trauma included propeller strikes, severe impacts, shark bites, fishing gear entanglement, bullets, sharp objects, beach carrion feeders, and unknown causes. The kinds of trauma were recorded as superficial, bone erosion, fracture, laceration, removal of part, penetrating wound, other, and unknown. Size (ccl x w), species, sex, state of maturity as revealed by gonad examination (adult or immature), reproductive state, date of stranding, and general state of health were also recorded. The dates were analyzed as in the earlier study and results compared.

RESULTS

The total strandings for the 1994-95 (156) exceeded those of 1986-87 (133), and the major contributor to the increase was the number of Kemp's ridley turtles, Lepidochelys kempii (Table 1). Stranding numbers of the other three species were similar in both studies. The percentage of carcasses useful for each study were essentially the same (89.5% for 86-87; 90.4% for 94-95).

The percentage of stranded animals with trauma was slightly reduced in 94-95 and the incidence of postmortem and antemortem trauma were also reduced. Trauma at or near the time of death increased dramatically to over one-half of the carcasses (Table 1), an order of magnitude increase over the previous study. Lacerations and fractures were the most frequent type of damage with the incidence of shark damage considerably reduced. A smaller percentage of loggerheads contained shrimp or fish in the gastrointestinal tract, but a greater proportion of ridleys contained these items.

In 1995, deliberate opening of the body cavity by cutting along the inframarginals of one side was observed in one specimen, another had dorsal parts of cervical vertebrae fractured, and several had deep, single, straight cuts across the ventrum of the neck. Sharks would likely be attracted by opening or wounding an animal and their subsequent damage would obliterate signs of knife damage, lower the laceration incidence rate. Three specimens had paint on the carapace along the edges of fractures.

Some specimens had the plastron shattered with the carapace intact. Such damage suggests anthropogenic causes. We are unable to suggest a way in which such damage could occur naturally in the marine environment, especially since it often affected only one side of a structure.

Of the nearly 1,500 sea turtles we have necropsied in the last 20 years, only one showed recovery from propeller strikes (non-lethal, antemortem damage), a leatherback in 1995. During that time, we observed several carcasses with propeller strikes. Given the ability of sea turtles to withstand extreme trauma (e.g., removal of one-quarter of the body, full carapace facture, shark penetration of the body cavity, etc.) the lack of antemortem propeller damage suggests either than propeller strikes are usually fatal, or that propeller strikes of living sea turtles are rare. Based on this observation we judge that most propeller strikes observed were postmortem damage or damage to comatose turtles.

While TED use during 1994-95 naturally did not exclude very large or very small sea turtles, the high frequency of apparently human-caused trauma to the remaining turtles suggests that either the TED were not working properly or another factor is now involved. Shrimp trawling has been determined to be the major cause of sea turtle mortality by the National Research Council (1990) but full compliance with TED regulations was reported by the Georgia Department of Natural Resources during the study period (M. Harris, pers. comm.). The increased numbers of strandings in 1994-95 compared with the "non-TED years," coupled with increased frequency of human-damaged turtles, demonstrate that the TED regulations have failed to protect sea turtles in the waters adjacent to Cumberland Island.

If there is any doubt about the cause of the mortality being a direct result of commercial fishing activity, we suggest that a large zone excluding commercial fishing be established and strictly enforced (e.g., Zone 30). Stranding data from one typical season would settle the question. Such a sanctuary would also provide for recovery of other native invertebrate and vertebrate stocks impacted by commercial trawl fishing.

LITERATURE CITED

National Research Council. 1990. Decline of the sea turtles; causes and prevention. National Academy Press, Washington, D.C.

Shoop, C.R. and C. Ruckdeschel. 1989. Trauma to stranded sea turtles on Cumberland Island, Georgia, during 1986 and 1987. In Eckert, S.A., K.L. Eckert, and T.H. Richardson (compilers). Proc. of the Ninth Annual Workshop on Sea Turtle Conservation and Biology. (NOAA Technical Memorandum, NMFS-SEFC-232. 306. p.

Table 1. Comparisons of sea turtle stranding data for 1986-87 and 1994-95 on Cumberland Island, Georgia.

	86-87	94-95
Total stranded sea turtles	133	157
Specimens useful for trauma study	119	142
Total loggerhead strandings	117	120
Total ridley strandings	12	30
Total green turtle strandings	2	3
Total leatherback strandings	2	4
Specimens with tauma (%)	84 (71%)	93 (65.5%)
Percentage with antemortem trauma	44.0	31.2
Percentage with postmortem trauma	61.9	49.1
Percentage with death-associated trauma	4.8	50.5
Percentage antemortem trauma to loggerheads w/heads	24.0	16.5
Percentage antemortem trauma to all species w/heads	23.0	15.3
Percentage with shark damage to limbs	32.0	17.6
Percentage carcasses with shark damage	33.6	18.3
Percentage with fractures and lacerations	28.6	43.7
Percentage loggerheads w/shrimp-fish in gastrointestinal tract	44.0	16.3
Percentage ridleys w/shrimp-fish in gastrointestinal tract	14.0	27.8

MARINE DEBRIS INGESTION BY SEA TURTLES IN SOUTH TEXAS: PRE- AND POST-MARPOL ANNEX V

Donna J. Shaver and Pamela T. Plotkin

National Biological Service, Padre Island National Seashore, 9405 S. Padre Island Drive, Corpus Christi, Texas 78418
Drexel University, Department of Bioscience and Biotechnology, 32nd and Chestnut Streets, Philadelphia, Pennsylvania 19104

MARPOL ANNEX V, put into force internationally on December 31, 1988, prohibits dumping of any plastics from ships at sea and sets standards for disposal at sea of other solid wastes. This study was undertaken to determine if the frequency or amount of marine debris ingested by sea turtles decreased after implementation of MARPOL ANNEX V (post-MARPOL).

Entire gut contents were analyzed from 473 dead turtles found stranded along the south Texas coast, in inshore and offshore areas, in shrimp statistical zones 19-21, between 1983 and 1995. Debris comprised less than 1% of the gut content dry mass of most turtles. Debris was the primary cause of death of 7 of the 473 turtles analyzed, including 2 from large fishing hooks, 1 from a piece of glass, 1 from a long piece of monofilament line, and 3 from gut obstruction by large amounts of plastic. However, those killed by hooks and monofilament line probably died because they were previously caught by hook-and-line and the line was cut.

The 473 analyzed included 57 head started turtles (47 found inshore and 10 found offshore) and 416 non-head started (wild) turtles (70 found inshore and 346 found offshore). The 57 head started Kemp's ridleys (Lepidochelys kempii) were restricted from further analysis after determining that a significantly higher proportion of those found offshore had consumed debris than had wild Kemp's ridleys found offshore (Test for Comparing Binomial Proportions [TBP], P<0.05). The 70 wild loggerhead (Caretta caretta), Kemp's ridley, and green (Chelonia mydas) turtles found inshore were also restricted after determining that significantly lower proportions of them had consumed debris than had their counterparts found offshore (TBP's, P<0.05).

The remaining 346 wild turtles found offshore were used for comparison of pre-and post-MARPOL marine debris ingestion. Among the 346 were: 164 loggerheads, 103 Kemp's ridleys, 47 greens, 27 hawksbills (Eretmochelys imbricata), and 5 leatherbacks (Dermochelys coriacea); 155 were pre-MARPOL (1983 - 1989) and 191 post-MARPOL (1990 -1995). The proportions of turtles that had ingested debris were not significantly different pre- and post-MARPOL, for each species and all species combined (TBPs, P>0.05). The median percent dry mass and median weight of ingested debris items were not significantly different pre- and post-MARPOL, for loggerhead, Kemp's ridley, and green turtles (Mann Whitney Rank Sum Tests, P>0.05). For each species, the proportion of turtles containing ingested debris did not decrease throughout the study years.

During pre- and post-MARPOL periods combined, 51.7% of the 346 wild turtles found offshore had ingested debris and debris comprised 0.16% of their gut content dry mass. The % frequency of debris ingestion was highest for greens and hawksbills and the percent dry mass of debris was much higher for hawksbills than for the other species. The percent frequency of debris ingestion was highest for turtles measuring less than 40 cm curved carapace length. A reduction in the percent frequency of debris ingestion with increasing size was found for Kemp's ridley but not for any of the other species. Pre- and post-MARPOL, and during both periods combined, 42% of the turtles analyzed contained ingested plastics. The most common debris items found ingested by the wild turtles that stranded offshore were plastic bags, sheets, fragments, and straps. Although most of the ingested debris was clear or white, items of a wide variety of colors were consumed.

THE EFFECT OF PREDATION BY THE GHOST CRAB OCYPODE CURSOR ON EGGS AND HATCHLINGS OF MARINE TURTLES IN N. CYPRUS

Remani C. Smith[1], Brendan J. Godley [1&2], and Annette C. Broderick [1&2]

[1] Division of Environmental and Evolutionary Biology, I.B.L.S., Graham Kerr Building,
University of Glasgow, Glasgow, G12 8QQ, Scotland, U.K.
[2] Department of Veterinary Anatomy, University of Glasgow Veterinary School, Bearsden Road, Glasgow,
G61 1QH, Scotland, U.K.

Predation of marine turtle hatchlings by ghost crabs has been observed (Fowler, 1979; Erkakan, 1992) as the hatchlings crawled to the sea. This has also been observed in N. Cyprus (Godley and Broderick, 1992). The level at which this occurs has not been quantified. In addition, Ocypode species have also been reported to prey upon the pre-hatching stages, by burrowing into nests (Hughes, 1974; Hopkins et al., 1979). Again, this has been observed in Northern Cyprus, but not quantified. The results presented here attempted to quantify these effects and were part of a larger study (Smith, 1996) which took part at Alagadi, N. Cyprus.

METHODOLOGY

Presence or absence of any nest predation was investigated at time of hatching. The number of burrows within a 2 m quadrant around the epicenter was compared to those in 2 m quadrants to the right, left, above and below the central section. Preliminary observations showed hatchlings tended to fall down and be attacked by residents of, burrows with opening diameter greater than 3 cm. The spatial distribution of O. cursor burrows along two beaches at Alagadi in Northern Cyprus was investigated to quantify the proportion of burrows that were of this size. The speed at which hatchlings moved was compared with that of O. cursor using a 5 m runway constructed on the beach. Time trials were carried out at night in an attempt to keep conditions as natural as possible. Investigation was undertaken into possible depredation of hatchlings. Dead hatchlings were obtained from hatched nests, attached to lengths of wire and dragged past occupied crab burrows, at speeds approximating that of live hatchlings. The burrow diameter and the response of the resident crab were recorded. O. cursor were observed to determine how far they would travel to either side of burrow entrances, thus enabling the distance that crabs would typically venture to catch hatchlings to be estimated. The possible impact O. cursor could have upon the hatchlings from nests of both species was investigated by enumerating the mean number of burrows with openings greater than 3 cm that a full clutch of hatchlings encountered upon their passage to the sea. The distribution of hatchling tracks was used to estimate this. Additional account was made of those burrows lying within a further 3 m either side (the hypothesized mean distance crabs traveled) of the furthest ranging hatchling. The clutch size and hatching success were determined from nest contents within the egg chamber.

RESULTS AND DISCUSSION

Crabs were found to burrow into a very small proportion of turtle nests (n = 7; 1.7% of all nests hatched in 1995). When this occurred, they did not have a substantial predatory effect upon the clutch. There was no significant increase in burrow numbers around nests compared to the surrounding 2 m quadrants (Chi2 = 9.249, d.f. = 4, P<0.05). Intra-nest depredation was not, therefore, considered to be a significant problem to the hatching success of marine turtles in N. Cyprus. The proportion of burrows large enough for a hatchling to fall/be dragged down (i.e., >3 cm) was at least 10% of the total number of burrows on the study beach (see Table 1.). Chelonia mydas hatchlings were observed to move faster than C. caretta hatchlings. It was not possible to test between the species, since the sample size of C. caretta was sufficiently small to preclude statistical analysis. Crabs ran at least 20 times as fast as hatchlings (t = - 9.25, P <0.001).

The response of crabs to dragged hatchlings differed according to burrow opening diameter (Table 2). Crabs from burrows with diameters less than 2.7 cm primarily ignored or ran away from oncoming hatchlings. Crabs from burrows with diameters 2.7 - 3.2 cm ran towards and attacked hatchlings but were often unable to drag them to/down their burrow. All crabs with burrow openings greater than 3.2 cm attacked hatchlings and then dragged them down the burrow. After a crab successfully depredated, a second hatchling was dragged past a burrow entrance. The second hatchling was never attacked. This suggests that every crab of sufficient size is only likely to depredate one hatchling per wave of hatchlings emerging. In N. Cyprus, hatching is more synchronous than in other areas of the Mediterranean and most nests tend to emerge in a single wave. The primary area attacked was the neck/head region, but the flippers and carapace were occasionally grabbed. Although crabs from burrow diameters of 2.7-3 cm were unable to drag hatchlings down their burrows, they did attack them and could render them immobile. Immobilized hatchlings with claw marks on the head have also been reported by (Arndt, 1994). It was found that O. cursor is territorial in N. Cyprus and the larger crabs did not venture more than 5.2 m to either side of the burrow. The distance traveled depended on how close other larger burrow openings were. The mean distance traveled was 3 m.

The maximum possible predation O. cursor could exact upon individual nests was found to range widely, flatter areas of the beach having a high number of burrows compared with steep sections which had none. On a typical stretch of beach, the maximum predation by O. cursor of hatchlings from any nest would be: The mean number of burrows >3 cm encountered by the hatchlings, divided by the mean clutch size x hatching success of the species:

For Chelonia mydas in 1995 this was: 8.3 / (112.25 x 0.8438) x 100 = 8.763%
For Caretta caretta in 1995 this was: 7.9 / (70.48 x 0.7525) x 100 = 14.895%

These estimates of the possible impact of crabs are conservative since only burrow diameters greater than 3 cm were counted between the nest and the sea. Smaller crabs also attacked hatchlings. Also, the presumed 3 m maximum distance traveled by crabs is likely to be an underestimate as it is not possible to observe the crabs at night.

It is therefore concluded that the real detrimental efface Ocypode has on marine turtles is upon hatchlings. This impact will be highly variable between nests, but is likely to be significant.

ACKNOWLEDGMENTS

The primary author would like to thank Dr. Alan Taylor for supervising the initial project, all the members of Glasgow University Turtle Conservation Expedition who assisted in data collection. Participation was possible due to a symposium overseas student travel grant.

LITERATURE CITED

Arndt, R. G. (1994). Predation on hatchling diamondback terrapin, Malaclemys terrapin, by the ghost crab, Ocypode quadrata. Florida Scientist. 57 (1): 1-5.

