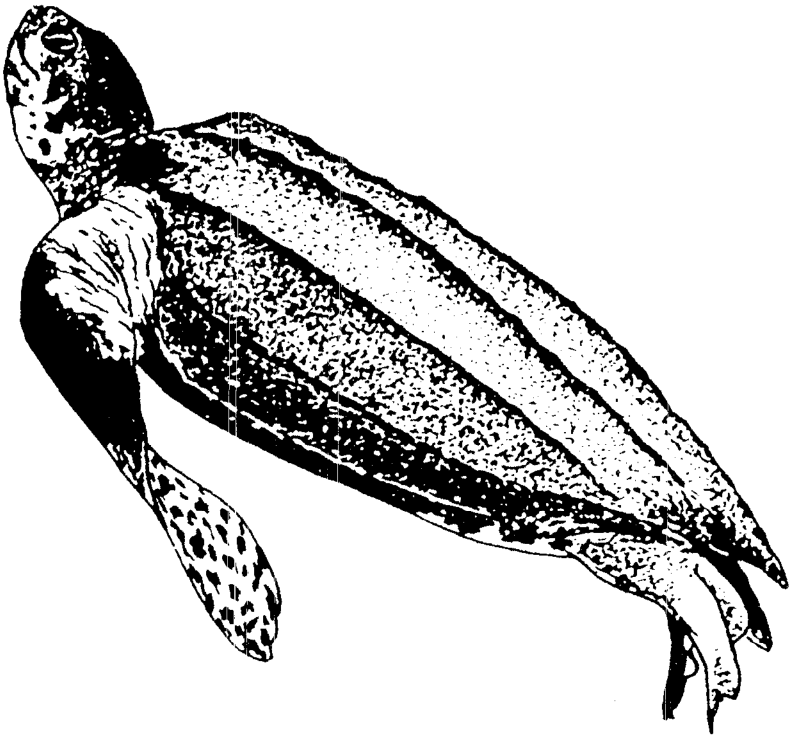
NOAA Technical Memorandum NMFS-SEFSC-387

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

20-25 February 1995
Hilton Head, South Carolina

Compilers:

John A. Keinath
Debra E. Barnard
John A. Musick
Barbara A. Bell



U.S. Department of Commerce
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Southeast Fisheries Science Center
75 Virginia Beach Drive
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U.S DEPARTMENT OF COMMERCE
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NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
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NATIONAL MARINE FISHERIES SERVICE
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NOTICE

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Preface

The 15th Annual Symposium on Sea Turtle Biology and Conservation, held in February 1995, was hosted by the Virginia Institute of Marine Science, College of William and Mary. The Symposium was convened at Hilton Head Island, South Carolina, USA. It brought together 602 participants representing 28 nations. Eighty-three papers and 78 posters were presented over the course of the meeting. The Symposium also hosted three special meetings of the I.U.C.N. Marine Turtle Specialist Group and its subcommittees, meetings of the Leatherback Working Group, the WATS III organizing committee, the Wildlife Rescue and Conservation Group, the U.S. Fish and Wildlife Service, and the U.S. Army Corps of Engineers. The Symposium was proceeded by two days of meetings by the WIDECAST Working Group, and by a special Latin American Sea Turtle Workshop. The Best Student Paper award was given to Matthew Goff (Florida Atlantic University) and the Best Student Poster award went to David Penick (Drexel University). As usual, the Virginia Institute of Marine Science again vanquished the University of Rhode Island in their Annual Gumbo Cookoff. The success of the Symposium was ensured by the efforts of the Symposium Secretary, Thelma Richardson, and Treasurer Ed Drane. In addition, the Symposium owes a large debt of gratitude to the following: VIMS Organizing Committee, J. A. Keinath, S. Moein, D. Barnard, W. Coles, J. Newton, and K. Davis; VIMS Art Department, W. Cohen, S. Stein, S. Motley, and E. Horne; International Grants Committee, K. Eckert; U.S. Student Grants and Student Awards, D. K. Dodd; Auction Committee, J. Logothetis and S. Krebs; Audio-Visual Committee, J. Serino, C. Hope, A. Foley; Nominations Committee, P. Pritchard; Time and Place Committee, J. Wyneken; Vendor Room, T. McFarland; Trivia Quiz, B. Witherington. Thanks also to the National Marine Fisheries Service for providing xeroxing and mailing services. My sincere apologies to the many other unnamed volunteers whose timely contributions insured the success of the Symposium.

JOHN A. MUSICK, School of Marine Science, Virginia Institute of Marine Science, College of William and Mary, Gloucester Point, Virginia 23062, USA.

Armageddon and the Endangered Species Act

15th Annual Sea Turtle Symposium Presidential Address
February 23, 1995 <<< >>> Hilton Head Island, South Carolina
J.A. Musick

Fourteen years ago a small group of sea turtle biologists and conservationists met in a chapel in Jacksonville, Florida for the first annual Sea turtle workshop. That modest beginning has evolved into the largest annual meeting in the world devoted solely to sea turtle research and conservation. The most highly respected sea turtle workers from nearly 30 different nations now gather each year to share new findings and discuss old problems.

Sea turtle science has advanced substantially in the last 14 years. Genetic techniques have been developed to define breeding populations, estimate how long populations have been isolated, and even to reconstruct phylogeny. Modern aging techniques have provided accurate estimates of growth rates and age-at-maturity; from this information, population models have been developed to predict the demographic fate of turtle populations under differing levels of mortality. Thus, the impact of incidental take of sea turtles by various fisheries may be assessed.

Species are vulnerable to extinction because of two principal factors: (1) life history characteristics such as slow growth, late maturity, and low fecundity render species particularly vulnerable to overexploitation. Such K-selected species are prone to population collapse at relatively low levels of mortality. Cetaceans and large sharks are good examples. (2) some species have habitat requirements that are specialized, localized, or just vulnerable to destruction. Small fishes like the desert pupfishes in the Southwestern U.S. are an example.

Unfortunately, sea turtles are vulnerable on both counts. They are extremely K-selected, and their specialized nesting beach habitats are prime targets for destruction through commercial development. Regardless, sea turtle conservation has advanced much during the last 14 years. Individual nesting beaches in many countries are being patrolled and the eggs and hatchlings are being protected. Problems such as disorientation of hatchlings by beach lighting have been recognized, and in part solved. In some instances, conservation techniques first publicly aired at past Sea Turtle Symposia have been adopted and successfully used worldwide. Much remains to be done.

Sea turtle eggs are still collected illegally in many places for human consumption. Even here in the United States, where egg collecting has been stopped, smuggling of sea turtle eggs into the country for the ethnic restaurant trade still continues. Many advances have been made to reduce the incidental mortality of sea turtles in various commercial fisheries. Fourteen years ago conservationists were endeavoring to convince the federal government that shrimp boats were killing large numbers of sea turtles. Now, turtle excluder devices are mandated in U.S. waters and are being used increasingly in other areas.

Yet, the high number of Kemp's Ridley mortalities in the gulf of Mexico last year are a strong reminder that regulation needs strong enforcement. Education is preferable to enforcement, but may prove to be fruitless when faced with the incorrigible intransigence of some (certainly not all) members of the fishing industry. Regulation is the legimate responsibility of government. Regulation attempts to ensure that individuals, businesses, or governments operate in a manner that protects the public welfare. Protection of endangered species and the maintenance of biodiversity in healthy, natural ecosystems are not only in the public welfare, they are the primary means by which the biotic birthright of future generations is protected.

Even with all that has been accomplished to understand the biology of sea turtles, and to develop effective conservation programs based in science, all may be lost in the next several months. Recent political changes in the United States Congress have placed in power some who view endangered species solely as an impediment to economic development. These people would attempt to undermine any environmental regulations that stand in the way of profit margins. The endangered species act is one of their prime targets. The situation is critical. The problem has arisen in part because conservationists and educators have failed to effectively convey to the public and some legislators that irreversible destruction of ecosystems or extinction of species to serve economic interests is basically unethical. The arrogant ideological reasoning that focuses on short-term economic considerations at the expense of longterm--or even permanent--environmental perturbations is shortsighted and can only lead to disaster in the future.

The noted sociologist Jackson Tobey has observed that all human babies are born barbarians. They must be taught a moral code of conduct in order that they interact with their fellow humans in a humane and productive way. Without such a moral code of conduct, societies are dysfunctional. We need to teach an environmental ethic that complements the basic moral system that is the foundation for functional societies. Conservation of biodiversity should not have to be justified by arguments that certain vulnerable animals are large, cute, or cuddly, or that certain plants might harbor potentially valuable pharmaceuticals. Rather, conservation of biodiversity is a social responsibility based on the proposition that it is morally reprehensible to damage the Earth's ecosystems, and the organisms that live therein, so that the biotic richness available to future generations is substantially and permanently reduced.

Extinction is obviously irreversible. There will be no way for future generations to recover what is being destroyed for short-term economic gain today.

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MARINE TURTLE (<u>CARETTA</u> <u>CARETTA</u>, <u>CHELONIA</u> <u>MYDAS</u>) NESTING ON FLORIDA'S LOWER WEST COAST - COLLIER COUNTY, 1994

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Collier County is located on the southwest coast of Florida. Its coastline extends approximately 58 km from the Lee County line to Cape Romano. Southeast of Cape Romano is the maze of mangrove islands and tidal rivers known as the Ten Thousand Islands. Ranging in length from 200 m to slightly over 1 km, the beaches on many of these islands support sea turtle nesting.

During the 1960s and 70s Charles LeBuff and his co-workers compiled considerable data regarding loggerhead nesting in southwest Florida. With the exception of the Ten Thousand Islands, surveys were conducted at various times on most of the beaches in Collier County. In 1994 an opportunity arose to examine nesting activity on all of the County's beaches with the exception of some of the isolated beaches in the Ten Thousand Islands. This survey provided, for the first time, an overview of loggerhead and, surprisingly, green turtle activity on both urban and non-urban beaches in 1994 (Fig 1).

The northern-most urban unit begins at the Lee/Collier County line. Table 1 shows turtle activity levels in these areas. Typically, nesting was highest on those parts of the urban units which were least developed and had the most extensive dune systems. In the Marco unit, activity was lower on the less developed portion of the beach. This was probably due to the presence of a low-laying accretional island that fronts the less developed portions of the northern end of the Marco. In 1994, most of the reported beach lighting violations occurred on Marco. These violations are reflected by the fact that 23 of the 27 hatchling disorientations recorded were in this unit.

Table 2 presents a summary of sea turtle activity on non-urban beaches. The North and South Key Island beaches were surveyed daily. Nests were caged on both beaches; however, only the South Key Island beach was patrolled at night hence the difference in depredation rates. Records for both Seaoat and Coconut Islands are based on a one-time survey of depredated nests. This was done before the end of the nesting season so the figures are low. Kice Island, Morgan Beach and Cape Romano Island were surveyed twice a week. In the Ten Thousand Islands 8 islands were checked for nests and false crawls twice weekly. Approximately half of the nests were caged. Without caging nest destruction by raccoons would have approached 100%. The U. S. Fish and Wildlife Service has begun a project to assess predator control measures.