Erkakan, F. (1992). Nesting biology of loggerhead turtles on Dalyan beach, Turkey. Biological Conservation. 66: 1-4.

Fowler, L. E. 1979. Hatching success and nest predation in the green sea turtle Chelonia mydas at Tortuguero, Cost Rica. Ecology. 60: (5) 946-955.

Godley, B. J. and Broderick, A. C. 1992. (eds.). Glasgow University Turtle Conservation to Northern Cyprus 1992 - Expedition report. Dept. Vet. Anatomy, Glasgow University Vet School, Bearsden, Glasgow, G61 1QH.

Hopkins, S.R. 1992. Biotic and abiotic factors affecting nest mortality in the Atlantic loggerhead turtle. Proceedings of the Annual Conference of Southeast Association of Wildlife Agencies. 46: 36-41.

Hughes, D. A. 1966. Behavioural and ecological investigations of the crab Ocypode ceratophthalmus. Journal of Zoology. London.. 150: 129-143.

Smith, R.C. 1996. An investigation into the predation of the ghost crab, Ocypode cursor, on the eggs and hatchlings of the turtles, Caretta caretta and Chelonia mydas. Unpublished Honours Thesis. University of Glasgow.

Table 1: Showing percentage of burrows of different size classes along Alagadi beach.

Burrow diameter (cm)	<1cm	1-2cm	2-3cm	3-4cm	4-5cm	>5cm
Percentage	28.6	44.79	15.96	5.543	4.213	0.886

Table 2: Showing crab reactions to dragged hatchlings.

Response	% Crabs reactions					
	0-1cm	1-2cm	2-3cm	3-4cm	4-5cm	>5cm
Escaped	73	42	0	5	0	0
No Reaction	27	43	9	11	0	0
Ran Towards	0	5	55	5	0	0
Attacked	0	10	9	5	8	0
Not dragged down	0	0	27	53	0	0
Dragged down	0	0	0	21	92	100

FIBROPAPILLOMAS IN THE GREEN TURTLES (Chelonia mydas) OF AVES ISLAND

G. Sole and C. Azara

Foundation for Defense of Nature - FUDENA

From 1979, FUDENA monitors the green turtles that nest in Aves Island (15° 40' 30" N and 63° 36' 26" W). For each turtle, it was registered the position of anomalies present in their body. In total, there were reported 26 different turtles with fibropapillomas in their body, the first case occurring in 1986. There were detected fibropapillomas on the front fins and neck, largely in numbers of 1 or 2, and very numerous in 2 turtles. None of the fibropapillomas was sufficiently large to avoid swimming. The maximum number of turtles affected in a year was 9, and the maximum percentage of the infected nesting population for a specific year was 2, 7% (mean: 0, 44%; sd: 0,78), lower than some populations of green turtles in Hawaii and of Florida (USA), with nearby 50% of the population infected. Since its appearance, it is not possible to assure that occurrence frequency of this disease is increasing in Aves Island population. It is suggested a detailed record of all the cases of fibropapillomas that occur in Venezuela, until a better knowledge is acquired about the etiology of this disease, is increasing in different populations of green turtles around the world and constitutes a serious threat for their survival.

THE BIOLOGY OF BASKING IN THE GREEN TURTLE, Chelonia mydas

Yonat B. Swimmer[1] and George H. Balazs[2]

[1]School of Natural Resources and Environment, University of Michigan, Ann Arbor, Michigan 48109-1115 USA
[2]National Marine Fisheries Service, Southwest Fisheries Science Center, Honolulu Laboratory, Honolulu, Hawaii 96822-2396 USA

The green turtle, Chelonia mydas, is the only species of marine turtle known to atmospheric bask, and this occurs in aggregations in only a few populations worldwide. Numerous studies of basking in freshwater turtles conclude that the behavior serves a host of physiological functions (reviewed in Boyer 1965), yet benefits of basking in marine turtles have never been fully investigated. Given potential disadvantages associated with this behavior (i.e., net energy loss due to elevated body temperature), results from preliminary data indicate that basking results in numerous physiological advantages, specifically in the areas of thermoregulation, immune response, and energy demand.

Data collected during two field seasons, one with captive turtles maintained in Honolulu, Hawaii, and one with wild turtles on East Island in the Northwestern Hawaiian Islands (NWHI), indicate that basking serves a multitude of biological responses. Basking results in raised body temperature (fig. 1) (for methods, see Swimmer et al. in press), and the behavior is positively correlated with air temperature in captivity (fig. 2) and air and sand temperature in the wild (fig. 3), thereby suggesting the behavior has a thermoregulatory role. Data of air and sand temperature and number of turtles basking in NWHI suggest that turtles behave in ways that limit their potential heat gain (eg., basking on cooler beaches). Whittow and Balazs (1982) reported similar results for green turtles basking on another atoll in the NWHI. These data combined suggest that thermoregulation alone cannot explain the occurrence of basking.

In captivity, the significantly greater frequency of basking of diseased turtles (afflicted with fibropapillomatosis) than non-diseased turtles indicates that diseased animals prefer to maintain higher body temperatures. This observation could suggests that sick animals bask in an attempt to attain a behavioral fever, which has been shown to enhance the immune system in numerous ectothermic species (Kluger 1979).

Preliminary metabolic demand data of both basking and non-basking diseased turtles indicate that basking serves to lower oxygen consumption despite the increase in body temperature (fig. 4). Such energy-conserving behaviors would be especially valuable during the nesting season (when basking primarily occurs) due to the high energetic demands of reproduction and the minimal energy input from reduced foraging. Furthermore, animals that had not basked voluntarily, but rather had been placed on the basking ramp (noted with *) had higher metabolic rates than when the turtles had "chosen" to bask (fig. 4).

These data suggest that basking of green turtles affects numerous physiological functions that may be evolutionarily advantageous.

LITERATURE

Boyer, D.R. 1965. Ecology of the basking habit in turtles. Ecology 46:99-118.

Kluger, M. 1979. Fever: It's Biology, Evolution and Function. Princeton University Press, NJ.

Swimmer, J.Y. Whittow, G.C. and G.H. Balazs. In press. Atmospheric basking in the Hawaiian green turtle, Chelonia mydas: Comparisons of Tumored and Non-Tumored Turtles. In: Proceedings of the Fifteenth Annual Workshop on Sea Turtle Conservation and Biology. NOAA Technical Memorandum, NMFS-SEFC.

Whittow, G.C. and G.H. Balazs. 1982. Basking behavior of the Hawaiian green turtle (Chelonia mydas). Pacific Science Vol. 36, No. 2, pp. 129-139.

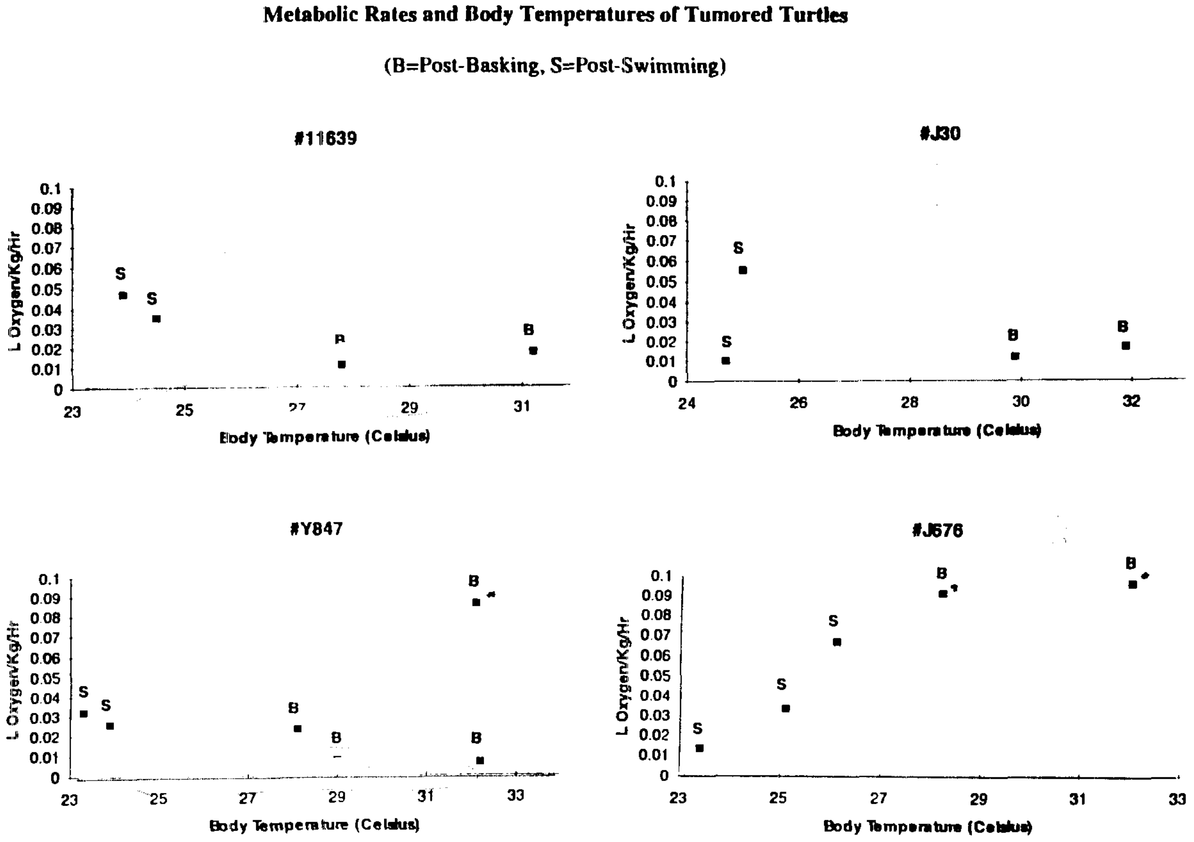

Fig. 4. Data points adjacent to an asterix (*)for turtles #J676 and Y847 indicate that the turtle had been "forced" to bask in determination of this metabolic rate. All other turtles had metabolic rates determined after they had "chosen" to bask.

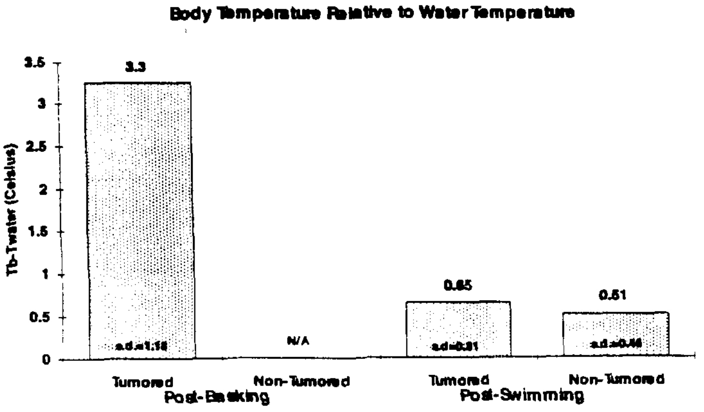

Fig. 1. Post-basking body temperatures were obtained after turtles had been observed basking for a minimum of two hours (tumored turtles n=5 individuals over 19 days). As non-tumored turtles were never observed basking, no data are available for their post-basking T_b. Post-swimming T_b's were determined after turtles had been observed in the water for a minimum of two hours before temperature determination (tumored turtles n=5 individuals over 15 days; Non-tumored turtles n=4 individuals over 27 days). All measurements were taken between 1500-1700.

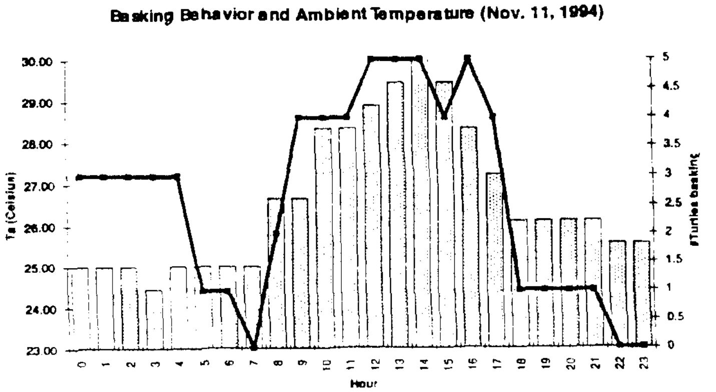

Fig. 2. Number of turtles (bar graph) and air temperature (line graph) at the captive site in Honolulu, HI, Nov. 11, 1994.

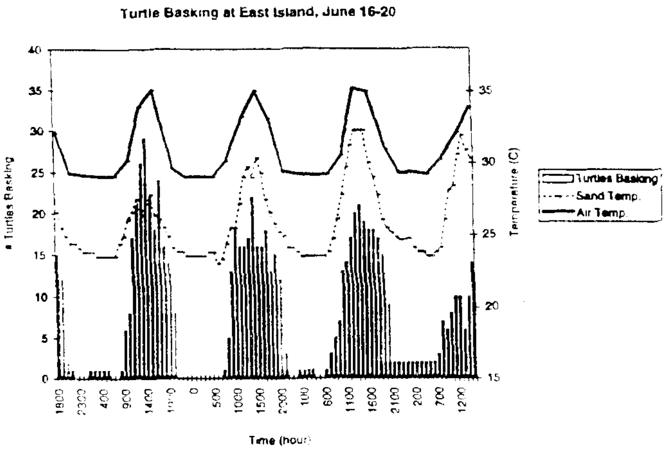

Fig. 3. Number of turtles basking, air and sand temperatures on East Island, French Frigate Shoals, Northwestern Hawaiian Islands, June 15-20, 1996.

AN INTERACTIVE METHODOLOGY FOR RESOLVING CONFLICTS AND FACILITATING COLLABORATIVE SEA TURTLE CONSERVATION IN DEVELOPING COUNTRIES

Charles R. Tambiah

OCEAN Initiative, Department of Geography, 501 McCone Hall, University of California-Berkeley, Berkeley, CA 94720, USA.

In developing countries, many sea turtle conservation programs face difficulties in striving for sustainability of the turtles, as well as for sustainability of the project. Conflict, an important cause of the lack of sustainability, has often been overlooked, ignored, denied, or avoided in many projects. Conflict exists among people who interact directly or indirectly with sea turtles. People make conservation happen, and where there are people there are conflicts. In this paper, my objectives are to emphasize the connection between conflicts and sustainability, and to share a methodology for resolving conflicts at the local project level, while furthering the sustainable conservation of sea turtles through the resolution of conflicts.

Common causes of conflict are:
1. Differences in people's perspectives, definitions, expectations, and claims;
2. Historical relationships and distrust;
3. Distribution and availability of benefits, information, and resources;
4. Presence or absence of opportunity to be heard and to participate;
5. Presence or absence of information; and
6. Different solutions to a problem and different ways of reaching a solution.

I believe however that all the causes of conflict can be synthesized into five critical issues:
1. Differences (primarily cultural and political);
2. Inequity (of information, opportunity, benefits, and resources);
3. Control (over access and development);
4. Information (i.e. the lack of adequate and accurate information); and
5. Communication.

These five issues can be used as a template in evaluating the presence and dimension of conflicts in a project and the framework for their resolution.

CONFLICTS, COLLABORATION, AND SUSTAINABILITY

Many conservationists realize why sea turtle conservation cannot be carried out by a single entity or at a single level, yet many of them continue to pursue "single track" approaches. By this, I mean that a group will consider themselves to have all the ideas and the resources and will work with only themselves in focus. One group might "consult" or "employ" another group when necessary, but active collaboration is rare. One explanation that is often given for limited collaboration is either the presence of conflict or the avoiding of anticipated conflict. It is understandable that the greater the number of groups working on a project the greater the opportunity for and dimension of the conflict. At the same time there is an awareness of the benefits of collaboration, and collaboration cannot be more relevant than it is today in an era of co-management and decentralized conservation.

I would like to present a larger perspective on the need for bringing different groups working with sea turtles together and resolving conflict. The extent of collaboration, as in the number of people or groups involved with sea turtles, determines the level of immediate conflict and the level of future conflict. It also determines the amount of resources available for the project, the overall output of the project, and most importantly, the probability of sustainability of the project (Table 1). I agree that this is a simplified version of a complex picture. But the relationship is indeed that simple: conflicts, if left unresolved, erode sustainability. How then can conflicts be resolved and sustainability improved?

METHODOLOGY FOR RESOLVING CONFLICTS

There are a few standard methods for resolving conflicts that are often discussed in the literature, such as negotiation, facilitation, mediation, and arbitration. As to which of these standard methods could be used for resolving a conflict depends on the dimension of the conflict. I would like to propose an integrated method which has some standard elements, while being adaptive to a variety of cultural and political settings surrounding sea turtle conservation at the local project level.

This integrated method has sequential steps, some of which can be used independently of others. I recommend doing the following:

1. Identify a facilitator(s) or coordinator(s): The success of this process rests on the selection and participation of a good facilitator. The person acts as a neutral anchor, and in doing so bears great responsibility. He/she should be a person who is respected by all parties to the conflict, should be an excellent listener and a positive thinker, and should be impartial, sensitive, aware, and creative. He/she could also be a good source of information on sea turtle conservation, or other more specific issues at hand. The facilitator guides the development and implementation of the remaining seven steps of this integrated method; in essence he/she "facilitates" the resolution of the conflict.

2. Identify various groups with interests in sea turtle conservation (often referred to as "interest-groups" or "stakeholders"): In a typical setting there are a variety of interest-groups, operating at a variety of levels, with different agendas and resources, and with varying distances from where the turtles actually are. Interest-groups can be categorized as follows: researchers, managers, educators, funders, utilizers, developers, and enforcers; or communities, NGOs, and government; or many other sub-categories under each of these groups. Compiling a complete list ensures that all interest-groups will be included in the conservation process.

3. Identify individual positions and understand the backgrounds of these interest-groups: This can be done through one-on-one discussions or through group meetings. Using both techniques, if possible, can provide insight into the diversity of individual opinions within a group, which may not surface during group discussions. Group meetings can be used to facilitate the development of a clear group position on sea turtles, to identify what specific objectives the groups would like to see accomplished, and to identify what activities they would like to undertake to accomplish these objectives.

4. Invite for dialogue: Present the need and benefits of dialogue, and invite the stakeholders to convene at a neutral place and at a common time. Ensure participation and confirm adequate representation of each group.

5. Conduct a conflict resolution workshop(s), at which I recommend that the facilitator do the following:

    a. Introduce the purpose of the meeting.

    b. Invite individuals to introduce themselves and the interest-group they represent. Facilitator introduces him/herself and is accepted all present.

    c. Establish ground rules or guidelines for conducting the meeting: Such guidelines encourage all present to participate fully and openly, to ensure equal status among participants, to direct attention to the problems not on the people present, and to understand that as much as there are problems there are solutions.

    d. Agree on basic objectives and an agenda for the workshop.

    e. Share aspirations, goals, and concerns (which are derived from information presented by representatives at the meeting and supported by information collected from the interviews conducted prior to the workshop). From this exchange the diverse groups involved with sea turtles will often recognize that they share a common ground with a common goal, a realization that makes a powerful first step towards communication and collaboration.

f. Determine and establish a common goal: This is a critical step. Declaring a common goal brings people together and detracts from the tendency to separate each other by harping on differences. Often the common goal identified is simple: the continued availability and benefit from sea turtles.

g. Develop an interactive sociogram: A sociogram, a visual display of interactions, helps the participants to understand how stakeholders are connected to one another. Once the "map" has been made, the quality of the interaction among groups can be classified, and the cause of conflicts identified. Stakeholders now have a picture of where the tensions are and why, sometimes even identifying third party causes and those whose roots go deep into historical colonization. This understanding helps to identify strategies necessary for healing tense relationships and for strengthening healthy ones. Developing this sociogram provides participants with an understanding of the complexity of the interactions, and being aware of this complexity is one of the greatest first steps in resolving a conflict.

    (1) Conduct a role-playing exercise in which representatives of each stakeholder play the part of other stakeholders in mock interactions: This is a very effective tool for understanding the positions of fellow groups. In a variation of this process, each group speaks to all participants on each of the three positions, a pro position, a con position, and a median position.

    (2) Share scientific and technical information on sea turtles: This sharing of information develops a common understanding of sea turtle ecology, distribution, and research techniques. It also presents an opportunity for participants to share their own knowledge and experience about sea turtles and to clarify misconceptions and misinformation. A slide presentation could be an effective method for sharing such information.

    (3) Share case-studies from other localities: Sharing the conflict resolution experiences of other locations can help people involved in a conflict to appreciate their situation. It can be motivating and informative to know of conflicts, impacts, and resolutions from other locations. Again, a slide presentation can be very effective.

    (4) Develop collaborative action plans and agreements (which contain objectives, activities, organizational responsibilities, needs, resources, and time-lines): It is important to work on smaller discrepancies and objectives first, complete them, and move on to greater issues. Each step solved adds to a stronger foundation for future resolution and collaboration. Each action or agreement can be developed by small working groups comprised of a member of each stakeholder, and presented to the larger group for discussion. Each working group can then combine their efforts into a final agreement.

h. Exchange thanks, encouragement, commitment, and agreement.

6. Create follow-up and implementation mechanisms identified during the workshop or by mutual agreement

7. Evaluate regularly, and act accordingly.

8. Keep a "finger on the pulse," as in maintain close contact with all interest-groups and encourage continued communication between the groups.

CONCLUSION

Conflict, a given in any conservation situation, is inherent and challenging, yet full of opportunity. It is therefore invaluable to recognize the existence of conflicts and to use their resolution in achieving greater sustainability. In this paper, I have described a framework that can assist in identifying and resolving conflicts successfully, with the condition that it will be carefully integrated into the cultural and political organization of a local situation. In keeping with the underlying philosophy of communication and collaboration in this paper, I hope that there will be sharing among those who will be adapting this framework to their local needs. Further application and development of this method will support greater success in resolving conflicts and greater collaboration in furthering sustainable sea turtle conservation, for that is our common goal.

TABLE 1. Impact of collaboration on project conflict, development, and sustainability.

group\ examples\	immediate conflict	future conflict	resources & outputs	sustainability project/activity
government ------------ NGO ------------ community	LOW	HIGH	LOW	LOW
NGO government ------------ NGO community ------------ government community	MODERATE	MODERATE	MODERATE	MODERATE
community NGO government	HIGH	LOW	HIGH	HIGH

MARINE TURTLE NEST PRODUCTION AND REPRODUCTIVE SUCCESS AT PATRICK AFB; SUMMER 1995

Linh T. Uong, Dean A. Bagley, William B. Blihovde, Karen G. Holloway, and Llewellyn M. Ehrhart

University of Central Florida Marine Turtle Research; Department of Biology; P.O. Box 25000; Orlando, Florida 32816

The summer of 1995 was the ninth consecutive season that the U.C.F. Marine Turtle Research group has studied nesting activity and reproductive success along the 7-km stretch of beach at Patrick Air Force Base (PAFB), Florida. Surveys were conducted 7 days a week from 5 May to 31 August, except the morning of 2 August. A representative sample of nests was marked to assess reproductive success.

This season loggerhead nest production totaled 1619, the second highest total since this project began in 1987 (figure 1). It exceeded the comprehensive average (1218 nests) of the past 8 years (1987-1994) by 33%, making this another above average year for loggerhead nest production.

During the 1993 and 1994 seasons a man-made berm of sand, silt and shell prevailed on the southern half of the beach, that is otherwise sloped gently, with several short section of rip-rap. This affected nesting success and distribution, and reproductive success. Before 1993, section 3 always had the greatest nest production and the highest nesting success, or ratio of nests to false crawls. However, in 1993 and 1994, nesting success in section 3 fell, and much of the nesting was displaced into section 4. In 1995, the berm was absent. As a result, nesting success and distribution reverted to the pre-1993 pattern (figure 2).

Reproductive success, defined here in terms of emerging success or the percentage of eggs producing hatchlings that escape the nest, has always been quite high (66-80%) at PAFB. This is partly due to the total lack of raccoon depredation. However, during the 1994 and 1995 seasons, reproductive success faltered. Last year, it appeared to be the result of the man-made berm. This year, it was largely due to the flurry of tropical storms that began in late summer and continued into September.

Usually storm activity begins around Labor Day or later, after most of the loggerhead nests have hatched. This summer, Hurricane Erin made landfall on 2 August; it was followed a week later by large swells and heavy surf from Hurricane Felix, which was followed by Tropical Storm Jerry and Hurricane Luis. During this period many nests were still incubating and the results indicate that 48.6% of the total number of eggs deposited were inundated or washed out. Hence, overall reproductive success was only 35.31%. Storm activity also affected the single green turtle nest, deposited two days after the landfall of Hurricane Erin. Traditionally, Florida green turtles follow a biennial nesting pattern of "highs" and "lows," and 1995 was predicted to be a low year for PAFB (figure 3). In past low years, there have been no nests at PAFB. This year, however, one nest was laid on August 4, in the southern half of the base, where green turtle nesting is usually concentrated in high years. Of the 144 eggs in the clutch, none hatched; 136 were arrested at the fetal stage, and 8 were addled.

Despite the severe impact of weather on reproductive success this season, loggerhead nest production at PAFB continues to be high. Relative to other Florida nesting beaches, PAFB still ranks in the "top ten" and therefore merits consideration as an important component in the system of Southeast beaches that constitute the primary nesting beaches for the Western Atlantic loggerhead turtle.

We thank Patrick Air Force Base for its support of this project.

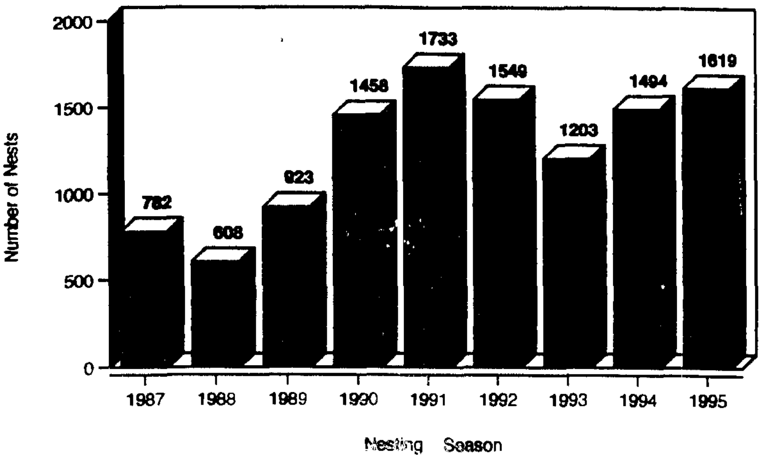

Figure 1. Loggerhead nest totals by year at Patrick Air Force Base, Florida, 1987 through 1995.

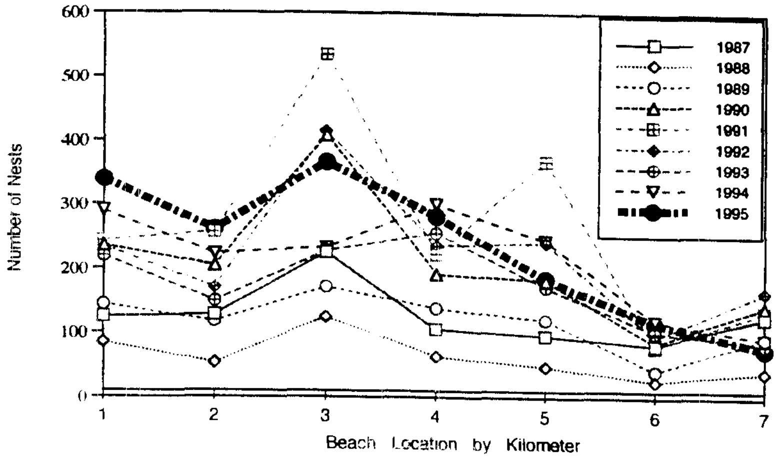

Figure 2. Loggerhead nest production by location at PAFB, 1987-1995.

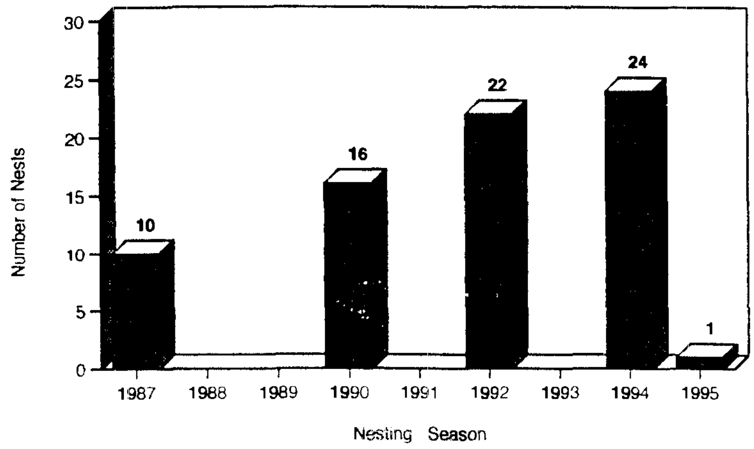

Figure 3. Florida green turtle nest totals by year at Patrick Air Force Base, Florida, 1987 through 1995.