Green turtle nesting has been reported in this region periodically, but never verified. Although green turtles have likely nested in the County before, it was not until 1994 when 9 nests were documented that nesting was confirmed (Table 3).

A total of 1,206 loggerhead nests were documented (Table 4). As a number of the beaches were not surveyed every day, this figure is conservative. The mean inclubation period for all nests was 66 days while the clutch size averaged 102 eggs. Aside from the non-urban beaches which could not be checked daily, there are at least 8 additional islands in the Ten Thousand Islands which contain suitable nesting beaches. Depredated nests have been observed on some of these islands so the total number of nests in this region is higher than the 175 documented during the survey.

The fact that all the available beaches in the County are utilized to some extent demonstrates the importance of managing these areas with sea turtles in mind. While nesting activity in this region does not approach east coast levels, that sea turtles nest here in greater numbers than we suspect was previously thought, is noteworthy. Depredation levels on portions of some of the urban beaches suggests that site specific predator control measures would be appropriate.

Table 1. Loggerhead sea turtle nesting on urban beaches-1994.

	Beach Length (km)	Nests	False Crawls	% Nests Depredated	Hatching %	Total Live Hatchlings
County Line - Wiggins Pass	5.0	102	97	27	76	7.622
Wiggins Pass - Clam Pass	5.9	153	122	38	50	4,374
Clam Pass - Doctor's Pass	4.7	153	107	17	85	13,252
Doctor's Pass - Gordon Pass	8.0	58	120	3	76	4,135
Marco Island	8.4	61	100	3	74	4,444

Table 2. Loggerhead sea turtle activity on non-urban beaches.

	Beach Length (km)	Nests	False Crawls	% Nests Depredated	Hatching %	Total Live Hatchlings
North Key Island	4.0	58	87	55	52	1,960
South Key Island	5.9	167	206	11	81	12,055
Seaoat Island	1.4	48	na[1]	100	na	na
Coconut Island	.2	11	na	100	na	na
Kice Island	2.0	60	na	55	na	na
Morgan Beach	1.4	145	na	48	na	na
Cape Romano Island	1.2	15	na	48	na	na
Ten Thousand Islands[2]	4.4	175	75	56	71	2,956

[1] No data.
[2] Totals from beaches on eight islands.

Table 3. Green sea turtle nesting in Collier County-1994.

	Beach Length (km)	Nests	Hatching %	Total Live Hatchlings
Doctor's Pass	8.0	1	87	122
South Key Island	5.9	1	98	132
Turtle Key[1]	.12	7	0	0

[1] Located in Ten Thousand Islands.

Table 4. Total loggerhead sea turtle nesting in Collier County-1994.

	Urban Beaches	Non-urban Beaches	Totals
Beach Length (km)	32	20.5	52.5
Nests	527	679	1,206
Total Live Hatchlings	33,827	16,971[1]	50,798

[1] Includes data from North and South Key Island, and Ten Thousand Islands, no hatchling counts done on other non-urban beaches.

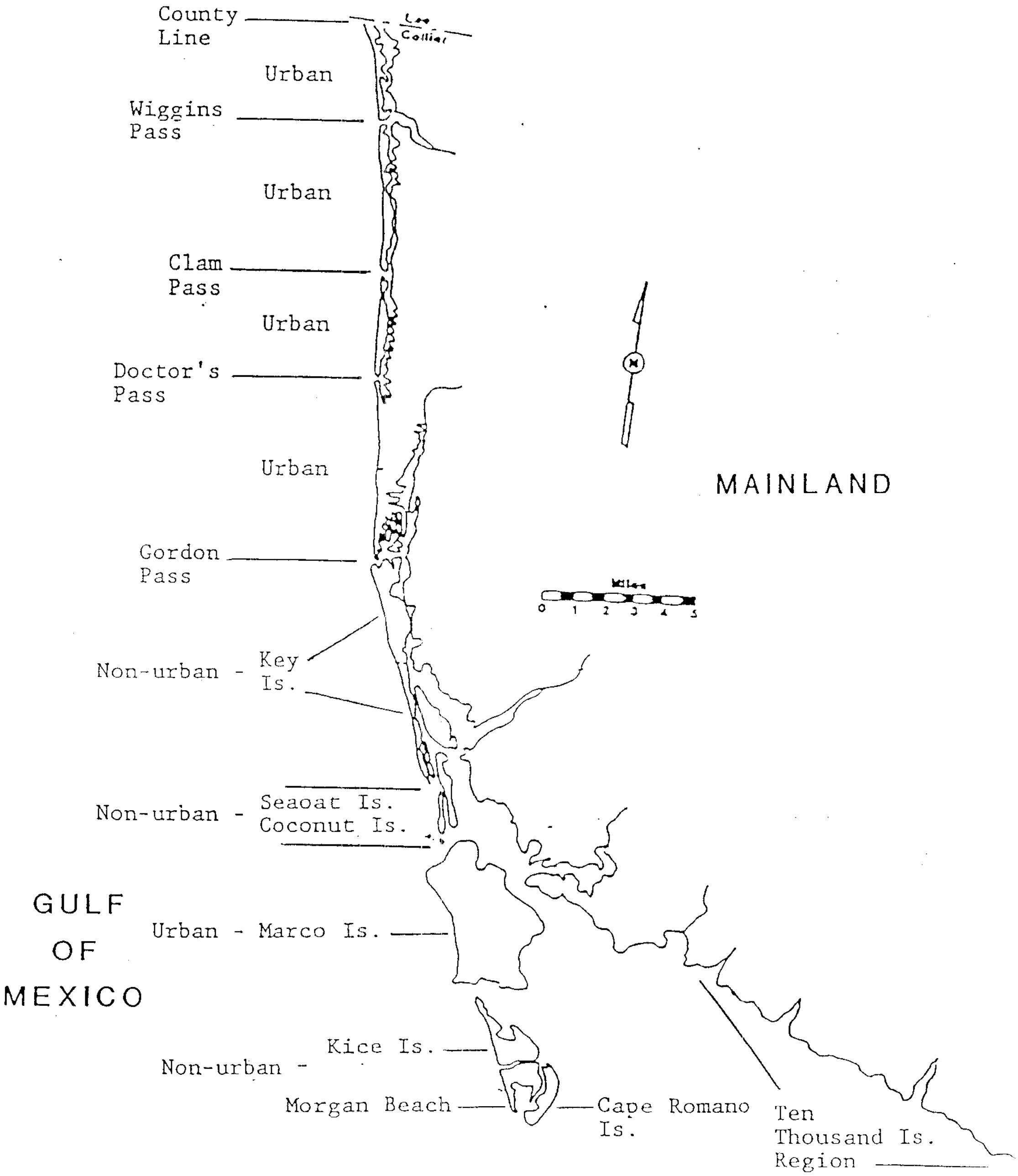

Figure 1. Urban and non-urban beaches - Collier County, Florida.

ELISA TEST FOR THE DETECTION OF ANTI-BLOOD FLUKE IMMUNOGLOBULINS IN HAWAIIAN GREEN TURTLES

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An enzyme-linked immunosorbent assay (ELISA) utilizing the surface glycocalyx crude antigen of adult blood trematodes *Learedius learedi*, *Hapalotrema dorsopora*, and *Carettacola hawaiiensis* was developed. This ELISA can detect circulating antibodies (Ab) in Hawaiian green turtles (*Chelonia mydas*) naturally infected with these parasites, and with or without green turtle fibropapillomas (GTFP). A concentration of 10.0 µg/ml of antigen was optimal in terms of test specificity and sensitivity. A direct ELISA with anti-reptilian/amphibian phosphatase-labeled IgG identified *C. mydas* Ab at a dilution of 1/12,800. Utilizing indirect ELISA, it was possible to detect Ab to blood flukes at a dilution of 1/3,200 in the plasma of the clinically infected turtle. Low absorbance values (< 0.074) of nonspecific background were observed. The gross lesions and histopathology in this turtle were typical for cardiovascular spirorchidiasis. Forty-seven of 59 (80%) samples, originating from five sites, gave a positive reaction with the pooled blood fluke antigen; six of the 47 (13%) specimens gave significantly ($P < 0.001$) higher absorbance values, and five of them originated from the same location. All 12 (20%) ELISA-negative turtles originated from another site; and the absorbance values of the animals from this location were significantly lower ($P < 0.015$) when compared with the other 4 sites. No significant relationship was found between the size of turtles and the degree of GTFP severity. The proposed assay is fast, has the feature of visual scoring, and can be used for determination of exposure of *C. mydas* to the spirorchid trematodes in field situations.

A DESCRIPTION OF THE CENTRAL AMERICAN SHRIMP FISHERIES WITH ESTIMATES OF INCIDENTAL CAPTURE AND MORTALITY OF SEA TURTLES.

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Section 609, Public Law (P.L.) 101-162, imposes and embargo on shrimp imports into the United States by nations not meeting or exceeding U.S. standards of sea turtle protection. However, these standards are unknown for Central America. Henwood, Stuntz and Thompson (unpubl.), provide gross estimates of turtle catch and mortality rates by foreign nations based on metric tons of shrimp exported, assuming turtle catch rates comparable to those in U.S. waters. Due to the different nature of the species of turtle sea turtle mostly affected by trawling activities in the Pacific, the olive ridley (*Lepidochelys olivacea*), this assumption underestimates true turtle CPUE rates in Pacific Central America.

My principal objective is to describe the Central American shrimp fisheries and provide reliable estimates of turtle catch and mortality rates in these waters.

The shrimping industry initiated operations throughout Central America during the mid 1950's. Vessels are "florida" type, with hull lengths ranging from 55 to 84 feet. On the Pacific, vessels pull one standard 50 to 65 ft. headrope length two seam balloon trawl from each outrigger, or a standard flat net. Target species in the Pacific include white (Penaeus occidentalis, P. stylirostris) and sea bobs (Trachypenaeus sp. and Xiphopenaeus sp.) in shallow aters (5-10 fathoms) and pink (P. brevirostris) and brown (P. californiensis) in deeper waters (30-40 fathoms). The shrimp season is open eyar round. Vessels used on the Caribbean are similar to the ones used on the Pacific, except for the use of twin nets on each outrigger. Target species in the Caribbean include pink (P. duorarum), at depths from 100 to 275 feet, white (P. schmitti), from shallow waters to 50 feet, and brown (P. aztecus) from 30 to 120 feet (Morales, 1994). Occasionally small species are included such as Xiphopenaeus sp. Each Caribbean country has different trawling seasons.

Belize Fishery. Since 1985 to 1993, 10 Honduran vessels have operated. The open season for shrimp trawling is from mid-August to mid-April. Since 1989 the seaon has been closed from 1 December to 15 January (RDA, 1991). During a study in 1990 carried out by RDA regarding by-catch in Belize, 6 sea turtles were caught during 98 nights and 188 drags of sampling. Four were loggerheads (Caretta caretta) and 2 were green (Chelonia mydas). Estimated turtle CPUE for Belize = 0.0057 turtles/hour. Since 1994 the fleet has been reduced to 5 vessels.

El Salvador Fishery. Approximately 60 to 70 vessels operate per year on the Pacific coast. Major fishing ports include Acajutla, La Union and La Libertad. Table 1 shows the results of turtle by-catch reports in El Salvador. Cruises 2 to 4 were done under research conditions using a TED on one outrigger by CENDEPESCA (1993). Since the results of Vasquez (1990) were not biased by the use of a TED, his results will be considered the most reliable for El Salvador (turtle CPUE in El Salvador = 0.0511 turtles/hr, 66% of which are olive ridleys, and 33% Pacific greens. (TABLE 2)).

Nicaragua. Nicaragua's Caribbean coast is more than 500 km long and has a continental shelf with an area of 55,000 km^2. In 1993, 40 vessels operated along the Caribbean, 21 of these wre foreign vessels. From April to June the season is closed. Major Caribbean fishing ports include Bluefields and Puerto Cabezas. The Pacific coast is 350 km long with an extension of about 30,000 km^2. Twenty-one vessels operated along the Pacific in 1993, 2 of which were foreign. Major Pacific fishing ports are San Juan del Sur and Corinto.

Honduras. Trawling grounds in Honduras range along the Caribbean cost, at depths ranging from 30 to 275 feet. Vessels add up to 89. The open season is from July to February, and is closed from March to June and from November 20 to December 22. Apparently, turtle catch in Honduras is very low (TABLE 3), with an average turtle CPUE = 0.0007 turtles/hr.

Guatemala. In Guatemala shrimping activity is carried out along the Pacific continental shelf, in wtares that are 10 to 100 meters deep and within three miles of the coast. There are currently 50 vessels operating. No turtle data available.

Costa Rica. An average 55 vessels operate along Costa Rica's Pacific coast. When only the pink fishery is evaluated (TABLE 4) turtle CPUE rages are very high; Gamboa, unpubl. (0.1395 turtles/hr); Arauz, 1944 (0.2164 turtles/hr); and Rice 1973 (0.787 turtles/hr)). For the case of the white fishery turtle CPUE is lower (Gamboa, unpubl. (0.04 turtles/hr), yet still considerably higher than the US standard (0.0076 turtles/100ft net hour, Henwood, et al., unpubl.). In the pink fishery, most of the turtles caught (TABLE 5) were olive ridley's; 86% (Gamboa, unpubl.), 100% (Arauz, 1944) and 100% (Rice, 1973). On the other hand, in the white fishery 100% of the turtles (Gamboa, unpubl.) were Pacific greens.

Extrapolations assumed to estimate turtle capture and mortality (TABLE 6).

Belize: 5.25 hr/drag, 2.5 drags/night, 25 days fishing/month/vessel. 10 vessels during the fall and 6 operating during the winter. Season closed from Dec 1 to Jan 15.
El Salvador: 5 hr drag, 4 drags/day, 25 days fishing/month/vessel. Season year round.
Honduras: 5.5 hr/drag, 4 drags/day, 30 days/month/vessel. SEason open 7 months.
Costa Rica: 5.5 hr/drag, 2.5 drags/day, 25 days fishing/month/vessel. Equal number of vessels operating in each fishery (white and pink).
*Constant turtle CPUE rates are assumed throughout the year for each country.

Total estimated turtle catch for Pacific Central America is 60,042, while total estimated turtle catch for Caribbean Central American is 514. Mortality rates are not estimated.

Conclusions. While turtle CPUE rates along Caribbean Central America are slightly lower than the US, they are extremely high along the Pacific coast of Central America. Olive ridleys nest massively on certain beaches in congregations known as "arribadas", which may involve several hundreds of thousands of turtles. Two of these beaches are in Costa Rica (Ostional and Nancite), and two are in Nicaraguan (La Flor and Chacocente). Solitary nesters are reported throughout the sandy coasts of El Salvador and Guatemala as well. Olive ridleys are carnivorous, and the foraging grounds of these numerous populations overlaps with shrimp trawling grounds. Thus the high turtle CPUE. Olive ridleys are mostly subject to being captured when fishing for pink shrimp (*P. brevirostris*), at depths of 30 to 45 fathoms. Pacific greens are captured when fishing for white shrimp (*P. occidentalis*) in shallow waters (5-15 fathoms).

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TABLE 1 - El Salvador, Turtle Catch Data

	Date	# drags	hr/drag	Depth fathoms	#turtles	CPUE turtles/hr
Cruise 1*	Jul,1990	47	5	8-37	12	0.0511
Cruise 2**	Sept,92	57	3.8	18.5	22	0.1016
Cruise 3**	Early Oct,92	57	3.7	16.1	8	0.03791
Cruise 4**	Late Oct,92	57	4	3.8	1	0.0044
Cruise 5**	Dec,92	57	3.8	3.8	0	0

*Vasquez, 1990
**Centro de Desarrollo Pesquero, El Salvador, 1993

TABLE 2 - Turtle Catch Analysis (Vasquez, 1990)

Total Catch	L.o.Alive	L.o.Dead	L.o%	C.a. Alive	C.a.Dead	% C.a.	Mortality%
12	4	4	66.6	3	3	33.3	58.3

TABLE 3 - Honduras Turtle Catch Data (Morales, 1994)

		drags	xhr/drag	Turtles	CPUE turtles
Cruise 1	Set 92	100	5.5	0	0
Cruise 2	October 1993	43	5.5	0	0
Cruise 3	Jan-Feb, 94	48	5.5	0	0
Cruise 4	Nov-Dic,94	88	5.5	1	0.002

Average CPUE turtles = 0.0007
Note: one live juvenile green turtle

TABLE 4 - Costa Rica Turtle Catch Analysis

	Sample	hr/drag	fathoms	dy/drag	CPUE shrimp lbs/d/v	CPUE fish lbs/d/v	Total Turtles	CPUE turtles/hr
Gamboa,92-93								
Pink fishery	48 drags (4exp)	6.6	36.5	1.8	612.7	98.1	44	0.1395
White fishery	36 drags (3exp)	4.6	10	3.3	387	682.5	6	0.04
Arauz,1994 Pink fishery	11 drags (1exp)	6.3	38.3	1.8	-	-	15	0.2164
Rice, 1973 Pink fishery	8 drags (1exp)	6	30	1.8	-	-	34	0.787
Power and Moertel,1980 Pink and White	28 drags (4exp)	5.5	3-30	-	-	-	18	0.0268

TABLE 5 - Species Composition and Mortality

	Total Turtles	L.o.Alive	L.o.Dead	C.a. Alive	C.a.Dead	% L.o.	%C.a.	%M
Gamboa, 92-93								
Pink fishery	44	28	10	3	3	86.43	13.6	23.7
White fishery	6	-	-	3	3	-	100	50
Arauz, 1994 Pink fishery	15	6	9	-	-	100	-	60
Rice, 1973 Pink fishery	34	25	9	-	-	100	-	26.4
Power and Moertel 1980 Pink and white	18	7	4	2	5	61	38.8	50

TABLE 6 - Estimated Turtle Catch for Central America, 1993

Country	#Vessels	Total CPUE turtles/hr	Turtles/year
Belize	10	0.0057	87
Guaemala	58	?	(10000)
El Salvador	70	0.0511	21280
Honduras	89	0.0007	287.5
Nicaragua (Caribbean)	40	?	(140)
Nicaragua (Pacific)	21	?	(8000)
Costa Rica	55	0.0899	20762

Total Estimated Turtle Catch for Pacific Central America = 60042
Total Estimated Turtle Catch for Caribbean Central America = 514

Note: Figures in parenthesis are estimated

A VIEW OF MORTALITY

Linda Armstrong[1], Carol Ruckdeschel[2]

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A graphic illustration of some of the 1300 dead sea turtles that have washed ashore on the 17 mile beach of Cumberland Island, Georgia during the last 16 years. No change in the stranding rate has occurred despite the use of Turtle Excluder Devices (TEDsy. The present National Marine Fisheries Service (NMFS) criteria for closing a zone to commercial fishing activities will result in no effective action and we suggest writing Congressmen and urging that they see that the Department of Commerce, NMFS, establishes the maximum allowable incidental "take of sea turtles at two turtles (or less) per zone, per week. When that quota is exceeded the Department of Commerce should temporarily close the zone to commercial net fisheries for a two week period. Buy only turtle-safe shrimp.

MARINE TURTLE NESTING AT PATRICK AIR FORCE BASE, FLORIDA, IN 1994.

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The summer of 1994 was the eighth consecutive season in which U.C.F. Marine Turtle Research studied the levels of nesting activity, distribution and reproductive success over the 7 km stretch of beach at Patrick Air Force Base, Florida (PAFB).

Surveys were conducted 7 days a week from 6 May 1994 through 31 August 1994. To assess clutch mortality and reproductive success within the study area, a representative sample of nests was marked and later inventoried. Survey results of nest production at PAFB in previous years are shown in Figures 1 and 2. Loggerhead nest production was above average again in 1994, and Florida green turtle nests exceeded all previously recorded totals by 2 nests.

The PAFB landscape is characterized by a predominately flat beach with several short sections of rip-rap. We reported last year that a beach nourishment project from the winter of 1992/1993 had resulted in a 2-3 meter vertical scarp over approximately 2 km of our study site, from our 1.5 km to 3.4 km. While this sand-silt-clay-shell scarp drastically changed nesting success rates and distribution, nest production and reproductive success seemed unaffected, largely due to the presence of good nesting beach both north and south of this area. It was hard to make any definite conclusions or predictions for the future based on this one year of data.

When we began our beach work in 1994 we found that, due to its composition, the 2-3 meter vertical scarp was still in place; the 3rd week of May brought several days of northeast winds, large waves and high tides which removed sand from much of the beach, creating an even sharper edge to the base of the nourishment berm and carving a 1 meter scarp along the good nesting beach at the southern 1.5 km of the study site. To the north of the nourished area there remained approximately 2.5 km of good beach; the slope became slightly steeper, but remained unaffected by scarp.