AWAKENING AWARENESS: THE SEA TURTLE CLUB BONAIRE 1995 PROJECT

Paul van Nugteren[1], Niels P. Valkering[1], and Tom J.W. van Eijck[2]

[1]Faculty of Biology, University of Amsterdam, Kruislaan 318, 1098 SM, Netherlands.
[2]Sea Turtle Club Bonaire, Madurastraat 126 hs, 1094 GW, Amsterdam, Netherlands - P.O. Box 333, Bonaire, N.A

The Sea Turtle Club Bonaire (STCB) is a non-profit NGO, it's main goal being the conservation of the sea turtles around the island of Bonaire (Netherlands Antilles). After the pioneer project in 1993 (T. van Eijck & K.L. Eckert, 1994), a follow-up of this project was executed in 1995. In cooperation with WIDECAST, The University of Amsterdam (Netherlands), and various local organizations such as the Bonaire Marine Park, an extensive sea turtle research and conservation project has taken place from June to December 1995. Main sponsors of this project were the WWF Netherlands, the Dutch National Postcode Lottery, and the Bonaire Trading Company.

A very important part of the STCB 1995 project consisted of enhancing the public awareness about the endangered status of sea turtles. To inform the public, folders were distributed, posters were sold, information about sea turtle conservation was placed in the museum of the national park and weekly slide shows were given. Also, regular press updates, radio and television interviews and a weekly column in the islands main Papiamentu newspaper were published.

Special attention was paid to the local children. Every school on the island received an information package about sea turtles, consisting of a video, various folders, a booklet, posters, and a slide presentation. In cooperation with the Bonaire Marine Park, children were taken on regular snorkel trips to educate them on underwaterlife in general. Finally, the STCB organized the coastal cleanup during as a part of the World Cleanup Day on 16 September, during which several potential nesting beaches were cleaned. After the first project in 1993, awareness about sea turtle conservation has increased on Bonaire. However, a lot needs to be done still. Therefore, the STCB will continue its projects in the following years.

LITERATURE

Van Eijck, T.J.W. & Eckert, K.L. 1994. Sea Turtles in Bonaire: 1993 Survey Results and Conservation Recommendations. Sea Turtle Club Bonaire, Amsterdam, The Netherlands. 89 p.

MATURITY STAGE OF A PERUVIAN POPULATION OF GREEN TURTLE (Chelonia mydas)

Patricia Vargas

Calle Inca Garcilaso de la Vega 453, Salamanca de Monterrico, Lima-3, PERU

From December 1,976 to March 1, 995, the Peruvian Government Office of Fishery permitted the capture of Chelonia mydas agassizii with a total length of 80 cm, in 20 islands and 17 localities along the Peruvian coast. The percentage of sea turtles of this size captured at the northern and southern coast of Peru, was 8.8% and 5.6% respectively. The highest percentage of the capture was for individuals from 60 to 70 cm (approximately 85.3%).

The mean straight carapace length (SCL) of 14 immature Peruvian females (72.6Z6.3) was compared by the Student T test with the mean of nesting females from Galapagos (84.4 Z 5.34) and with the mean of immature individuals from the Gulf Coast of Florida (57.75 Z 8.3) and the Gulf of California (68.5 Z 8.3). The result for all the comparisons was significative difference. The Peruvian Coast could be a feeding area for juveniles, subadults, and presumably adults of Chelonia mydas.

INCREASED EMPLOYMENT OPPORTUNITIES: DECREASED HARVEST RATE OF MARINE TURTLES

Denis R. Castro W.[1], Cynthia J. Lagueux[2], and Cathi L. Campbell[2]

[1]Proyecto Cayos Miskitu, Puerto Cabezas, RAAN, Nicaragua
[2]Department of Wildlife Ecology and Conservation, 303 Newins-Ziegler, University of Florida, Gainesville, FL, 32611

A change in traditional fisheries on the Caribbean coast of Nicaragua has been observed over the past few years. We provide this information to illustrate the need to establish and enforce regulations to manage the harvest of natural resources, in this case green turtles, Chelonia mydas, in conjunction with developing alternative sources of food and income for rural peoples. We suggest that the availability of alternative resources for employment opportunities do not necessarily alone result in a decrease in the harvest rate of green turtles.

Last year we reported on the development and progress of the Miskitu Cays and Indigenous Communities Biosphere Reserve (MCICBR) located on the northeast coast of Nicaragua. The reserve was established in 1991 and covers an area of 12,000 km^2 including a 20-km wide coastal fringe from the Honduran/Nicaraguan border south 120 km. The reserve also includes offshore cays, seagrass beds, and coral reefs with a maximum seaward extension of 68 mi eastward from the mainland of Nicaragua. Several resources found in this reserve are harvested by the Miskitu Indians to meet subsistence needs and are used as a source of income. These include fish, lobster, shrimp, and marine turtles. Besides traditional fisheries, Miskitu men are employed by the lobster and shrimp industries which supply the international market.

Until recently, most of the lobster harvest was conducted by commercial lobster companies. Commonly, up to 60 Miskitu men live on a converted shrimp boat for 6 to 10 days while they harvest lobster. The men work in pairs from small dugout canoes. One man makes between eight and ten SCUBA dives per day, while the other man remains in the dugout canoe and is responsible for following the diver by tracking his air bubbles.

Although lobster traps have been in use in the southeast coastal region, Miskitu Indians of the northeast lacked the capital to purchase the materials to construct traps. Recently, business interests from Managua have provided Miskitu Indian communities in the MCICBR with funds to build lobster traps if the catch is sold directly to the benefactor from Managua. This has allowed the Indians in the northeast to use their own sailing dories primarily for harvesting lobster, rather than primarily for turtling and fishing. As a result, in the community of Sandy Bay there has been an increase in the number of dories used for lobster harvest from 0 dories to 75 dories from 1993 to 1995, and a decrease in the use of dories for turtle harvesting from 76 dories in 1993 to five dories in 1995. In the community of Dakura the use of dories for lobster increased from 0 dories in 1993 and 1994 to 19 dories in 1995 and dories used for turtling decreased from a high of 25 dories to six dories from 1994 to 1995. However, in the community of Awastara, only one dory was used to harvest lobster in 1995 and the number of dories used for turtling has decreased slightly from 30 dories in 1993 to 24 dories in 1995. The community of Awastara has not made the transition to lobster traps because theirs is a general mistrust between community members and they are not as knowledgeable and skilled in using traps to harvest lobster.

Overall, from 1994 to 1995, the number of dories used to harvest lobster in these three communities increased 58% and the number of dories used to harvest green turtles decreased 50%. It would be expected that the number of turtles harvested would decrease proportionately as a result. However, from

1994 to 1995, the approximate number of green turtles harvested decreased only 11.5% (Lagueux unpub. data). Apparently, the turtling effort per dory has increased. The number of turtles harvested in 1995 is in part an estimate based on the proportion of green turtles sold in the Puerto Cabezas market and consumed in the community in 1994. It was assumed that this proportion remained the same in 1995. The number of green turtles consumed in each community in 1995 was estimated from the actual number of turtles landed in Puerto Cabezas by community for 1995.

We also compared changes in the amount of shrimp and lobster harvested to turtles. From 1994 to 1995, the amount of shrimp harvested increased 94% and lobster increased 62% (MEDEPESCA 1994, 1995). Given the increase in shrimp and lobster harvested we expected the harvest rate of marine turtles to have decreased more than the estimated 11.5%.

Alternate sources of income to the marine turtle fishery were not intentionally provided, but might be expected to reduce turtle harvest rates. However, we did not observe this to be the case in Nicaragua. With developing alternative sources of income, it is necessary to establish and enforce regulations to reduce harvest pressures. Miskitu Indians must play a primary role in the establishment of these regulations to ensure that a change in resource use patterns are appropriate and acceptable. Their direct involvement in the management of the marine turtle harvest would encourage their cooperation in reducing the current harvest rate of marine turtles and ultimately the long-term availability of this resource.

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LITERATURE

MEDEPESCA. 1994. Boletín de Datos Estadístico. Ministerio de Pesquería Nicaragüense, Managua, Nicaragua.

MEDEPESCA. 1995. Boletín de Datos Estadístico. Ministerio de Pesquería Nicaragüense, Managua, Nicaragua.

SEA TURTLE CONSERVATION AND COMMUNITY PARTICIPATION IN KENYA

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

[1] Kenya Wildlife Service, P.O. Box 82144, Mombasa, Kenya
[2] Fisheries Department, P.O. Box 90423, Mombasa, Kenya
[3]Coast Development Authority, P.O. Box 1322, Mombasa, Kenya

ABSTRACT

Along the 640 km Kenya coastline sea turtles and their products are exploited by humans and their habitats/nesting sites destroyed due to development. Turtle oil which is considered medicinal has found its way into exclusive markets at very dear prices. Public awareness and educational campaigns through Art/Essay/Poem competition for schools, mass media, brochures, T-shirts and music to different target groups have formed a greater part of set conservation strategies. Communities of fishermen, beach users, divers, boat operators and other stakeholders have been integrated into the program for beach patrols, nest protection, etc. In an effort to enlist their support and responsibility towards sea turtle conservation.

INTRODUCTION

The sea turtle species occurring in Kenya's waters are the green turtle (Chelonia mydas), loggerhead (Caretta caretta), olive ridley (Lepidochelys olivacea), leatherback (Dermochelys coriacea) and hawksbill (Eretmochelys imbricata) (Olendo 1993; Mbendo and Mbwana, 1995 unpubl.). Of these, the green turtle and hawkbill nest along the coastline, however the green turtle is the most common.

Communities inhabiting coastal areas particularly the Bajuni have exploited the green and hawksbill turtles, both for subsistence and commercial purposes for a long time. Turtle meat, the female being preferred, continues to form part of their diet as a delicacy and even aphrodisiac, while the oil is used for medicinal purposes for ailments such as asthma, paralysis and ear infection. The beautiful shell of the hawksbill turtle is sold to tourists for economic gain. Turtle eggs are also not spared. With the current trend of population increase, more pressure continues being exerted on these creatures, raising concern among marine resource managers.

The influx of foreign fishermen using hi-tech fishing technologies has added to the problems of sea turtles. Other threats however include; incidental capture in both artisanal and commercial fishermen's nets, where set and trawl nets trap turtles drowning them.

Beach development has rendered traditional nesting sites unavailable due to increased human activities and lights coupled with these are habitat loss, pollution and predation on both eggs and hatchlings by monitor lizards, mongoose, ants, crabs and crows. It has become necessary that conservation strategies be formulated to complement already existing legislation which has been found wanting and difficult to enforce for various reasons. The Protected Area system may have performed a useful service in the past, but today it meets with a lot of resistance from communities being served by the resource in question as they do not reap direct benefits. It is imperative therefore that the communities who are actually custodians of this resource be incorporated into conservation thereby creating a sense of belonging and identity with the project.

COMMUNITY PARTICIPATION

A community has been defined as an interacting group of people who share a common functional link such as kinship, occupation, interest, place of residence or religion. Participation on the other hand is the process whereby people act in groups to influence the direction and outcome of development programs that will affect them (Paul 1987).

There have been many forms of traditional and customary management of resources that have been developed and practiced for generations.

Community management involves decision making right from the grassroot level. It is more economical and technically efficient. Incorporation indigenous knowledge conservation management will provide useful information to planning and development agencies. The resource users are quick to adapt to change as monitoring and evaluation is left to them as much as possible making them more committed as they feel it is their resource.

The existing legislation which protects sea turtles i.e the Fisheries Act 1989 and Wildlife (Conservation and Management) Act 1977, respectively are inadequate to promote recovery of depleted stocks as they have no provisions for community based conservation strategies.

Also enforcement of these laws is ineffective due to lack of adequate resources and personnel. An integrated multisectoral committee comprising of government agencies, NGO's, private stakeholders and fishermen has been formed to spearhead sea turtle conservation in Kenya.

The Kenya Sea Turtle Conservation Committee (KESCOM) has emphasized the participatory approach that is significantly lacking within the national policies. Meetings have been held with the communities concerned to better understand their perception of turtle conservation.

Surveys have also been carried out in an attempt to establish nesting and foraging areas, indigenous uses, exploitation levels and threats to the sea turtle. There has been establishment of local beach patrols and monitoring volunteers. As an incentive KESCOM has established "Save The Turtle Fund" which is used for rewarding those who report nests (mainly fishermen) being given Ksh 500.00 guarding the nest, another ksh 500.00 and Ksh 2.00 for every successful hatchling emerging. It has been necessary to involve the local communities as some of the turtle nesting beaches are situated far from areas easily accessible to enforcement agencies. Nets destroyed due to incidental capture are also being replaced if the fishermen cut them to release turtles. Since the introduction of the incentive scheme the local people participate has been encouraging.

It is believed that the future viability of sea turtle conservation will depend on the support of all the stakeholders raging fishermen, tourist, hoteliers among others. Dispute resolving mechanisms for participating groups need to be developed to avoid conflicts and the "Impossible Performance" of the project.

EDUCATION AND PUBLIC AWARENESS

The different stakeholders need to be enlightened so as to understand the need to conservation for sea turtles. Awareness raising using both formal and informal mechanisms for education, training and human resource development is a necessary step in the implementation of strategies for conserving sea turtles.

It has been realized that for medium to long-term enhancement of sea turtle conservation there is a need to raise well informed future generations with a strong commitment to sustained management thus targeting the youth. This has been done through Art, essay and poem competition in schools and is to be carried out annually and awards issued to winners. The winning art work has been used to print T-shirts. These have served the dual purpose of awareness as well as fund-raising. Poems have been recited publicly to large audiences and recorded via mass media. Another medium of awareness was through a 350 km walk during which there was personal contact with coastal communities as well as fundraising. Brochures and posters have also been produced to this effect.

ECOTOURISM

Since resources are always defined in terms of a given economic system, conservation should be a means of adjusting short term uses and needs and future options. Conservation objectives must maintain essential ecological process and ensure sustainable, utilization of species and ecosystems. Conservation issues cannot be expected to enjoy a high rate of concern among people whose basic economic and nutritional needs are not being met.

Ecotourism is based on nature, cultural heritage and contact between guests and host populations. It must ensure balance to avoid comprise of the uses of these three resources.

Tourism development has a direct impact on the survival of turtles since beach hotels put up walls in front of turtle nesting grounds. Hotels with nesting beaches have in the past used the hatchling release as a tourist attraction, where guests handled the hatchlings releasing them into the sea after prolonged periods of time.

This has proved detrimental to the turtle as it interferes with the orientation and other biological aspects. It has been discouraged by KESCOM and in situ nest incubation is being encouraged. Nests that are located at hotel beach fronts must not be disturbed nor are the hatchlings allowed to be kept in tanks as tourist attractions.

It is believed that the future viability of Sea Turtle Conservation will depend on the support of all the stakeholders ranging from fishermen, tourists, hoteliers among others. Mechanisms for dispute resolving need to be developed to avoid conflicts and the "impossible performance" of the project.

REGIONAL COOPERATION

Since sea turtles are migratory, regional cooperation within the WIO region is a priority as sea turtles are a shared resource. Kenya's Sea Turtle Conservation efforts will be incorporated within the regional and international initiatives.

LITERATURE CITED

Frazier, J. 1975. "The status of knowledge on marine turtles." East African Wildlife Society. 16 pp.

Olendo, D. 1993. "Report on Sea Turtles and Dugong survey." Kenya Wildlife Service Internal Report. 20 pp.

Paul, S. 1987. "Community participation in world bank projects." Finance and Development, 24 (4): 20-23.

USAID, 1993. African Biodiversity; Foundation for the future. 149 pp.

SEA TURTLES OF GALIBI, SURINAME

Mariska Weijerman, Luc H.G. van Tienen, Arnoud D. Schouten, and Willem E. J. Hoekert

Saenredamstraat 1-II, 1076 CA AMSTERDAM, The Netherlands

Three sea turtle species are common visitors to the beaches of Galibi, Suriname: Chelonia mydas, which had a stable population; Dermochelys coriacea, of which the Galibi population is part of the large population nesting primarily at Yalimopo in French Guiana; and, Lepidochelys olivacea, which population is the largest in the West Atlantic. Before 1968 "arribadas" (mass nesting aggregations) were recorded at Eilanti, the most important nesting beach in Suriname for the L. olivacea. However, since 1972 the number of nesting females has declined and no subsequent arribadas have been encountered.

In 1964, conservation and management plans were implemented and since then have been carried out by STINASU, a semi governmental institute. All beaches of Suriname are monitored and nests are recorded. Political instability made it impossible to carry out research between 1990 and 1994. Therefore, there is a gap of 5 years in the data set. The continuation of nest counting is very important to enable an accurate estimate of population trends to be made, particularly given the scale of fluctuations between "good" and "bad" years. In 1995 we carried out this data gathering process. In addition, hatching percentages for the three species have been determined. Furthermore, we investigated whether the recently evolved sand bank close to the coast of Eilanti is suitable as a nesting beach. The suitability of the other beaches of Galibi as a nesting beach has also been determined.

MATERIALS AND METHODS

A stretch of 2 km beach has been monitored every night between 9 May and 15 June, and every morning between 9 July and 8 August. False crawls and nests were recorded. In addition, during the whole research period sea turtle tracks and nests were regularly counted on the other beaches of the Galibi Reserve. Also the number of poached nests was counted. Between 22 July and 7 August the number and location of emerged nests based on the fresh tracks of hatchlings, were recorded every morning. Most nests of the L. olivacea and doomed nests were relocated in a hatchery close to the camp within 2 hours after laying.

Three days after emergence, relocated nests were dug up, empty egg shells were counted, and the remaining eggs were opened to determine the state of development. Encountered albino hatchlings were recorded. For reference some natural nests were dug up as well.

RESULTS AND DISCUSSION

Nest counting - In the research area (63% of the Galibi Reserve) we counted a total of 155 C. mydas, 465 D. coriacea and 169 L. olivacea nests. STINASU employees counted nest in the whole reserve except for the newly evolved sand bank, the Spit, and for the entire nesting season. To make an accurate population estimate it is necessary to combine the data sets. When doing this and taking into account the intraseasonal and interseasonal nesting values, the estimated nesting population is 4200 C. mydas, 1200 D. coriacea and 280 L. olivacea (table 1). Comparing the 1995 estimates with the last 2.5 decades, it seems that the female population of C. mydas is stable; of D. coriacea is low but within the range of normal fluctuations; and, of L. olivacea is alarmingly decreasing.

To get an idea of nesting beach preferences by the sea turtles, the number of nests was divided by the length of the specific beach. The relatively high sandy beaches with no obstacles, mangroves or mud banks were most favored. Adjacent to the beach Thomas (first part of Eilanti) a huge mud bank has developed which makes it difficult for large sea turtles to reach the beach. For decades this beach was the most important nesting site for the L. olivacea. However, in comparison with other beaches the number of nests decreased which indicates a declining suitability as nesting beach.

New beach - Our monitoring results for the Spit is the first recorded data. Only tracks of D. coriacea and L. olivacea were seen with a high number of false crawls. Unfortunately, most of these nests can be classified as doomed nests because of the high ground water level and the frequent flooding. This will have a major negative impact on the future of the already greatly reduced L. olivacea population because 45% of the total number of nests were made on this beach. Considering this, the low estimate for the female population is even more alarming.

Poaching - For centuries Indians have collected sea turtle eggs for subsistence use. In the seventies and the first part of the eighties STINASU had successfully regulated the taking of eggs. At present, it is allowed to collect eggs in May except on a stretch of beach close to the STINASU camp. The taking of L. olivacea eggs is always forbidden. However, poaching occurs during the whole season and the eggs of the L. olivacea are most sought after. In the peak of the nesting season more than 40% of their nests were poached especially on the beaches furthest of the STINASU camp.

Hatching success - Table 2 shows the hatching results. There was no significant difference in the hatching success of the relocated nests and the natural nests ($P>0.05$). Most L. olivacea nests near the camp were moved, consequently only two nests were dug up which made comparison impossible.

By opening the eggs a number of albino hatchlings were found. All of them had malformations especially on their head. Albinos were found in 22% of the C. mydas nests, 3% in D. coriacea nests and 5% in L. olivacea nests.

Figure 1 shows the development of the eggs. It seems that more eggs showed development in the natural nests but there were no significant differences ($P>0.05$). A crude estimate of the percentage natural nests with emergence was made by comparing these with the number of laid nests at the start of the season. In this way, it was estimated that about 75% of the laid nests had emergence. Though it seems that the development of eggs is less in relocated nests (see fig. 1), the chance of emerging is higher. Consequently, nests under threat of flooding or poaching should be moved for better emerging results.

LITERATURE

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

Schultz J.P., 1975. *Sea turtles nesting in Surinam.* Zool. Verh. Rijksmuseum van Natuurlijke Historie, Leiden, No. 143, The Netherlands. 172pp.

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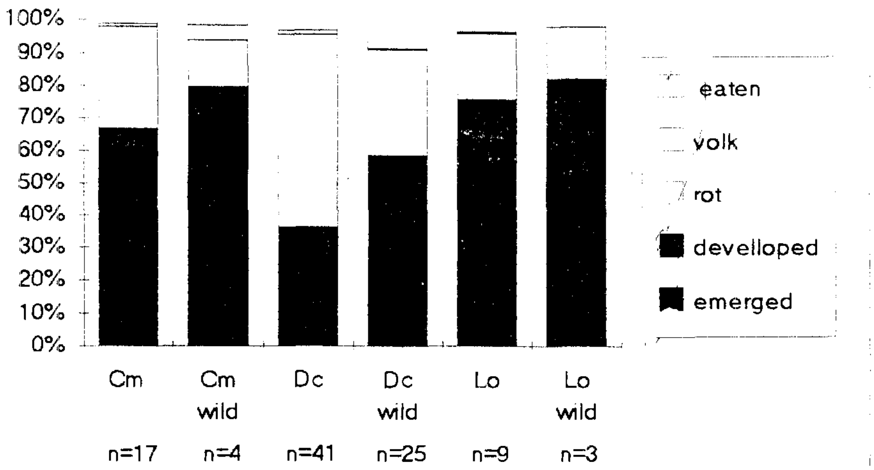
Table 1. Number of nests and population estimates for the Galibi Nature Reserve in 1995. Nest countings for April are intrapolated.

	C. mydas	D. coriacea	L. olivacea
Nest counting STINASU (without April)	4357	1175	226
Intrapolated nest estimates	6313	1324	231
Nest counting Spit	0	275	59
Estimated nests Spit	0	484	104
Total number of nests	6313	1808	335
Intraseasonal nesting average	3.5	3	1.7
Interseasonal nesting average	2.3	2	1.4
Estimated female nesting population	4200	1200	280

Table 2. Summary of the hatching results.

		Nests on hatchery	Natural nests
D. coriacea	Relocated	44	-
	Nests with emergence	41 (91%)	46 (after 21 July)
	Mean hatching %	28 ± 21 (n=41)	32 ± 25 (n=24)
	Mean incubation time	62	-
C. midas	Relocated	18	-
	Nests with emergence	17 (95%)	24 (after 21 July)
	Mean hatching %	58 ± 27 (n=17)	71 ± 26 (n=14)
	Mean incubation time	56	-
L. olivacea	Relocated	20	-
	Nests with emergence	20 (100%)	4(after 21 July)
	Mean hatching %	63 ± 24 (n=19)	29 (n=2)
	Mean incubation time	52	

Figure 1. The development of the eggs represented as the percentage of the total number of eggs per nest. Developed eggs are the total of late embryo, pipped dead and buried hatchlings.



ESTIMATION OF HATCHLING SEX RATIOS OF HAWKSBILL SEA TURTLES FROM BUCK ISLAND REEF NATIONAL MONUMENT

Thane Wibbels[1] **and Zandy-Marie Hillis**[2]

[1]Department of Biology, University of Alabama at Birmingham, Birmingham, AL 35294-1170
[2] National Park Service, Buck Island Reef National Monument, Christiansted, U.S.Virgin Islands
00821-0160

The sex of many reptiles, including sea turtles, is determined by the temperature at which the egg is incubated (Bull, 1980; Raynaud and Pieau, 1985; Janzen and Paukstis, 1991; Ewert et al., 1994; Lang and Andrews, 1994). Sea turtle sex ratios resulting from temperature-dependent sex determination are of conservational significance since sex ratio can significantly affect reproduction and thus the restoration of endangered populations. Further, a knowledge of naturally occurring sex ratios is prerequisite to understanding the ecological and evolutionary significance of temperature-dependent sex determination. In the current study we examine sex ratios of hatchling hawksbill sea turtles, Eretmochelys imbricata, from nests on Buck Island Reef National Monument in the U.S. Virgin Island. This study site is a natural and undeveloped nesting beach of the hawksbill sea turtles in the Caribbean.

METHODS

Sex ratios of hatchling hawksbill sea turtles were examined on Buck Island Reef National Monument. This site is composed of an undeveloped island together with its surrounding reef located 2 km north of St. Croix in the U.S. Virgin Islands. Buck Island Reef National Monument is administered and protected by the National Park Service. It is one of the three known islands in the Caribbean where hawksbill sea turtles nest in relatively large numbers (Hillis and MacKay, 1989: Hills, 1990).

To evaluate sex ratio from nests on Buck Island, dead hatchlings were collected from nests several days after most of the hatchlings had emerged from a given nest. The locations of nests were recorded and marked on the day of laying and the total number of eggs were counted in each nest. Approximately 60 days after each nest was laid, the nest was then checked to determine if hatchlings had emerged. If they had emerged, the nests were excavated and any dead hatchlings found in the nest were placed in Bouin's preservative.

The kidney/gonad/adrenal complex was dissected from the preserved hatchlings, infiltrated and embedded in paraffin and then sectioned at 8 µm. These sections were then place on slides and stained with hematoxylin and eosin (Humason, 1972). The sex of individual turtles was determined by examining the histological structure of the gonads (Yntema and Mrosovsky, 1980). Hatchling ovaries exhibit a distinct cortex and an unorganized medulla, whereas testes lack a cortex and have seminiferous tubules in the medullary region.

RESULTS AND DISCUSSION

The gonads from a total of 485 hatchlings were histologically examined to verify sex. The nests sampled were laid from 23 March 1994 to 26 October 1994. Most of the nests sampled (86.2%) were laid during the peak nesting months of July through October. Further, the four nesting areas on Buck Island are all represented (West Beach, 12 nests; North Shore, 13 nests; South Shore, 22 nests, Turtle Beach, 4 nests). The hatchlings sampled from 48 of the 51 nests were all female. The sex ratios from other 3 nests sampled were mixtures of males and females. These results indicate a significant female bias in 94.1% of the nests sampled and suggest an overall female bias in the sex ratio of hatchling hawksbill sea turtles from nests laid on Buck Island during 1994. These results together with those of past studies (reviewed in Mrosovsky, 1994; Wibbels et al., 1993; 1991) reveal that temperature-dependent sex determination can result in distinctly biased sex ratios in sea turtles. In many cases, such as the current study, significant female biases have been reported (Mrosovsky, 1994). Of particular interest, a study of sex ratios of hatchling hawksbill sea turtles nesting on another Caribbean island (Antigua) suggested no female biases (Mrosovsky et al., 1992). Considering the variability in sex ratios indicated by these studies, the adaptive significance of temperature-dependent sex determination (if any) may not be easily revealed. Future studies including comprehensive evaluations of sex ratios within specific populations and the affects of sex ratio on reproductive success could provide insight on the adaptive significance of temperature-dependent sex determination.

From a conservational viewpoint, the variability revealed by this and previous studies, indicated that the monitoring of hatchling sex ratios is definitely warranted. It is plausible that some circumstances (e.g., extreme male biases) might require the manipulation of sex ratios to enhance reproduction and thus the restoration of an endangered population.

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LITERATURE

Bull, J.J. Sex determination in reptiles. Quart. Rev. Biol. 55:3-41.

Ewert, M.A., Jackson, D.R., and Nelson, C.E. 1994. Patterns of temperature-dependent sex determination in turtle. J. Exp. Zool. 270: 3-15.

Janzen, F.J. and Paukstis, G.L. 1991. Sex determination in reptiles: ecology, evolution, and experimental design. Quart. Rev. Biol. 66:149-179.

Hills, Z.M. 1990. Buck Island Reef National Monument sea turtle program: 1989 the year of hawksbills and hurricanes. Proceedings of the Tenth Annual Workshop on Sea Turtle Conservation and Biology. Richardson, T.H. (eds)., Richardson, J.I., and Donnelly, M. NOAA Technical Memorandum NMFS-SEFC-278.

Hills, Z.M. and MacKay, A. 1989. Buck Island Reef National Monument sea turtle program 1987-1988. Proceedings of the Ninth Annual Workshop on Sea Turtle Conservation and Biology. Eckert, S.A., Eckert, K.L., and Richardson, T.H. (eds). NOAA Technical Memorandum NMFS-SEFC-232.