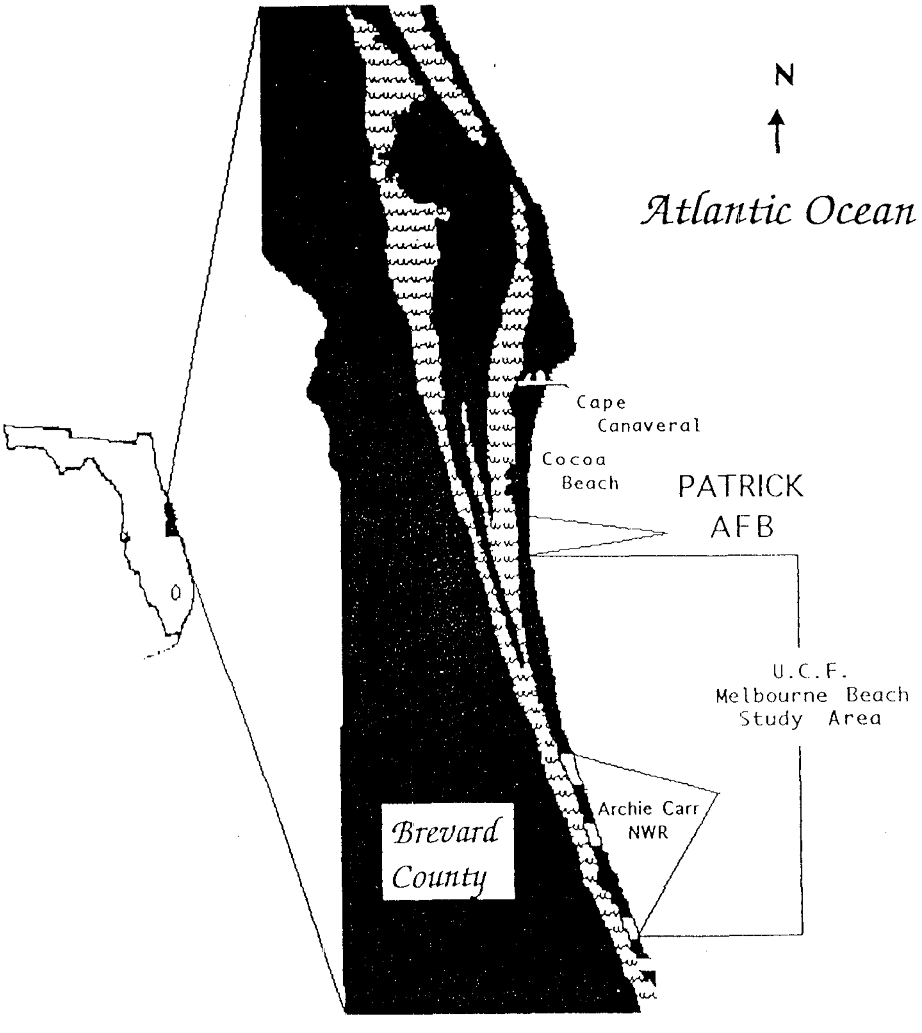
Figure 3 summarizes the number of loggerhead emergences and the percent of nesting success over the 7 km beach. Scarp formation affected the beach from 0-3.4 km, where false-crawls exceeded nests in all but 2 sections of beach. This was also seen in 1993, but in 1992, before the nourishment project, 5 km out of 7 km had nesting success ratios greater than 50%. Each encounter with the nourishment berm by nesting females was documented; results in Figure 4 indicate that this man-made wall posed quite a deterrant to nesting turtles within this area. The displacement phenomenon is evident in Figure 6, where the distribution of nesting for the last eight years is shown. The similarity in the shapes of the distributions for 1993 and 1994 is quite remarkable and they are in marked contrast to those of previous years.

Florida green turtles adhere to a biennial pattern of "highs" and "lows", and while 1994 constituted a "high" year, and we did record 2 nests more than ever before, there might have been reason to expect a higher nest count. First of all, it has become apparent that virtually all green turtle nests at PAFB are found in the southern half of the study site. This is reflected in 1992 (20 out of 22 nests) and again in 1994 (22 out of 24 nests, with one of the remaining two just a few meters north of the mid-point). Coincidentally, this is exactly where the nourishment area and newly formed scarp occur. Secondly, while it would not be appropriate to expect the numbers found further south, the Archie Carr NWR showed an increase of 61% in Florida green turtle nesting, leaving us to wonder what might have occurred in the absence of the nourishment and scarp formation.

We have said many times that "high rates of reproductive success have become the hallmark of the nesting colony at PAFB" because these rates have been uniformly higher (Figure 6) than those seen on nearby beaches. Due to formation of a salient scarp over a greater extent of the nourished beach in 1994, most of the nests were deposited lower on the beach, seaward of the scarp (Figure 4), where they were more suceptible to inundation. The lowered success in this part of the beach reduced the overall reproductive success to 60.45%, down from 80% in 1993. (Similarly, Florida green turtle reproductive success was reduced from 68% in 1992, to 53% in 1994). To reiterate, in 1993 the interaction of loggerheads with the nourishment project caused changes in nesting success rates and the overall distribution of nesting, but there was no apparent effect on reproductive success or total nest production. In 1994, nesting success and distribution were again affected and, more importantly, the one thing that elevated the relative importance of the PAFB beach and set it apart from others of similar size and nesting density---reproductive success---clearly declined for both loggerheads and Florida green turtles. Only total nest production remained unaffected.

In the recent report entitled "Sea Turtle Nesting Activity in the State of Florida, 1979-1992" by Meylan, Schroeder and Mosier, there is a 23-page table that documents, among other things, loggerhead nest production on over 140 beaches in 26 counties and provides some real perspective on the relative importance of PAFB as a loggerhead nesting beach. Only five of those 140 beaches support greater loggerhead nest production than Patrick, and one of those (Singer Island) is smaller and supports less nesting activity overall. Only the "Big Four" (Archie Carr NWR, Hobe Sound NWR, Jupiter Island, and Juno/Jupiter Beach) are clearly in a class by themselves and at the top level. Furthermore, there are only about five other beaches in the "second tier" with PAFB, with densities between 200-350 nests/km/season, making it even more relevent as a key element in the system of Southeast beaches that constitute the primary nesting ground for Western Atlantic loggerhead turtles.

Thanks to Patrick Air Force Base for their continued support of this project. Thanks to Doc, who still makes being here better than being anywhere else.



Patrick Air Force Base in relation to Brevard County and the State of Florida.

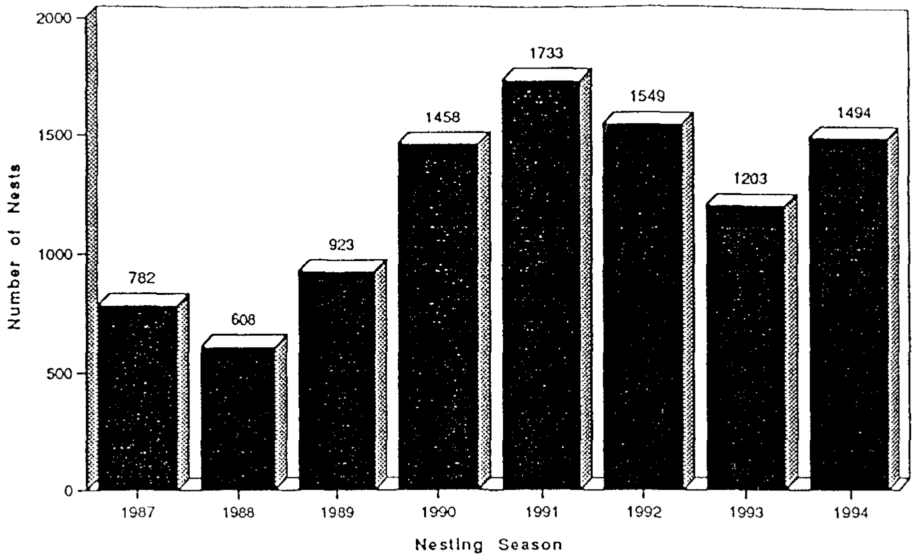


Figure 1. Loggerhead nest totals by year at Patrick Air Force Base, Florida, 1987 through 1994.

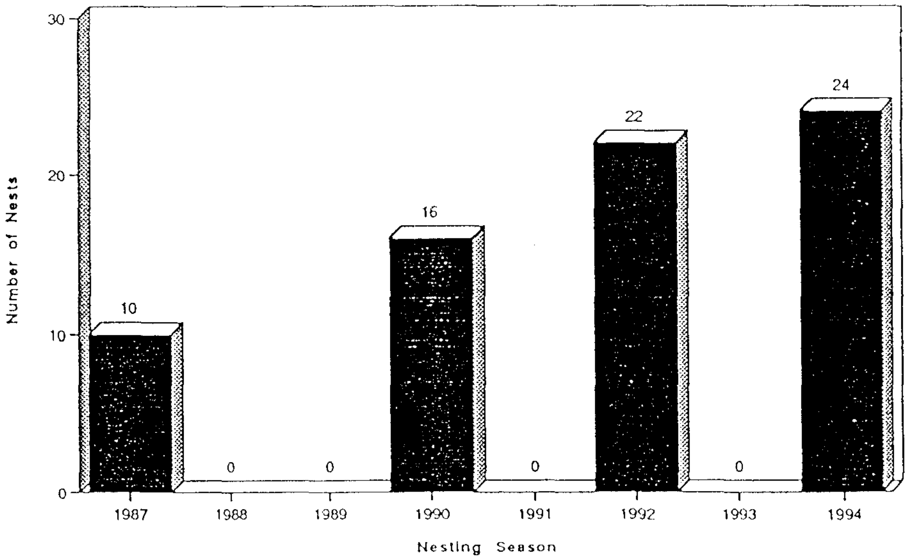


Figure 2. Florida green turtle nest totals by year at Patrick Air Force Base, Florida, 1987 through 1994.

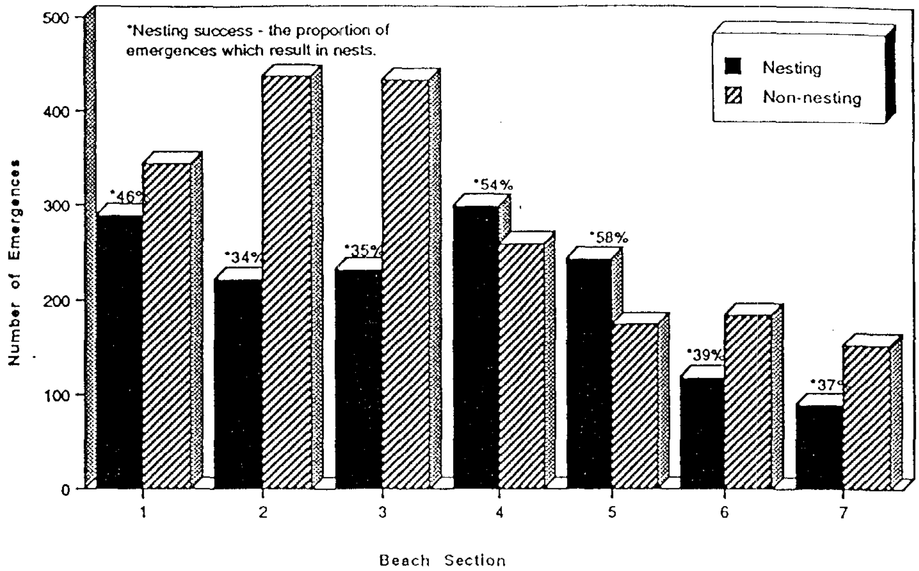


Figure 3. Loggerhead emergences and percent of nesting success by location at PAFB in 1994. Section 1 begins at the southern boundary of PAFB; section 7 ends at the northern boundary.