Humason, G.L. 1972. Animal Tissue Techniques. Freeman, San Francisco.

Lange, J.W. and Andrews, H.V. 1994. Temperature-dependent sex determination in crocodilians. J. Exp. Zool. 270: 28-44.

Mrosovsky, N. 1994. Sex ratios of sea turtles. J. Exp. Zool. 270: 16-27.

Mrosovsky, N., Bass, A., Corliss, L.A., Richardson, J.I., and Richardson, T.H. 1992. Pivotal and beach temperatures for hawksbill sea turtles nesting in Antigua. Can. J. Zool. 70: 1920-1925.

Raynaud, A., and Pieau, C. 1985. Embryonic development of the genital system. In: Biology of the Reptilia, Vol. 15. Gans, C. (ed). Wiley, New York, pp. 150-300.

Wibbels, T., and Balazs, G., Owens, D., and Amoss, M.S. Jr. 1993. Sex ratio of immature green sea turtles inhabiting the Hawaiian Archipelago. J. Herp. 27: 327-329.

Wibbels, T., Martin, R.E., Owens, D.W., and Amoss, M.S. Jr. 1991. Female-biased sex ratio of immature loggerhead sea turtles inhabiting the Atlantic coastal waters of Florida. Can. J. Zool. 69: 2973-2977.

Yntema, C.L., and Mrosovsky, N. 1980. Sexual differentiation in hatchling loggerheads (Caretta caretta) incubated at different controlled temperatures. Herpetologica 36: 33-66.

KNEE DEEP IN GREEN TURTLES: RECENT TRENDS IN CAPTURE RATES AT THE ST. LUCIE NUCLEAR POWER PLANT

J. Ross Wilcox[1], Gary Bouska[2], Jonathan Gorham[3], Bruce Peery[3], and Michael Bresette[3]

[1]Florida Power and Light Co., P.O. Box 088801, N. Palm Beach, FL 33408 USA
[2]Florida Power and Light Co., P.O. Box 1691, Jensen Beach, FL 34958 USA
[3]Quantum Resources Inc., P.O. Box 30008, Palm Beach Gardens, FL 33410 USA

Sea turtles have been captured from the intake canal of the St. Lucie nuclear power plant on Hutchinson Island on the east-central coast of Florida since 1976. Beginning in 1993, the number of green turtles (Chelonia mydas) captured have increased at an accelerating rate, from an average of 24 per year in 1976-93 to 673 in 1995. The power plant represents a consistent and relatively unbiased sampling device, and we feel that the increase in captures likely reflects a larger green turtle population in the immediate nearshore environment of east-central Florida.

METHODS

Cooling water enters the St. Lucie plant intake canal through a submerged intake structure located 365 m offshore of the barrier island. A constant volume of water is drawn from the ocean 24 hours a day, 365 days a year. Sea turtles encountering the intake structures are entrained with the cooling water and enter an enclosed intake canal from which they cannot escape. Thus, the intake canal system represents an efficient and unbiased sampling device for sea turtles in the immediate nearshore waters. Turtles are captured from the canal by tangle nets, dip nets, or by hand capture by divers, and every turtle entering the intake canal is accounted for. Morphometric data are collected from all turtles captured and turtles are tagged before release near the plant site. A database is maintained on all turtles captured at the plant since 1976.

RESULTS AND DISCUSSION

During the 16-year period from 1976-93, green turtle captures averaged 24 per year. Beginning in 1993, we noticed a dramatic increase in green turtle captures (figure 1). The green turtle catch for 1993, 1994, and 1995 was 745%, 804%, and 2084%, respectively, above the previous 16-year average annual catch. The vast majority of green turtles captured at the St. Lucie plant are juveniles and subadults (straight line carapace length less than 83cm) (Witherington and Ehrhart 1989). The size class distribution of green turtles captured in 1993-1995 (figure 2) shows a modest shift toward larger size classes compared to size class data from 1976 through 1992 (figure 3), but captures of adult green turtles are still infrequent. Prior to the 1995 season, catches of green turtles have shown a strong seasonal abundance pattern, with more than 50% of all catches occurring in January through March (figure 4). The 1995 capture data show a marked change in seasonal distribution, with captures distributed much more evenly throughout the year (figure 5). This trend, if it continues, may reflect an increasing use of the nearshore habitat by juvenile and subadult green turtles year round. We feel that the dramatic increases in green turtle captures over the last 3 years is suggestive of a larger green turtle population in the immediate nearshore environment of east central Florida.

LITERATURE CITED

Witherigton, B.E. and L.M. Ehrhart. 1989. Status and reproductive characteristics of green turtles (Chelonia mydas) nesting in Florida. Pages 351-352 in: L. Ogren, F. Berry, K. Bjorndal, H. Kumpf, R. Mast, G. Medina, H. Reichart and R. Witham, editors.

Proceedings of the Second Western Atlantic Turtle Symposium. Mayaguez, Puerto Rico, 12-16 October 1987. NOAA Technical Memorandum NMFS-SEFC-226.

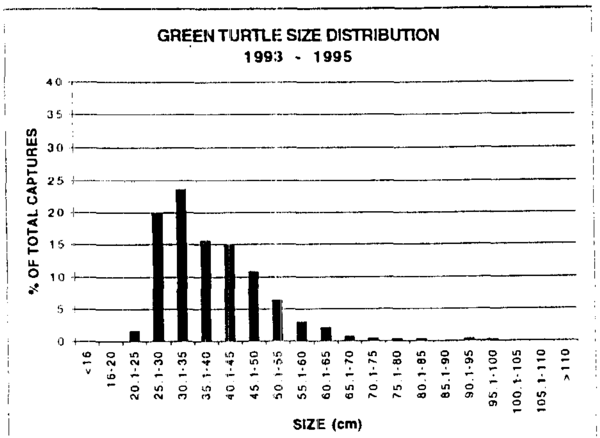


FIGURE 2. Size distribution of green turtles (*Chelonia mydas*) from the St. Lucie Power Plant intake canal, 1993 - 1995. N = 1042

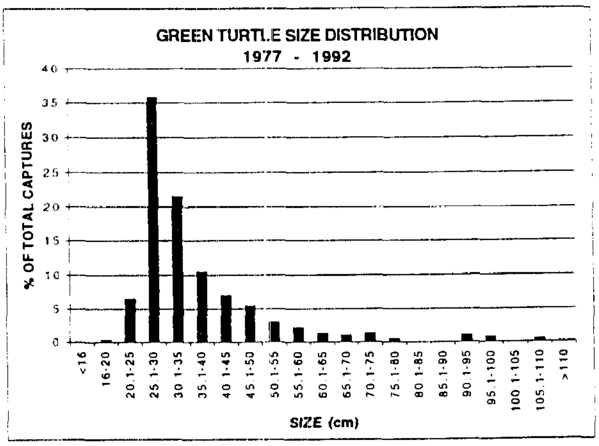


FIGURE 3. Size distribution of green turtles (*Chelonia mydas*) from the St. Lucie Power Plant intake canal, 1977 - 1992. N= 372

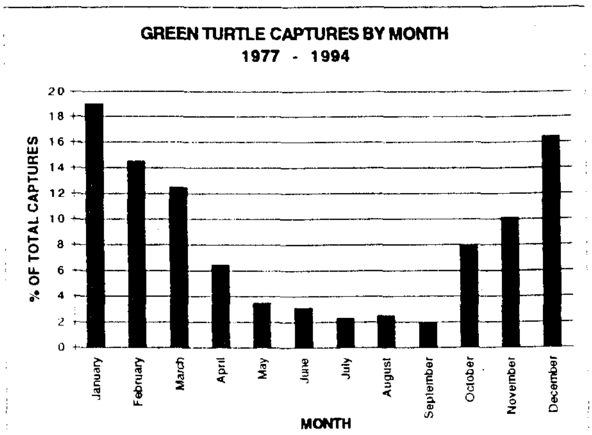


FIGURE 4. Green turtle (*Chelonia mydas*) captures by month from the St. Lucie Power Plant intake canal, 1977 - 1994. N = 751.

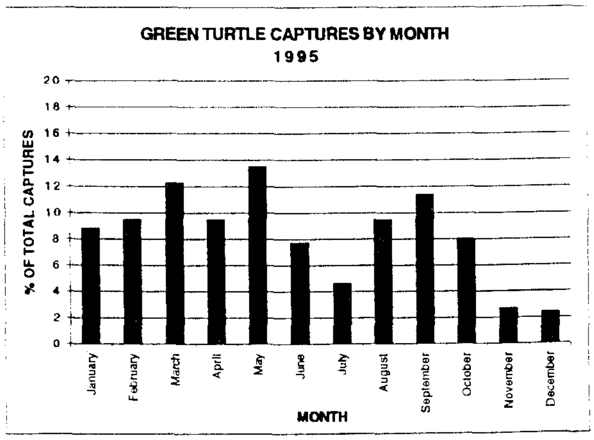


FIGURE 5. Green turtle (*Chelonia mydas*) captures by month from the St. Lucie Power Plant intake canal, 1995. N = 673.

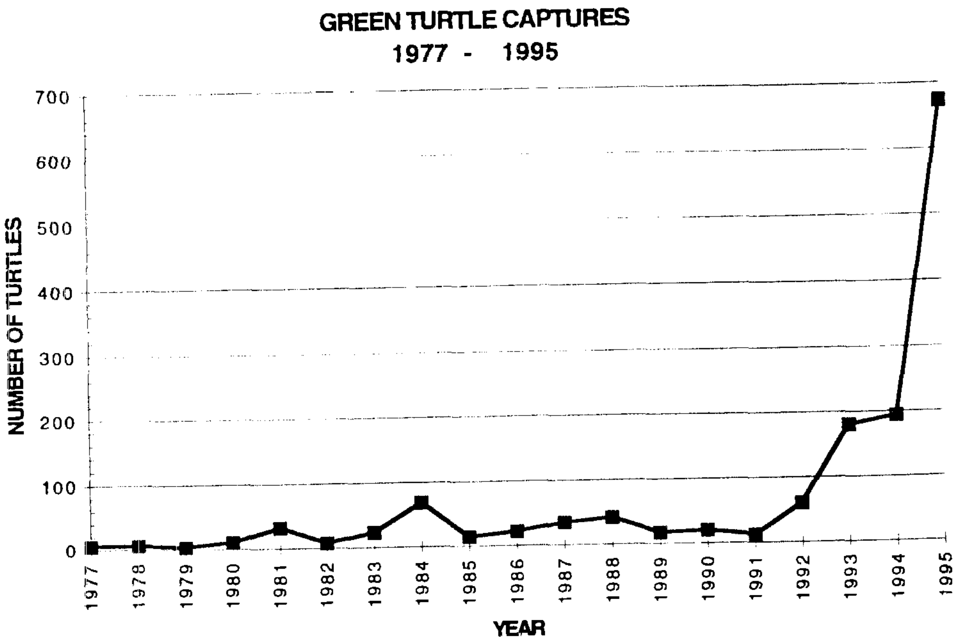


FIGURE 1. Annual captures of green turtles (*Chelonia mydas*) from the St. Lucie Plant intake canal, 1977 - 1995.

DARKENING LUCIFEROUS BEACHES: THE DEVIL IS IN THE DETAILS

Blair Witherington

Florida Department of Environmental Protection, Florida Marine Research Institute, 19100 SE Federal Highway, Tequesta, FL 33469, USA

Artificial lighting that is visible from sea turtle nesting beaches is known to deter females from nesting and to misdirect and kill hatchlings. As nesting beaches become developed, the potential for these detrimental effects is expected to increase. Yet, of the many effects of human development, effects from artificial lighting may be among the most easily mitigated. In this summary I offer answers to commonly asked questions about the effects of beach lighting and provide methods by which light can be managed to protect sea turtles.

What effect does artificial lighting have on sea turtles? Sea turtles that nest nocturnally (which includes most of them) are deterred from emerging to nest on beaches that are artificially lighted. Because nesting attempts are abandoned in the water rather than on the beach, the ratio of nests to false crawls (obtained from beach track counts) is not a reliable indicator of the effects of lighting on nesting. Artificial lighting can have lethal effects on hatchlings, which depend in part upon brightness cues to lead them seaward. Light sources can attract hatchlings and lead them away from the ocean where they succumb to dehydration, exhaustion, or predation. Adult turtles returning to the sea from nesting can also be misdirected by lights.

Why not light the beach more to keep turtles safely away? Sea turtles do need to nest somewhere. But even if the number of dark beaches were infinite and turtles always had an opportunity to go somewhere else, brightening a beach further to keep away nesting turtles will not save their hatchlings. This is because it takes more light to frighten away nesting turtles than it takes to misdirect hatchlings. Sea turtles often nest on beaches that are too brightly lighted to allow their hatchlings to escape.

If hatchlings are not misdirected by the moon, why do artificial lights harm them? It is true that on unlighted beaches, regardless of moon phase or moon position, hatchlings move unerringly from nest to sea. Although hatchlings tend to move in the brightest direction, they also rely on shape cues associated with the dune to determine the seaward direction. These additional cues help hatchlings find the sea even when the ocean is not the brightest direction.

However, there is an important difference between light from the moon (and other celestial sources) and light from artificial sources. The difference is in how light from these sources reaches a hatchling. Celestial light sources are bright but distant and their light reaches a hatchling both directly and indirectly as it is scattered in the atmosphere and reflected from clouds and landscapes. This indirect light helps to moderate the brightest direction and to provide visual cues other than brightness. Artificial lighting, however, produces little moderating indirect light. Artificial sources appear bright because of their proximity and the light fields they produce are highly directed. In essence this means that they have a lot of glare. Lights on beaches do not misdirect hatchlings because they are simply the brightest direction, but because they are overwhelmingly the brightest direction. Under these exaggerated or "supernormal" conditions, hatchlings seem to rely exclusively on brightness cues and will struggle to reach an artificial brightest direction until they die.

How bright can an artificial light source be without harming sea turtles? Unfortunately, this is a complicated assessment. The harm a light source can cause will vary with its color, where it is positioned, the amount of visible structure on the dune, the level of ambient light, and likely, other characteristics that are yet to be fully understood. Fortunately, there is a simple rule that one can use to determine whether a given light source can harm sea turtles that use a nesting beach. If an observer located anywhere on the beach can see light that is produced by the source, then that light can harm sea turtles. Even dim lighting can harm turtles on the darkest nights of the month.

My neighbor has lights that shine on the beach. Why should I darken mine? Although it is important to enlist help from all beachfront residents in order to completely protect the turtles that use the beach, it is also true that every little bit helps. If only some residents darken their portion of beach, at least hatchlings on those stretches or the hatchlings that emerge on the brightest moonlit nights will be able to find the sea. The darker a beach becomes, the more hatchlings will reach the water.