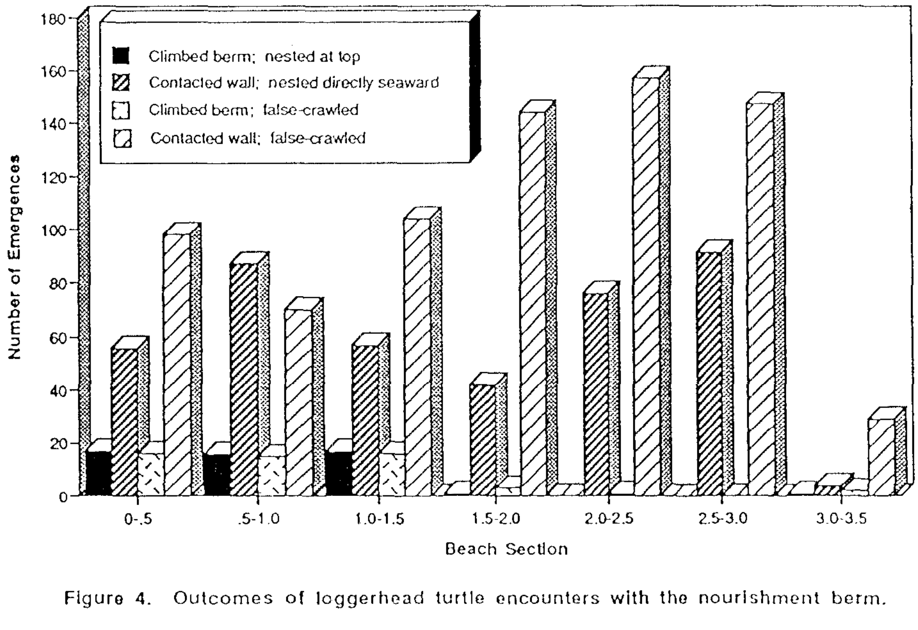


Figure 4. Outcomes of loggerhead turtle encounters with the nourishment berm.

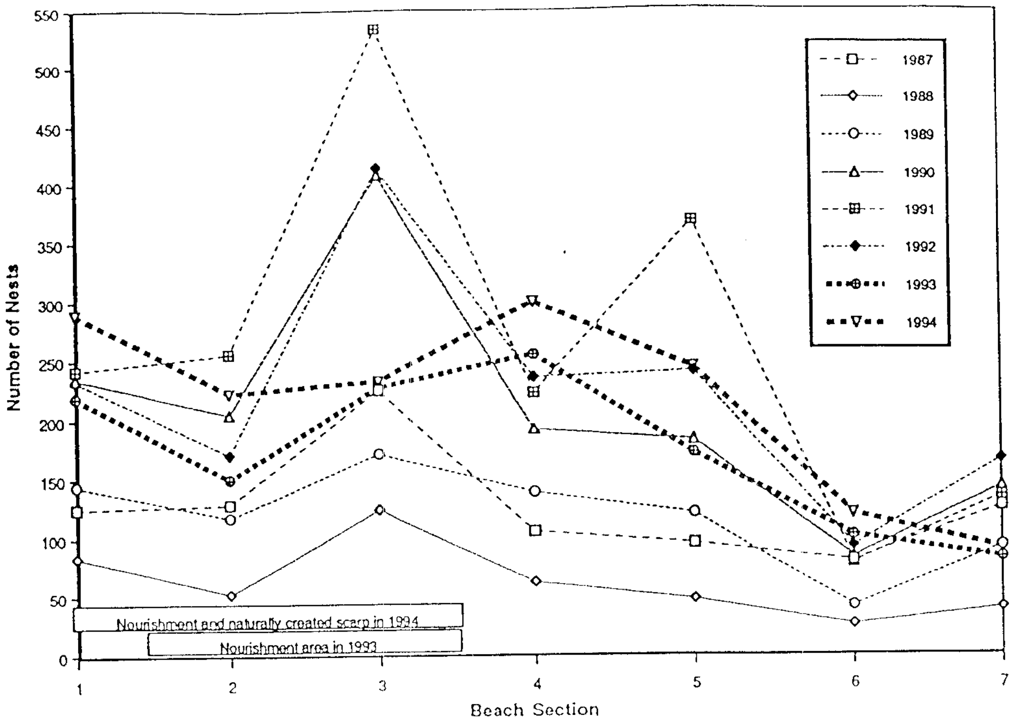


Figure 5. Loggerhead nest totals by location at Patrick Air Force Base, 1987 through 1994.

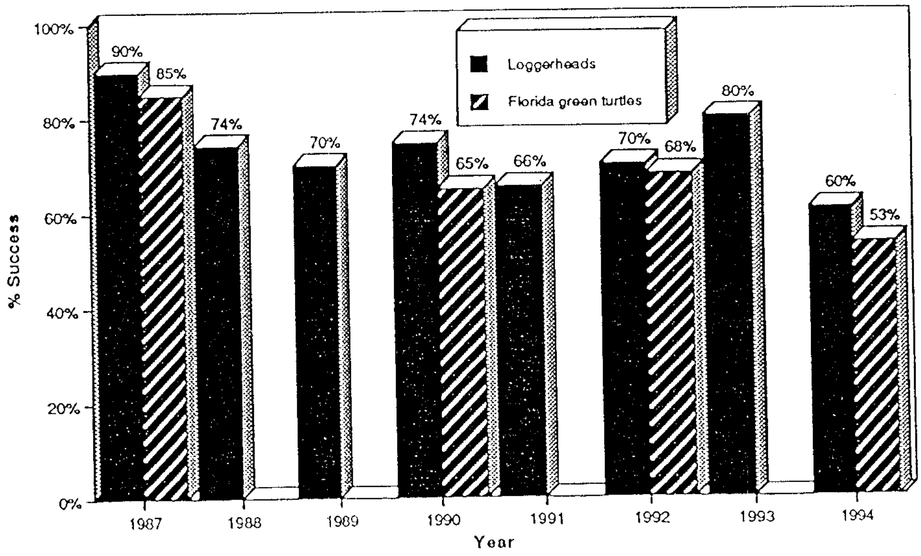


Figure 6. Reproductive success rates for loggerhead and Florida green turtles by year at PAFB, 1987 through 1994.

BEHAVIORAL CHANGES WITHIN THE RECOVERING HAWAIIAN GREEN TURTLE POPULATION

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Following decades of intensive exploitation, the Hawaiian green turtle (honu), *Chelonia mydas*, is presently showing some promising signs of population recovery 16 years after becoming protected under the U.S. Endangered Species Act. Green turtles throughout the 2,400 km span of the Hawaiian archipelago migrate to breed at isolated French Frigate Shoals (24°N, 166°W), the mid-point of the island chain (Balazs 1976, 1980, 1983). Systematic monitoring of nesting females at this site for 22 consecutive years has shown a gradual but definite increase (Fig. 1). Considerable interannual fluctuation during this period emphasizes the necessity of long-term studies to reliably ascertain population trends (Wetherall and Balazs, submitted).

An increase has also been seen in the number of immature green turtles residing in foraging pastures of the eight main Hawaiian Islands with human habitation at the southeastern end of the chain (Balazs et al. 1993, 1994a, 1994b). The narrow band of shallow water around these large islands accounts for 96% of the benthic habitat potentially available for recruitment by post-pelagic green turtles. Research at multiple sites in nearshore waters is ongoing to gather baseline data on growth rates, food sources, movements, health status, habitat requirements, and population trends (Balazs 1982, 1991; Balazs et al. 1987; Russell and Balazs 1994; Koga and Balazs, this volume).

Pronounced changes in the behavior of immature and some adult turtles have been documented in the main Hawaiian Islands. These changes include shifts in foraging times, greater tolerance to humans, formation of discrete cleaning stations, terrestrial emergence for resting purposes, utilization of warm-water discharge, and the apparently rapid occupation of certain feeding and resting sites with no historical record of such use. This paper gives short examples of the behavioral changes and highlights several locations where they are known to have occurred. The role of turtle-watching as a form of ecotourism is emphasized, along with the need to ensure this activity is conducted appropriately with the best interests of the turtles in mind.

FINDINGS

Foraging Times-- The most striking change in behavior by green turtles in the Hawaiian Islands involves the time of day when juveniles and subadults actively feed. Several kinds of benthic algae are utilized (e.g., *Pterocladia*, *Gelidium*, *Acanthopora*, *Hypnea*, *Amansia*, *Codium*, *Ulva*) and, to a much lesser extent, the only sea grass present in Hawaii, *Halophila hawaiiensis*. All of these food items frequently grow in shallow water close to shore. Prior to the mid-1980's turtles were seldom seen foraging during the daytime, except in very remote areas or at the base of ocean cliffs inaccessible to humans. The common knowledge among local fishermen was that turtles fed principally at night, especially along developed coastlines, when they entered the shallows on high tides. This information was verified when in-water research was initiated by the author during the mid-1970's at such sites as Punalu'u and Kiholo Bay on the island of Hawaii, and Kaneohe Bay on Oahu. Presently, diurnal feeding at these sites, and many others, is exceedingly common and widespread. The turtles now forage during all hours of daylight, whenever and wherever tides provide access to the desired marine vegetation. However, most of the large adults which comprise only a small segment of the population are not seen feeding during the day. Presumably these turtles continue to be nocturnal and/or feed at greater depths farther from shore.

Tolerance to Humans-- The willingness to forage during the daytime is believed to be closely related to the increased tolerance to humans shown by many (but by no means all) turtles during recent years. Tolerance to humans in the Hawaiian Islands ranges from being virtually tame with no apparent fear (i.e., swimming right up divers even when there is no history of hand-feeding), to turtles exhibiting guarded caution and only swimming away when approached too close. The "normal" behavior previously displayed in the Hawaiian Islands, and which still occurs at most places worldwide, was for green turtles to flee at the first sign of human presence. This does, in fact, still happen in Hawaii but it is no longer prevalent at many of the sites investigated.

The behavior presently exhibited by turtles at Kahalu'u Beach Park on the Kona Coast of the island of Hawaii represents the ultimate in tolerance to people in association with daytime foraging. The small calm bay at this site is visited daily by hundreds of tourists and local residents for snorkeling and swimming in waist-deep water. In spite of the intensive human use, turtles routinely forage in plain view and commonly rest under shallow coral heads not more than 50 m from shore. A remarkable photo showing people standing in the water watching a turtle forage near their feet recently appeared in Sea Frontiers (Parks 1993). During two short study visits to Kahalu'u 11 turtles weighing 11-40 kg were easily captured and tagged. All were healthy and robust. Recently 34 turtles were counted at high tide feeding in plain view inside the bay.

Cleaning Stations-- Green turtles in the Hawaiian Islands have established numerous discrete underwater sites where they aggregate to be cleaned by fish. The turtles exhibit distinctive solicitation postures at these locations, which are most often associated with a specific coral formation. A highly specialized cleaning symbiosis has been recorded in the case of the wrasse, Thalassoma duperry, feeding on barnacles attached to the turtle's skin (Losey et al. 1994). In most instances, however, herbivorous fish graze on and remove algae from the carapace and other body surfaces of the turtle. During the cleaning process turtles and fish are sensitive to being approached by divers and will leave the area if this happens. Prominent cleaning stations are known at Puako (Hawaii), and Waikiki and Kaneohe Bay (Oahu). However, many others have been reported by dive tour operators throughout the islands.

Terrestrial Emergence-- Green turtles in small numbers are exhibiting a basking type of behavior in increasing incidence in the main Hawaiian Islands. The turtles emerge along the shoreline and on the tops of bare coral heads in areas where foraging occurs. In some cases this activity happens in the late afternoon or at night, in the absence of solar radiation. Turtles may be out of water in the same place for hours, if left undisturbed. On sand beaches, such as at Punalu'u and nearby Kamehame, the turtles crawl only as far as the high-tide mark. At Kiholo Bay emergence occurs on lava rock ledges bordering an area used by turtles for resting underwater. Apparently the shoreline constitutes an acceptable, alternate resting location for some turtles. All turtles examined ashore at the various locations appear to be heathy and vigorous. This is in sharp contrast to stranded turtles that crawl or wash ashore in Hawaii when injured or afflicted with fibropapillomas.

Terrestrial basking by green turtles has been known for centuries at French Frigate Shoals and other sites in the remote Northwestern

Hawaiian Islands (Whittow and Balazs 1982). However, until recently emergence of this nature has been exceedingly rare in the main inhabited islands.

Warm-water Bathing-- Since the mid-1980's green turtles have been aggregating each night in increasing numbers in the warm-water discharge of a power plant at Kahului Bay, Maui (Balazs et al. 1987). This is the only location where such behavior is known in Hawaii. Steam turbine generating units discharge cooling water 27-33°C that cascades down a boulder embankment to form a plume about 20 m in diameter. The depth at this site is only 2 m or less. The turtles are mainly large subadults and adults of both sexes. They lie motionless on the bottom or drift back and forth within the plume often stacked one over the other. People can easily view the turtles from a nearby elevated pathway. Entering the water with the turtles causes them to flee, but watching them from shore seems to have no negative impact. The turtles are almost never present during the daytime. They start to arrive in the late afternoon, and most leave before sunrise. No algal or other food sources exist at the discharge site. The sole attraction to the turtles is the thermal bath. Some of the turtles are known to have fibropapillomas. A video made at sunset on March 19, 1994 indicated that 50-80 turtles were present in the plume. The video also documented a copulating pair that remained together for at least 30 min. However, green turtle nesting has never been reported on Maui.

Occupation of New Foraging Sites-- The relatively sudden appearance of numerous green turtles occupying new foraging grounds has recently been documented. This phenomenon happened in waters fronting Pu'uhonua o Honaunau National Historical Park on the Kona Coast of Hawaii. There is no prior record of such use at this location. Honaunau is one of the most sacred sites known in Hawaiian culture. In past centuries sanctuary and forgiveness for offenses were given to all who successfully reached this area. Park personnel witnessed scores of turtles feeding along the rocky shoreline starting in early 1994. During two short study visits 30 turtles weighing 8-50 kg were captured and tagged. Turtles were found resting on the bottom a short distance from shore in depths of 5-15 m. Most of the turtles captured were far larger (>10 kg) than ones known to be recent recruits from pelagic habitats. None had been previously tagged. It is unknown where these turtles formerly resided or why relocation occurred. Presumably they arrived from elsewhere along the 200 km expanse of the island's western coastline. Movements of this scope and magnitude have not been previously recorded for immature green turtles in coastal habitats of the Hawaiian Islands.

Turtle-Watching and Ecotourism-- Turtle-watching in the Hawaiian Islands is becoming an increasingly popular activity for both tourists and residents. Dive tour operators frequently promote sea turtles as the major attraction of underwater sightseeing (see Roberts 1992). Watching turtles from shore is also gaining in popularity, such as from highrise hotels on Waikiki Beach and coastal lookouts around the islands. Children in particular seem to enjoy seeing the turtles surface and dive while foraging close to shore. Clearly the behavioral changes described in this paper substantially increase the number and quality of opportunities to view turtles from both above and beneath the sea. A recent survey of tourists in Hawaii found overwhelming interest in people wanting more information about turtles and how to go about seeing them (Rebelo 1994). At present, sea turtles are probably only second to humpback whales as the most popular marine life attraction in the Hawaiian Islands.

CONCLUSIONS

New and intriguing forms of behavior are being exhibited by some green turtles at certain foraging and resting sites in the main Hawaiian Islands. An increase in the number of turtles, and the turtles' greater tolerance of humans, are believed to be the result of 16 years of protection under the U.S. Endangered Species Act. The positive aspects resulting from this protection now offer unprecedented opportunities for enhancing and expanding the role of turtle-watching in the ecotourism industry. However, the public needs to be better informed and educated about all aspects of sea turtles. Vigorous law enforcement must be continued. Such efforts will ensure that divers and other ocean users don't intentionally harass or inadvertently disrupt the turtles at cleaning stations, sleeping areas, and other sensitive sites. In addition, it must be recognized that many turtles, mainly adults, continue to be disturbed and flee when people approach too close.

Threats that are a continuing concern for green turtles in the Hawaiian Islands include an enigmatic tumorous disease known as fibropapillomatosis, accidental drowning in nearshore gill nets, illegal hunting, vessel collisions, coastal development, and incidental capture by high-seas longline and other fisheries. An interim recovery plan for Hawaiian sea turtles formulated by a recovery team appointed in 1985 continues to successfully serve as a guide for research and management issues (Balazs et al. 1992).

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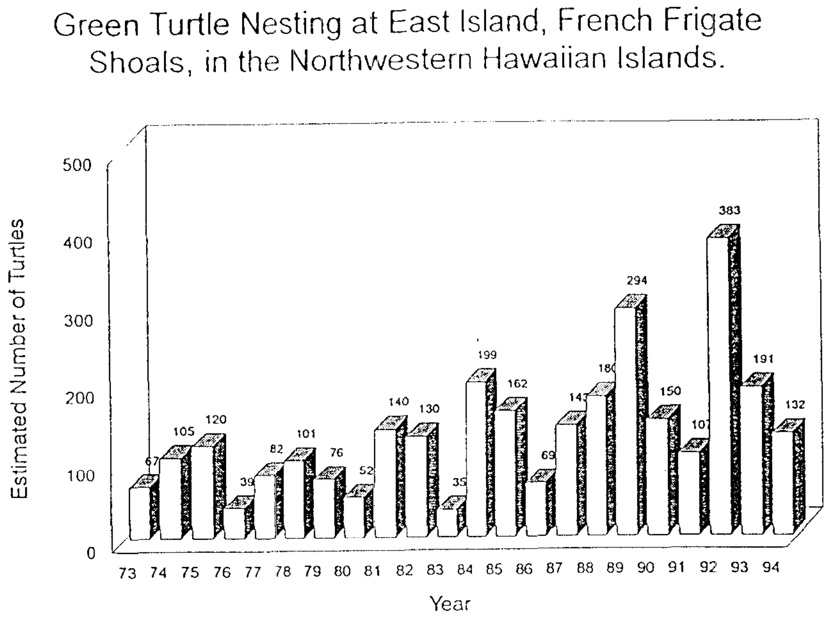
Green Turtle Nesting at East Island, French Frigate Shoals, in the Northwestern Hawaiian Islands.

Figure 1. Historical trend for 22 nesting seasons, 1973-94. East Island accounts for 50% or more of all green turtle nesting at French Frigate Shoals.

PROCEDURES TO ATTACH A SATELLITE TRANSMITTER TO THE CARAPACE OF AN ADULT GREEN TURTLE, CHELONIA MYDAS

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There are no published accounts providing details on how to safely and securely attach a transmitter to hard shelled sea turtles (Cheloniidae) for use in satellite telemetry studies. The ST-3/ST-14 (765 g) and the smaller ST-6 (470 g), manufactured by Telonics Inc. (Mesa, Arizona USA), are the most commonly used transmitters for sea turtle satellite tracking. Several researchers have reported using polyester resin and fiberglass cloth to attach a transmitter to a sea turtle's carapace (Balazs 1994, Balazs et al. 1994, Beavers et al. 1992, Byles and Keinath 1990, Renaud et al. 1993). However, in this paper we describe the specific procedures, step-by-step, so they can be easily carried out by workers initiating a satellite telemetry program. The use of Silicone Elastomer, described here as an integral component, is an innovation originally suggested by one of us (SCB) and used in Hawaii for the first time on both captive and wild turtles.

The following techniques have been successfully carried out by the senior author to deploy 13 ST-3 and, with minor modification, 2 ST-6 transmitters on green turtles (Chelonia mydas) at nesting beaches. This work included five turtles at French Frigate Shoals, Hawaii (three in 1992, two in 1993); five at Rose Atoll, American Samoa (three in 1993, two in 1994); three at Melbourne Beach, Florida (in 1994); and two at Wanan Island, Peng-Hu Archipelago, Taiwan (in 1994). In addition, the attachment techniques were pretested in captivity during 1992 on two adult green turtles at Sea Life Park Hawaii.

METHODS

Holding the turtle in a prone position- A four-sided rectangular plywood "pen" (i.e., open on the top and bottom) can be safely and easily used to hold an adult turtle in a natural prone position while attaching the transmitter. A pen for this purpose can be constructed of 1 cm thick plywood measuring 60 cm high, 125 cm long, and 85 cm wide. The exact dimensions used will be determined by the size of the adults in the population under study. The corners of the pen need to be reinforced with blocks of wood 10 cm by 10 cm by 60 cm to fasten the plywood together with nails or screws. The sharp interior corners of each block of wood should be rounded to a smooth surface.

The size of the container should allow only minimal sideways movement of the turtle. It is important that the width not afford enough space for the turtle to turn around. The desire to crawl usually subsides shortly after the turtle's head comes to rest against the plywood. Periodic movement of the turtle from side to side usually occurs, but does not interfere with the transmitter attachment procedure, nor harm the turtle in any way. A wet cloth draped over the turtle's eyes to completely block vision often reduces the turtle's desire to move around.

If transmitter attachment is conducted during the daytime under intense sunlight, shade must be provided for the turtle (and the researcher) by using a tarp or large umbrella. Attachment of the transmitter at night requires lights which can stimulate movement if the turtle's eyes are not kept covered. Working at night under tropical conditions may present special problems, such as the resin curing at an unacceptably slow rate due to higher humidity, lower ambient temperature, and less breeze for ventilation. The preferred time to attach the transmitter is during the early morning hours, shortly after sunrise.

There are several advantages to using a simple plywood pen to confine the turtle during transmitter attachment. First and foremost, the turtle remains in a natural position without the use of ropes, straps, or other means of binding to physically control flipper movement. Second, the pen affords complete access to the turtle's carapace. And third, in areas where the public has access to nesting beaches, there is the visual perception (perhaps rightfully so) that a turtle lying on the sand inside a plywood pen is being treated in a more humane fashion than one bound or restricted in some other manner.