Will lighted barges offshore work to attract hatchlings off lighted beaches? Apart from being an expensive and complicated feat of engineering, this proposal would not be expected to produce benefits for sea turtle conservation. If there were any effect, it would be that hatchlings on beaches adjacent to those with lighted barges would be misdirected. If hatchlings were attracted to the lighted barges, they may get no farther in their journey. The lights would also attract predatory fish that would consume many of the hatchlings reaching the barge.

How can sea turtle conservation justify turning off lights that are needed for human safety and security? Thankfully, there is no need to abandon human safety for sea turtle conservation efforts. The key to protecting turtles from artificial lighting is not to prohibit light but to manage it. Light management is the process of getting light where it is needed most and keeping light away from areas where it can do harm. Below, I list some methods for managing light.

Light Management on Sea Turtle Nesting Beaches

Turn off unnecessary beach lighting. A large part of successful light management is turning off lights that are not necessary. This non-essential lighting includes decorative lighting and lights that illuminate areas where there are no people in need of safety or where there are no goods in need of security.

Use timing. Although the most effective alterations to lighting are permanent, temporary seasonal alterations can also be effective. The critical period for light management alterations is throughout the nesting and hatching season, and during this period, throughout each night. Although there are peaks of nightly nesting and hatchling activity, this activity can span the entire night.

Limit duration. The more momentary a light source is, the smaller its effect on sea turtles. Motion detectors are the best way to limit the period that a light source is on. These switches turn lighting on only after the unit is approached and work only with incandescent lamps.

Use good light control. Light control involves controlling the direction of lighting. Good light control can allow a property owner to increase the brightness on his or her property without affecting the beach. Lowering lights, is a good way to hide them from the beach. Lights on tall poles can be seen from great distances but low-level lighting might not be seen at all from the beach if there is sufficient dune to hide it. Shielding is also useful. The best shields are opaque, durable, and attached to a fixture in a permanent way. Aluminum flashing sheets make good light shields. Recessing lights into eaves, is a good way to hide them and many lights are specifically designed for this. Redirecting, also helps. The best directed light sources are well focused and point down and away from the beach.

Use light screens. Sometimes it is difficult to remedy a light at the source. Some lighting might even be considered to be a non-point-source problem, such as the glow from a distant city. One way to lessen the effects of non-point-source light is to screen it from the beach. Although artificial structures can do this, the best method may be to simply allow dune vegetation to grow, providing a natural light screen.

Substitute long-wavelength light sources. Because even the best light-control techniques may allow some light to reach the beach, it is beneficial to use sources that emit wavelengths that least affect sea turtles. There is evidence that hatchling loggerheads, green turtles, hawksbills, and olive ridleys are less attracted to yellow and red light than to light composed of shorter wavelength green and blue. For this reason, a pure-yellow source known as low-pressure-sodium vapor may be the least harmful commercial light source. Yellow "bug lights," the incandescent lamps advertised to not attract insects, are a cheaper alternative, but are not a pure a yellow source. Most lamps that are tinted red can fade and emit some short-wavelength light. However, some red sources are good alternatives, such as red, light-emitting diodes (LED's), and the old-fashioned true neon tubes (not to be confused with colored-fluorescent tubes).

Limited copies of a manual are available that outlines the problems of lighted nesting beaches in greater detail and presents solutions that include ratings and contact information for different commercial light sources. A tentative citation for the manual is:

> Witherington, B. E. and R. E. Martin. 1996. Understanding, assessing, and resolving light-pollution problems on sea turtle nesting beaches. Florida Marine Research Institute Technical Reports.

Those wishing to obtain a copy of this manual can contact:

Bureau of Protected Species Management, Department of Environmental Protection,
3900 Commonwealth Blvd., M.S. 245, Tallahassee, FL 32399 USA

CITES: AN UPDATE ON IMPLICATIONS FOR MARINE TURTLE CONSERVATION

Daniel W Wood, Manjula Tiwari, Kate Moran, and Sarah Bouchard

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

The Convention on International Trade of Endangered Species (CITES) was concluded 3 March 1973. The convention recognizes the importance of international cooperation in protecting wild fauna and flora from over-exploitation through international trade. It became effective 1 July 1975 upon ratification by 10 of the original 21 signatories. Parties to the convention now number 130.

Four appendices comprise the fundamental principles of CITES. Appendices I, II, and III offer various levels of international trade protection based on the permit form elaborated in Appendix IV. International trade of species listed on Appendix I is strictly prohibited, except in certain circumstances. Export of species on Appendix II is limited based on scientific evidence that evaluates the impact of international trade on the survival of the species' wild population. Finally, international trade of species listed on Appendix III must be controlled in conformity with the provisions of the treaty.

The criteria used to assign a species to an appendix were revised during the biennial meeting in Fort Lauderdale, Florida, USA, in November 1994. As written, the incumbent criteria had negative implications for long-lived, slow-growing, and migratory species (e.g. marine turtles) because they require quantitative population data. According to the previous criteria, a species was assigned to Appendix II only if threatened with extinction. The new criteria are more flexible. The numerical data were moved to an annex of definitions where they have a marginal role in the list decision. In addition, a new species now qualifies for listing on Appendix II if international trade will reduce the population to a level that cannot continue in perpetuity.

Guidelines for marine turtle ranching were also approved during the November 1994 meeting in Fort Lauderdale, Florida. These new guidelines are significant in that they require nations wanting to initiate a ranching program to provide a comprehensive biological assessment of the species' population, promote a national program for the conservation of the species, organize and implement a regional management plan, and establish measures to thwart the growth of illegal trade in the species and species products.

THE NESTING GREEN SEA TURTLES OF NORTH CAROLINA

Heather Miller Woodson[1], W. David Webster[1], and Leigh Creech[2]

[1] Department of Biological Sciences, University of North Carolina at Wilmington, Wilmington, NC 28403, USA
[2] Jekyll Island 4-H Center, Jekyll Island, GA 31520, USA

From 1980 to 1994, 34 green sea turtle (Chelonia mydas) nests have been confirmed on North Carolina beaches. Date laid, nest location, number of eggs per nest, nest treatment, emergence date, and incubation period were recorded for each nest. The average number of eggs per nest was 155.3. The average hatch rate was 83.0% and the average incubation was 62.5 days. Hatching success was significantly (one-way ANOVA, df=2, P=0.0361) greater for nests laid in June (90.7%) compared with those laid in August (52.7%). The various treatments had no significant (one-way ANOVA, df=3, P=0.4249) effect on hatching success. Four tagged individuals laid an average of two nests per season with a nesting interval averaging 17.75 days. The number of nests per year varied from zero to nine. Since North Carolina represents the northernmost range of the green sea turtle, this report of the nesting activity on North Carolina beaches is worthy of note.

INTRODUCTION

The waters off the North Carolina coast have been historically viewed as feeding grounds for the green sea turtle, Chelonia mydas (Hirth 1971). However, North Carolina has not been considered a component of the nesting range of this species and no attempt to quantify or evaluate all nesting records of Chelonia mydas on North Carolina beaches has been attempted.

From 1980 to 1994, 34 green sea turtle nests have been confirmed on North Carolina beaches by the North Carolina Wildlife Resources Commission. Nests were reported from nine different beaches, with the highest concentrations occurring at Camp Lejuene Marine Base (N=17), Bald Head Island (N=7), and Cape Hatteras National Seashore (N=3), the remaining six beaches with one nest each.

MATERIALS AND METHODS

Date laid, nest location, number of eggs per nest, nest treatment, emergence date, and incubation period were recorded for each nest. Four treatments were used - no treatment, relocated, wired in place, or relocated and wired. The placement of wire cages around the nest serves as protection against predators.

RESULTS AND DISCUSSION

The average number of eggs was 155.3 per nest. This number is higher than those reported for Ascension Island or Tortuguero, Costa Rica, which averaged 115.5 (Carr and Hirth, 1962) and 112.2 eggs per nest respectively (Bjorndal and Carr, 1989). The average hatch rate was 83.0% and the average incubation period was 62.5 days. Hatching success was also higher for North Carolina green turtle nests compared with Ascension Island or Tortuguero. Ascension Island hatch rates were 54% for natural nests, while Tortuguero reported average hatch rates of 50% for nests relocated to hatcheries (Carr and Hirth, 1962). Hatching success was significantly (one-way ANOVA, df=2, P=0.0361) greater for nests laid in June (90.7%) compared with those laid in August (52.7%). The various treatments had no significant (one-way ANOVA, df=3, P=0.4249) effect on hatching success. During this period, four tagged individuals each laid an average of two nests per season that is slightly higher than the figures reported for French Frigate Shoals, Hawaii, with an average of 1.8 nests per female per season (Balazs 1980). Nesting interval for tagged turtles (N=3) was 17.75 days, which is higher than the 10 to 15 day averages reported by Hirth (1971) and the 13.9 day interval reported for Ascension Island (Mortimer and Carr, 1987). The number of nests per year varied from zero to nine and is displayed in Figure 1. In Florida, the only other state in the continental United States with regular green sea turtle nesting, the number of Chelonia mydas nests per year has varied from 62 to 2,509 (Meylan et al. 1995) The nesting activity of three turtles tagged in 1994 is shown in Figure 2.

The number of green turtles nesting on North Carolina beaches cannot be accurately obtained from the data since few individuals have been tagged. At least three turtles are responsible for the nests as indicated by the 1994 tagged turtles. Natal beach fidelity has been shown for green sea turtles nesting in other locales and is expected here as well. Due to this fidelity, it is speculated that the nesting population of green sea turtles in North Carolina in the future may increase as hatchlings from these nests reach reproductive maturity.

Previously, Amelia Island, Florida, was thought to be the northern boundary for green sea turtle nesting. However, due to the regular nesting for the past 14 years on North Carolina beaches by the green sea turtle, North Carolina should be considered the northernmost limit of the nesting range of the green sea turtle. This report of the nesting activity of Chelonia mydas on North Carolina beaches is therefore worthy of note.

ACKNOWLEDGMENTS

Many thanks to Ruth Boettcher, NC Sea Turtle Coordinator, for all the advice and help with data collection. Thanks also to Dr. Dargon Frierson and Christopher Powell for help with statistical analysis and graphics.

LITERATURE CITED

Balazs, G.H. 1980. Synopsis of the biological data on the green turtle in the Hawaiian Islands. NOAA Tech.Mem. NOAA-TM-NMFS-SWFC-7.

Bjorndal, Karen A. and Archie Carr. 1989. Variation in clutch size and egg size in the green turtle nesting population at Tortuguero, Costa Rica. Herpetologica 45(2):181-189.

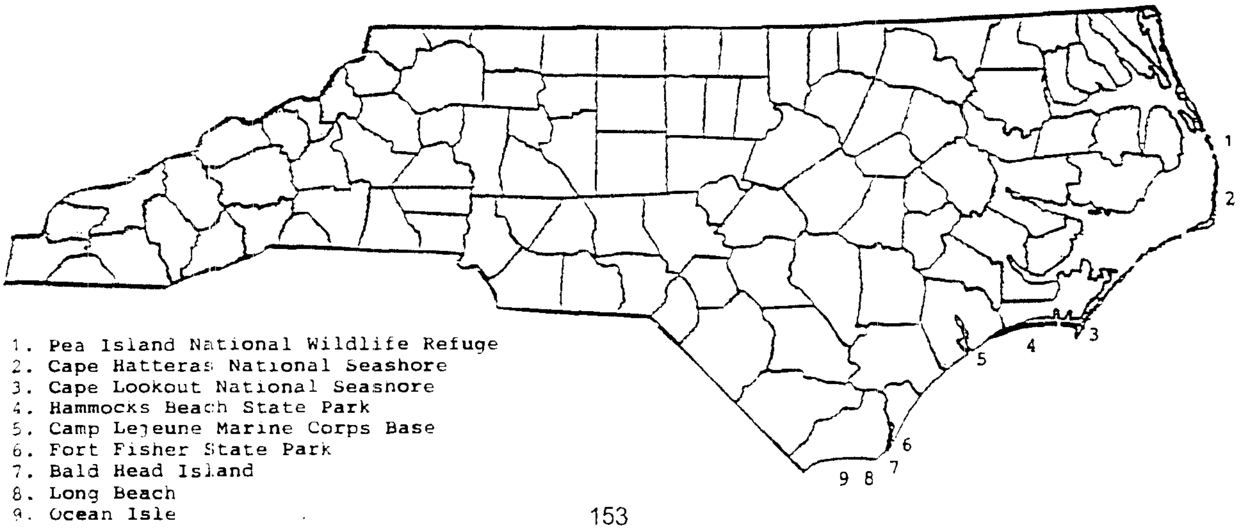
Carr, A. and H. Hirth. 1962. The ecology and migrations of sea turtles.5. Comparative features of isolated green turtle colonies. Am.Mus.Novit.,(2091):42 pp.

Hirth, H.F. 1971. Synopsis of the biological data on the green turtle, Chelonia mydas. FAO Fish Synop., (85):pag.var.

Mortimer, Jeanne A. and Archie Carr. 1987. Reproduction and migrations of the Ascension Island green turtle (Chelonia mydas). Copeia 1987(1):103-113.

Meylan, Anne; Barbara Schroeder and Andrea Mosier. 1995. Sea turtle nesting activity in the State of Florida. Florida Mar. Research Pub. 52: 51 pp.

FIGURE 1. Nesting sites of the green turtle in North Carolina.



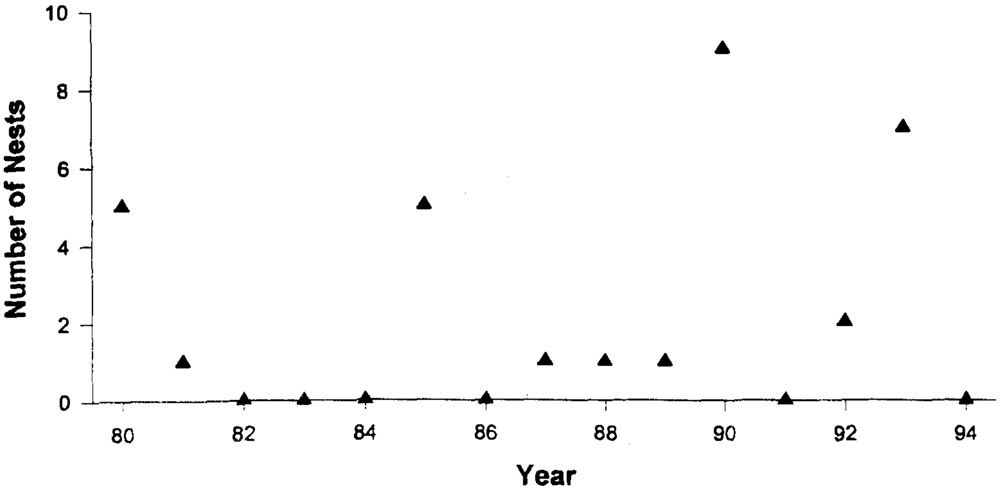


Figure 2. Number of *Chelonia mydas* Nests per year in N.C.