Preparing the carapace- Barnacles, algae, and other fouling material must be removed from the carapace where transmitter mounting and bonding will occur. For an adult green turtle, the second central scute is the ideal site to place the transmitter. This section of the carapace (hence the antenna on the transmitter) rises to a maximum point above the ocean surface each time the turtle breathes. Fiberglass bonding will also encompass sections of the first and third central scutes and the first, and possibly second, lateral scutes. All of these areas should be lightly sanded with sandpaper and then thoroughly scrubbed and rinsed with fresh water. When dry, the entire area should be lightly wiped with an acetone-dampened cloth.

Mounting the transmitter on the carapace- Mix and use a sufficient quantity of Silicone Elastomer (Nephew and Nephew Rolyan Inc., Menomonee Falls, Wisconsin 53051) on the flat bottom of the transmitter in order to mold and mount it firmly against the curved and/or irregular surface of the carapace. Use 16 drops of catalyst with 115 g (4 oz) of Elastomer Base for an adult green turtle. Count the drops with an eyedropper and distribute them over the surface of the Elastomer Base in a plastic mixing cup. Note the instructions that come with the product concerning optimum ambient temperatures for successful use. Thoroughly mix the two parts together for 20-30 seconds. The Elastomer will then have a working time of about 2-3 minutes, so must be quickly spread on the bottom of the transmitter. Immediately press the transmitter firmly against the carapace on the second central scute to form an elevated and level platform. More than 115 g of Elastomer may be needed for other species and for immature turtles with greater curvature or spinal ridges to their carapace. A greater quantity of Elastomer may also be used to create a more elevated mounting platform, if so desired.

When the Elastomer has completely cured (<5 minutes), use a sharp knife to trim the excess material flush with the edge of the transmitter. Lightly resand the carapace where the Elastomer was cut away, and wipe this area lightly with an acetone-dampened cloth.

Note that absolutely no heat is generated while the Elastomer cures. Consequently there is no possibility of thermal damage to the turtle, even when large quantities are used. The use of two-part catalytic products that release heat are liable to harm the turtle when mixed in sufficient quantities to mount the transmitter in a one-step procedure, as described above. Silicone Elastomer is primarily used in human medicine as a splinting agent. Elastomer also has the advantage of bonding directly to itself when newly mixed material is applied to the cured product. It must be noted, however, that Elastomer is not an adhesive. Therefore, care must be taken not to dislodge the transmitter once the Elastomer has cured and before the fiberglass and resin have bonded to the carapace, as described in the following steps.

Bonding the transmitter to the carapace- Step One: Place small pieces of masking tape on the two metal screw heads located on the anterior of the transmitter that serve as electrical contacts for the unit's seawater switch. Note that the magnet that activates the transmitter will have already been removed by the researcher using satellite predictions for the deployment location to determine the optimum time to turn the transmitter on.

Use 45 drops of catalyst with 115 g (4 oz) of surfboard (polyester) "laminating" resin and mix thoroughly for about 15 seconds. Surgical gloves are recommended to reduce cleanup problems. A disposal wide-mouthed paper cup is an ideal mixing container. Note that under very cool conditions the resin may not cure. Refer to instructions on the container. Experiment beforehand to determine the amount of catalyst needed for your ambient conditions so that the resin will not harden too quickly, nor take excessive time to cure. A rapidly catalyzing mixture is undesirable because of the short working (brushing) time, and the more rapid release of heat. Thermal stress, however, is not a problem in this procedure since only thin layers of resin and fiberglass cloth are applied at any one time.

Liberally brush a coat of the mixed resin on the transmitter and carapace where the fiberglass cloth will be applied. Use four pieces of 10 cm wide fiberglass cloth with hemmed edges (sometimes referred to a "cloth tape"). Two pieces should be cut to 19 cm (slightly longer than the 17 cm length of the ST-3/ST-14 transmitter), and two pieces cut to 12 cm (slightly longer than the 10 cm width of the transmitter). Place each piece horizontally against the corresponding side of the transmitter into the resin flush to the top (except for the anterior surface). The remaining width of the cloth (16.5 cm, since the transmitter's height is about 3.5 cm) should be pressed down to stick into the resin on the carapace. For the anterior of the transmitter, apply the cloth starting just under (but not covering) the two screw heads, with the remaining cloth adhering to the carapace in front of the transmitter. The extra length of each piece should be folded around the corners and held in place with resin as it starts to cure.

Brush more resin into the four pieces of cloth, thoroughly soaking the fabric and taking care not to let any drip or run onto the turtle's skin. Be sure to work quickly before the resin starts to jell in order to thoroughly soak the cloth so it becomes transparent. The "working time" of a properly mixed batch of resin, that is, the time when the resin will readily soak into the cloth, will be only 5 minutes or less. Allow this initial layer to harden until fine threads of resin no longer form when the sticky surface is lightly touched. Hardening to this stage will ideally take about 15-20 minutes. However, it should be noted that a characteristic of laminating resin is that it remains slightly tacky even when curing is complete.

Step Two: When Step One of the bonding process is completed, mix a second cup of catalyst and laminating resin (45 drops into 115 g or 4 oz). Brush on a fresh coat of resin to the applicable surfaces and apply a 4 cm wide piece of cloth tape, 40 cm long, along the center of the transmitter, extending from anterior to posterior on the carapace. Then apply three pieces of the same width cloth crosswise on the transmitter so that each one extends down the side of the carapace bonding to the lateral scutes. The length of each crosswise piece should be 35 cm. Again, thoroughly soak the cloth with resin until it becomes transparent and allow to harden, as in Step One.

Step Three: This step may be optional under some circumstances. However, it is recommended to ensure a solid transmitter attachment in conditions where the turtle might be expected to impact with coral and other benthic habitats, such as while resting in caves or under ledges. All adult green turtles are believed to exhibit such behavior.

Mix a third cup of catalyst and laminating resin (35 drops into 85 g or 3 oz). Brush on a fresh coat on the applicable surfaces and apply a 10 cm long piece of 10 cm wide cloth to the anterior of the transmitter, starting just beneath the screw heads and extending to the carapace, as in Step One. Then apply two pieces of 4 cm cloth tape, 35 cm long, crosswise on the transmitter. Make a hole in one of these two pieces so that the antenna can pass through, thereby allowing the cloth to lay across the anterior-most top surface of the transmitter. Thoroughly soak the cloth with resin until transparent and allow to dry, as in Steps One and Two. During this step, any identifying information or message (i.e., return address or telephone number) may be written on a card with indelible ink and placed under the cloth to permanently seal into the resin.

Step Four: Prepare a final cup of catalyst and resin using surfboard (polyester) "sanding" resin. Mix 25 drops into 60 g (2 oz) of resin and stir thoroughly for 15 seconds. Brush a coat over all surfaces previously worked and allow to harden to the touch (about 15-20 minutes). If desired, a polyester pigment such as opaque olive or other color can be mixed into this final coat to help match the appearance of the transmitter to the carapace. Unlike laminating resin, sanding resin (as well as the product known as "finishing" resin) cures to a hard non-tacky surface. The advantage of using sanding resin instead of finishing resin is that it takes far less time to cure.

Remove the masking tape from the two screw heads and use sandpaper to ensure clean residue-free metal surfaces. In areas where biofouling may be excessive, a coat of antifouling bottom paint can be applied to the transmitter. The turtle can now be released and allowed to enter the ocean. The catalytic action of the several layers of resin will continue in seawater and reach a fully hardened state within 12 hours.

Removing the transmitter- The transmitter will eventually be shed by normal surface flaking of the scutes and, where applicable, by repeated contact with substrate when the turtle rests underwater. However, intentional removal may be desired to retrieve the transmitter if the turtle is recaptured. Safe removal can be achieved by carefully cutting the fiberglass along the edge of the transmitter where it rests on the Elastomer. The whitish Elastomer under the transmitter will be visible through the clear fiberglass, indicating where the cut can be safely made. The ideal cutting tool for this purpose is the 20,000 rpm Dremel Free Wheeler Mototool (Model 850) equipped with a 2.5 cm diameter saw blade. Make a shallow cut just deep enough to pass through the fiberglass and slightly into the Elastomer along the edge of the transmitter. After the cut is made, a putty knife can be used to pry under the transmitter to loosen and lift it off. No attempt should be made, nor is it necessary, to remove the remaining bonded strips of fiberglass along the sides and top of the carapace. This material will remain harmlessly attached until surface flaking of the scutes occurs over time. Thin layers of resin-bonded fiberglass cloth are commonly applied externally to the carapace during veterinary surgical repair of chelonians.

CONCLUSIONS

The procedures detailed in this paper constitute a safe, effective, and relatively easy means to attach the ST-3/ST-14 backpack mounted transmitter to an adult green turtle. The technique may be adapted for use on other Cheloniidae sea turtles, including immature turtles with the smaller ST-6 transmitter, principally by using more Elastomer to form a flat mounting surface along the more pronounced curvature of the carapace. We recommend that researchers first gain ample experience using the required products under simulated conditions before attempting to attach a transmitter to a live turtle.

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WEATHER CHANGES AND OLIVE RIDLEY NESTING DENSITY IN THE OSTIONAL WILDLIFE REFUGE, SANTA CRUZ, GUANACASTE, COSTA RICA.

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INTRODUCTION

Massive synchronous nesting behavior, locally known as "ARRIBADAS", of olive ridleys (Lepidochelys olivacea) occurs on two beaches of the North Pacific Coast of Costa Rica; in Nancite, Santa Rosa National Park and Ostional, in Ostional Wildlife Refuge (OWR).

The area of massive nesting in Ostional is 880 m. long, ranging from the mouth of Ostional River to the north, to Cocineras Rocks to the south. The total available area for olive ridley nesting reaches approximately 14,000 m^2.

Besides the nesting density estimation we are searching for a relation between environmental factors and the occurrence of arribadas. The massive nesting of olive ridleys are thought to be governed intrinsically. Nevertheless, there is a considerable evidence that some external factors, such a weather or climate, play a very important roles (Cornelius, 1986).

METHODS

For the nesting density estimation we are using a method developed by Cornelius an Robinson in 1981. The 880 meters area is divided in three sectors; each sector includes a 300 m^2 plot. The nesting density is determined by the following formula:

$$Pi= (Ni+.94xDi+.47x(Ti-(Ni+Di)))xAix1.25/ACix(HJ/(1.08xCJ))$$

Pi= number of nesting females per sector and per session.

Ti= total number of turtles per plot.

HJ= number of hours during each session.

.47= is the probability of a successful nesting of crawling turtles.

Ni= number of nesting females per plot.
Di= number of turtles actively digging a nest per plot.
Ai= area of each sector.
ACi= area of each plot (300 sq. m).

CJ= number of counts during a session.
.94 = probability of a successful nesting of digging turtles.

1.25= extrapolation to include turtles that nest out of the sector, such as turtles nesting close to high tide line or in vegetation areas.

1.08= average time a turtle takes to complete its nesting process.

Collected data is plugged into a computer program that uses the above formula to obtain the nesting density during each arribada.

Searching for a relation between weather conditions and the occurrence of arribadas we are recording climate conditions like: RAIN, WIND, AMBIENT AND WATER TEMPERATURE, TIDES AND MOON PHASES.