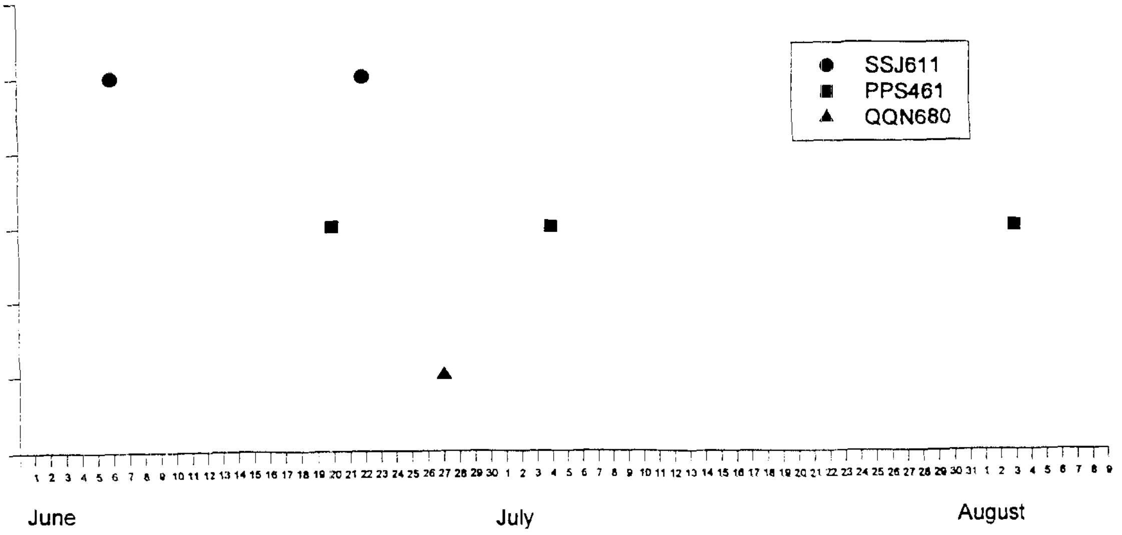


Figure 3. Nesting History of 3 *Chelonia mydas* individuals tagged in 1994

ON THE CONSEQUENCES OF TIMING, LOCATION AND FISH FOR HATCHLINGS LEAVING OPEN BEACH HATCHERIES

J. Wyneken[1], L. DeCarlo[1], L. Glenn[1], M. Salmon[1], D. Davidson[1], S. Weege[1], and L. Fisher[2]

[1]Department of Biological Sciences, Florida Atlantic University, 777 Glades Road, Boca Raton, Florida, 33431-0991 USA
[2] Broward County Department of Natural Resource Protection, Biological Resources Division, 218 S.W. 1st Avenue, Ft. Lauderdale, Florida, 33301, USA.

Hatcheries are among the most widely used of the conservation techniques for increasing hatchling sea turtle production. Although a number of studies have identified problems faced by nests in hatcheries (e.g., Stancyk, et al.; 1980, Stancyk 1982), there has been little attention paid to the aquatic risks hatchlings face upon leaving these sites (Gyuris, 1994; Wyneken, et al. 1994).

We studied the aquatic predators at hatcheries located along Hillsboro Beach, Florida, USA. We caught and identified predatory fish in the waters adjacent to open-beach hatcheries, documented predation, and tested alternative hatchery sites to reduce aquatic predation in northern Broward County, Florida. All hatcheries were located adjacent to sand bottom so bottom structure was simple.

Predatory fish in shallow waters (0.3-6 m deep) that had eaten hatchling turtles included Arius felis, Caranx crysos, C. hippos, Epinephelus morio, Lutjanus griseus, Megalops atlanticus, Sphyraena barracuda. The most common predators were the mangrove snapper (L. griseus) and the Tarpon (M. atlanticus).

In 1993, there was one hatchery in place that produced approximately 78,000 hatchlings between July and November. During a 5 night sampling period we captured 24 fish; 16 had eaten hatchlings. In 1994 and 1995, the nests were divided among three hatcheries which resulted in hatchling densities that were lower at each site than at the single hatchery in 1993. Predatory fish densities were monitored in front of these sites and at 2 control sites with ambient nest densities (approximately 90 nests/km).

We found that the proportion of predatory fish that had eaten hatchlings decreased when hatchling densities were lowered. But, more predators were caught in waters adjacent to hatcheries than at control sites. One control site that had very low fish densities in 1994 became a hatchery site in 1995. The density of predatory fish increased in 1995, but remained lower than at all the other hatchery sites. Although all hatcheries were located adjacent to sand bottom, the density of predatory fish was higher at hatcheries located near to areas with more complex structure (e.g., an inlet, rocks, jetties, or offshore hardbottom).

Hatchlings that were followed as they swam offshore from hatchery sites suffered higher levels of predation than hatchlings migrating away from control sites (Glenn, this volume).

Based upon the results of our monitoring we made several recommendations.

2. When hatcheries are necessary, multiple small hatcheries are better than one big one. This reduced the density of hatchlings entering the water at a given site and spreads the risk.

The location of a hatchery matters. Hatcheries should not be located near reefs or complex bottom structures.

3. Fish densities should be assessed before hatcheries are established. Some sites that host low densities of fish continue to have proportionately fewer predatory fish even after a hatchery is established. So potential hatchery sites should be monitored to determine if fish densities are low before placing the hatchery.

ACKNOWLEDGMENTS

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P. MacMillan allowed us access to sites. The study was funded by Broward County Department of Natural Resource Protection, Biological Resources Division.

LITERATURE

Glenn, L. (this volume) The consequences of human manipulation of the coastal environment on hatchling loggerhead sea turtles (Caretta caretta, L).

Gyuris, E. 1994. The rate of predation by fishes on hatchlings of the green turtle (Chelonia mydas). Coral Reefs 13: 137-144.

Stancyk, S. E., O. R. Talbert, and J. M. Dean. 1980. Nesting activity of the loggerhead turtle Caretta caretta in South Carolina, II. Protection of nests from raccoon predation by transplantation. Biol. Conserv. 18: 289-29

Stancyk, S. E. 1982. Non-human predators of sea turtles and their control. In: The Biology and Conservation of Sea Turtles. K. A. Bjorndal, ed. Smithsonian Institution Press. Washington, D.C. pp. 139-152.

Wyneken, J., M. Goff, and L. Glenn. 1994. The trials and tribulations of swimming in the near-shore environment. in Proceedings of the 14th Annual Symposium. on Sea Turtle Biology and Conservation. K. A. Bjorndal, A. B. Bolton, D. A. Johnson, and P. J. Elizar (Compilers). NOAA Tech. Mem. NMSF-SEFSC-351. 169-171

MAPPING SENSITIVE SEA TURTLE AREAS IN FLORIDA FOR OIL SPILL RESPONSE AND NATURAL RESOURCES MANAGEMENT

Scott Zengel[1], Anne Meylan[2], Henry Norris[2], Mark White[1], Lee Diveley[1], William Holton[1], and Karen Moody[2]

[1]Research Planning, Inc., 1200 Park Street, Columbia, SC 29202, USA
[2]Florida Marine Research Institute, Florida Department of Environmental Protection, 100 Eighth Avenue SE, St. Petersburg, FL 33701, USA

ABSTRACT

Sea turtles and their nests are commonly at risk from oil spills and spill response activities. Due to the diversity and abundance of marine turtles in Florida, sea turtles are a major component of the Environmental Sensitivity Index (ESI) atlases being produced for the Florida Department of Environmental Protection (FDEP) for oil spill response. Both nesting beaches and in-water distributions are depicted in the atlases. Shoreline habitats, submerged habitats, sea turtle species composition, seasonality, relative concentration, nesting beach survey boundaries, and source documentation are also included in the databases. In addition to spill applications, the ESI maps and associated GIS databases will be useful in the development of other mapping and database tools to be used for a variety of sea turtle research, management, and conservation efforts.

INTRODUCTION AND ESI BACKGROUND

Environmental Sensitivity Index (ESI) atlases are being developed for the coastal zone of Florida, for use in oil spill response and natural resources management. The hardcopy atlases and the digital geographic information system (GIS) databases contain three main components: shoreline habitats (shoreline types classified by oil spill sensitivity); biological resources (concentration areas and sensitive locations); and human-use resources (economic features, management areas, recreational resources, etc.). The biological component of the ESI atlases includes: geographic or spatial location in point or polygon format; species composition (common and scientific names); state and federal protected status (threatened/endangered); relative concentration (qualitative or numerical); seasonal presence/absence by month; and sensitive life history time-periods (nesting, hatching, etc.).

MARINE TURTLES AND THE FLORIDA ESI PROJECT

Marine turtles are an important part of the biological resources component of the Florida ESI atlases for two main reasons. First, the state contains an abundant and diverse sea turtle fauna. Second, marine turtle adults, juveniles, hatchlings, and eggs can be directly impacted by oil. For instance, nesting beaches were oiled during the 1993 Tampa Bay oil spill, and floating slicks also impacted turtles at sea. Turtles, especially nests and hatchlings, can also be indirectly impacted by spill response equipment and cleanup activities. The Florida ESI will assist FDEP's Bureau of Emergency Response, the U.S. Coast Guard, and other oil spill response and planning agencies in protecting marine turtle resources in the state.

As a part of the Florida ESI project, two types of sensitive marine turtle areas are being mapped, nesting beaches and "in-water" habitats (foraging, developmental, migratory areas, etc.). The nesting beach polygons correspond closely to beaches surveyed during the 1994 nesting season. In some cases, pre-1994 data, 1995 data, and local expert opinion also form the basis for nesting polygons. Specialized nesting beach look-up tables in the Florida ESI digital databases are designed to correspond closely to the FDEP Statewide Sea Turtle Nesting Database, and should allow frequent updating and manipulation of the digital nesting polygons and associated data.

Data on in-water distributions in Florida are extremely limited. Therefore, information in the Florida ESI atlases is based largely on expert opinion. The Florida ESI project represents an initial attempt to qualitatively compile information on turtle in-water concentrations on a state-wide basis. It is hoped that the information gathered for this project will serve as a base for gathering more detailed and quantitative data on marine turtle in-water distributions in Florida. Any further information on in-water concentrations in Florida would be greatly appreciated. Interested individuals should contact the authors at the Florida Marine Research Institute.

The Florida ESI atlases also contain additional information of interest to marine turtle researchers and resource managers. In addition to marine turtle distributions, the atlases and GIS databases also include: shoreline types (beach types, coastal structures, etc.); submerged habitats (seagrasses, oyster bars, coral and hardbottom reefs); nesting beach survey information (survey name, type of survey, survey locations and boundaries, etc.); conservation lands and waters (wildlife refuges, national parks, state parks, aquatic preserves, etc.); expert sources; and emergency contact information.

OTHER ESI APPLICATIONS

In addition to oil spill response and planning uses, the marine turtle and other data types listed above will assist with numerous marine turtle research and management goals. Data generated during the Florida ESI project, especially with other data sources, can be used to explore patterns of marine turtle occurrence and habitat use. The data can also be used to help resource managers evaluate the potential impacts of various fisheries, oil exploration, dredging, coastal development, and human recreational activities on marine turtles in the state. It is hoped that the ESI maps and associated GIS databases will be used to develop other specialized mapping and database tools for a variety of sea turtle research, management, and conservation efforts.

DATA SOURCES AND ACKNOWLEDGMENTS

Sources of marine turtle information for the Florida ESI atlases include various reports, publications, unpublished data, historical accounts, and personal knowledge from scientists and resource managers including personnel from: Florida Department of Environmental Protection; Florida Marine Research Institute; Florida Park Service; National Park Service; National Marine Fisheries Service; U. S. Fish and Wildlife Service; U. S. Army Corps of Engineers; University of Florida; University of Central Florida; Mote Marine Laboratory; Ecological Associates, Inc.; and various other government, private, and nonprofit organizations.

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GROWTH AND MATURITY IN LEATHERBACK SEA TURTLES, Dermochelys coriacea

George R. Zug[1] and James F. Parham[2]

[1]Department of Vertebrate Zoology, National Museum of Natural History, Washington DC 20560
[2]Department of Geology, University of Rhode Island, Kingston RI 02881

Sclerotic ossicles from the eyes of leatherback sea turtles show a pattern of concentric bony layers when examined histologically. This layering suggests cyclic growth. Assuming each bony layer represents 1-year of growth, skeletochronological analysis can estimate the ages of individual turtles.

Sclerotic ossicles from a small sample (n = 15) of subadults and adults, salvaged from a Peruvian fishing village dump, yield a range of age-estimates from 7 to 23 years (Table 1). Using a von Bertalanffy model with these age-estimates, a 1-year old wild-caught Samoan turtle, and one hatchling produce a growth curve with an asymptote of 148 cm CL. This curve predicts that eastern Pacific leatherbacks attain maturity on the average in 13-14 yr based on an average size (144 cm CL) of nesting eastern Pacific females. The curve also indicates that the growth of wild juveniles is similar to the growth rates observed in hatchlings raised in captivity.

TABLE 1. Summary of skeletochronological data for the Dermochelys sample.

CCL (cm)	Visible Bone Layers	Estimated Age (yr)	CCL (cm)	Visible Bone Layers	Estimated Age (yr)
22	0	<1			
43	1	1.0+			
132	10	22.7	146	7	14.4
135	9	13.0	147	5	11.8
137	7	8.0	147	4	20.7
137	5	16.3	150	3	19.4
139	4	6.9	151	4	21.0
140	4	12.3	156	8	15.5
142	6	13.4	159	6	14.8
160	5	18.6			

[or as a "single" column table, see below]

TABLE 2. Incubation periods of loggerhead turtle nests on Topsaid Island, NC, 1990-1995. Data presented as mean + standard deviation (sample size). All are significantly different.

CCL (cm)	Visible Bone Layers	Estimated Age (yr)
22	0	<1
43	1	1.0+
132	10	22.7
135	9	13.0
137	7	8.0
137	5	16.3
139	4	6.9
140	4	12.3
142	6	13.4
146	7	14.4
147	5	11.8
147	4	20.7
150	3	19.4
151	4	21.0
156	8	15.5
159	6	14.8
160	5	18.6