We are using the following instruments:

All Weather Rain Gauge, Model 88991 for a 11"x 0.01" capacity.
Sims Handheld Wind Powered Cup Anemometer, Model 890960.
Airguide Windial Wind Speed Indicator and Compass.
Taylor Maximum and Minimum Thermometers, Model 89025.
Pocket Case Thermometer, Model 89121.
Standard tide chart for Costa Rican Pacific Coast.
A normal calendar.

RESULTS AND DISCUSSION

Table 1 and figure 1 show the weather conditions prevailing during three arribada months for the 1991 nesting period.

February was a normal summer month, with no rain and with winds blowing mainly from northwest. Four arribada sessions were estimated in February accounting for 26,822 nesting females. This arribada began three days before the new moon.

From march 26 to April 05 there was a transition to the rainy season. The arribada began four days after the full moon, 46,843 nesting females were estimated. In March winds were a little stronger, blowing from southwest. There was no rain during this nesting period.

October was the month of the peak of the nesting activity. 286,620 nesting females were estimated for this month. Olive ridleys were active during the whole month. October was also one of the rainiest months in 1991. Almost 10 inches of rain fell from October 05 to 07. All the moon phases were present during the October nesting activity.

Statistical analysis results are presented in tables 2 to 7. These results indicate that all weather conditions tested could have an influence over turtle's nesting. Nevertheless, some of the climate factors, such as ambient and water temperature, do not have a great variation. Thus, the influence of these factors over the nesting activity is not easy to evaluate. In all the cases turkey test identifies groups in which the means are not significantly different from one another. In the other hand, T (student) test shows not significant differences between the variables for February and March-April arribadas. For October arribada T (student) indicates significant differences among the pair of variables considered in the analysis.

One way analysis of variance also indicates not significant differences for some the considered variables in the arribadas included in this work. Rain was only included in the October arribada because there was no rain in February nor in March.

Some of the data still indicate a coincidence of olive ridleys massive nesting with mid or high tides and with the last quarter of the moon. Nevertheless in winter months, such as in October 1991, the moon phase is not a useful cue for the arribada prediction.

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TABLE 1: WEATHER CONDITIONS FOR THREE ARRIBADA MONTHS IN THE OSTIONAL WILDLIFE REFUGE DURING 1991.

MONTH	NUMBER OF TURTLES	WIND (MPH)	RAIN (INCHES)	AMB. TEMP. (\`C)	WATER TEMP. (\`C)	TIDE RANGE (cm)	MOON PHASE
FEB. 01-09	26,822	5-12 NE	0	31-32	28-29	149-327	FM-LQ
MAR. 26 TO APR. 05	46,843	5-8 W-SW	0	31-33	28-31	211-299	FM-LQ
OCT. 03 TO NOV. 01	286,620	5-15 S-SW	15.5	28-31	27-30	128-317	FQ FM LQ NM

FQ: FIRST QUARTER, FM: FULL MOON, LQ: LAST QUARTER, NM: NEW MOON

TABLE 2: ONE WAY ANALYSIS OF VARIANCE FOR TURTLES AND SOME WEATHER CONDITIONS IN THE OSTIONAL WILDLIFE REFUGE, GUANACASTE, COSTA RICA. FEB. 01-09, 1991 NESTING PERIOD.

SOURCE	DF	SS	MS	F	P
BETWEEN	4	1.056E+07	2.604E+06	2.49	0.0585
WITHIN	40	4.243E+07	1.061E+06		
TOTAL	44	5.299E+07			

TABLE 3: TUKEY AND T (STUDENT) TEST FOR THE COMPARISON OF MEANS AND FOR TURT-TIDE, TURT-WIND, TURT-TAMB AND TURT-TWAT PAIR OF VARIABLES, FEB. 01-09, 1991 ARRIBADA. RAIN WAS EXCLUDED.

TUKEY VARIABLE	TUKEY MEAN	T TEST	TURT-TIDE	TURT-WIND	TURT-TAMB	TURT-TWAT
TURT	1269.8	MEAN	1023.1	1263.3	1237.8	1240.8
TIDE	246.67	ST.ERR	765.23	767.21	767.36	767.36
TAMB	32.000	T	1.34	165	1.61	1.62
TWAT	29.000	DF	8	8	8	8
WIND	6.4444	P	0.218	0.1382	0.1454	0.1446

TABLE 4: ONE WAY ANALYSIS OF VARIANCE FOR TURTLES AND SOME WEATHER CONDITIONS IN THE OSTIONAL WILDLIFE REFUGE, GUANACASTE, COSTA RICA. MARCH 26-APRIL 05, 1991 NESTING PERIOD.

SOURCE	DF	SS	MS	F	P
BETWEEN	4	3.001E+06	7.501E+05	7.84	0.0001
WITHIN	50	4.783E+06	95654.4		
TOTAL	54	7.783E+06			

RAIN WAS EXCLUDED FROM THE ANALYSIS

BARLETT' S TEST	CHI-SQ	P
OF EQUAL VARIANCES	373.35	0.9971

TABLE 5: TUKEY AND T (STUDENT) TESTS FOR THE COMPARISON OF MEANS AND FOR TURT-TAMB, TURT-TWAT, TURT-WIND AND TURT-TIDE PAIR OF VARIABLES. MARCH 26- APRIL 05, 1991 ARRIBADA. RAIN WAS EXCLUDED.

TUKEY VARIABLE	TUKEY MEAN	T TEST	TURT-TAMB	TURT-TWAT	TURT-WIND	TURT-TIDE
TURT	619.45	MEAN	587.55	590.18	613.14	369.18
TIDE	250.27	ST.ERR	208.22	208.22	208.36	199.94
TAMB	31.909	T	2.82	2.83	2.95	1.85
TWAT	29.273	DF	10	10	10	10
WIND	5.8182	P	0.0181	0.0177	0.0147	0.0946

TABLE 6: ONE WAY ANALYSIS OF VARIANCE FOR TURTLES AND SOME WEATHER CONDITIONS, IN THE OSTIONAL WILDLIFE REFUGE. OCT. 03-NOV. 01, 1991 NESTING PERIOD

SOURCE	DF	SS	MS	F	P
BETWEEN	5	1.351E+09	2703E+08	37.47	0.0000
WITHIN	162	1.169E+09	7.214E+06		
TOTAL	167	2.520E+09			

SIGNIFICANT DIFFERENCES WERE FOUND BETWEEN ALL VARIABLES TESTED

TABLE 7: TUKEY AND T (STUDENT) TESTS FOR THE COMPARISON OF MEANS AND FOR TURT-TAMB, TURT-TWAT, TURT-WIND, TURT-TIDE AND TURT-WIND PAIR OF VARIABLES. OCT. 03-NOV. 01, 1991.

TUKEY VARIABLE	TUKEY MEAN	T TEST	TURT-TAMB	TURT-TWAT	TURT-WIND	TURT-TIDE	TURT-RAIN
TURT	7668.9	MEAN	7639.3	7640.3	7661.37	7427.0	7668.3
TAMB	29.867	ST.ERR	1243.3	1243.3	1243.5	1240.0	1243.4
TWAT	28.607	T	6.14	6.15	6.16	5.99	6.17
WIND	7.0714	DF	27	27	27	27	272
RAIN	0.5411	P	0.0000	0.0000	0.0000	0.0000	0.0000
TIDE	241.89	*********	*********	*******	*******	******	******

SIGNIFICANT DIFFERENCES WERE FOUND AMONG THE VARIABLES

TURTLES AND SOME WEATHER CONDITIONS OSTIONAL WILDLIFE REFUGE, 1991

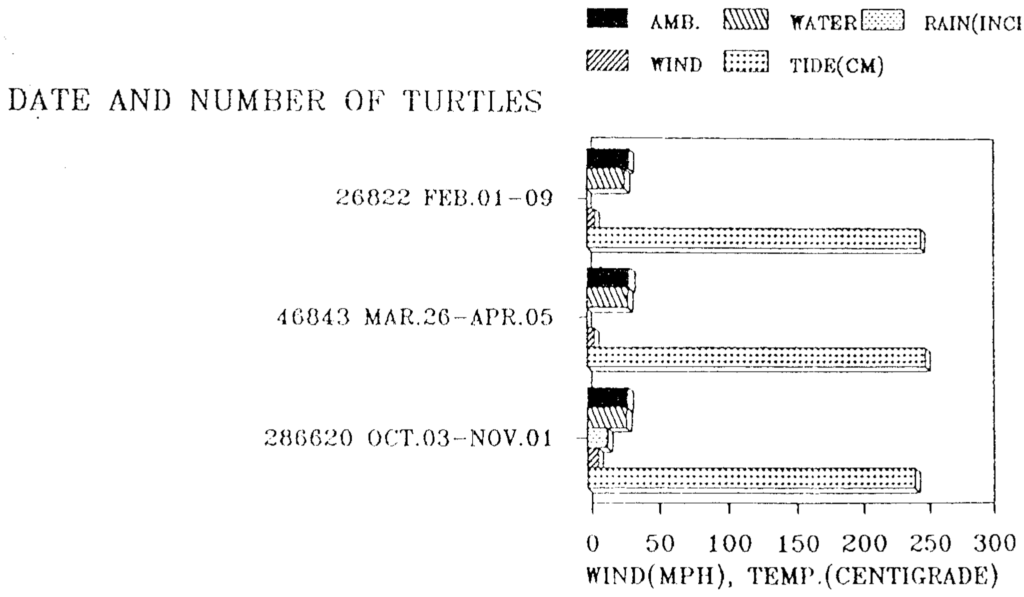

FIGURE 1

POTENTIAL THREATS FOR THE SURVIVAL OF SEA TURTLES IN THE OSTIONAL WILDLIFE REFUGE, SANTA CRUZ, GUANACASTE, COSTA RICA.

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BACKGROUND

In 1982, under decree 13200-A, Ostional is declared a Protected Area, ranging from the mouth of Nosara River to the south, to Quebrada Rayo to the north. In 1984 the area is declared as Ostional Wildlife Refuge (OWR, Wildlife Conservation Law (WCL) # 6919).

The predominant criteria for the creation of the (OWR) was the need to protect and study of sea turtle species, such as the olive ridley (Lepidochelys olivacea), which nests during the whole year in a behavior fashion known as "arribada", the leatherback (Dermochelys coriacea) and the eastern pacific green (Chelonia mydas agassizi), which nest seasonally, and the hawksbill (Eretmochelys imbricata), which reports of which are rare (Cornelius, 1986).

In 1985 the Refuge was extended to the south to Include the communities of Nosara and Guiones. The residents of Nosara petitioned and endorsed these measures, as they considered that it was very important to protect these beaches where turtle nesting activity is high, and because the original Refuge may not provide enough protection. Nonetheless, this decision resulted as a source of conflict since the new area to be included also enjoyed a greater economic development, with electricity, access by improved roads and a much greater receptive tourism industry. On the other hand, Ostional was characterized by a higher degree of isolation, difficult access by land mainly during the rainy season, and no electricity until 1993.

Ostional maintains, to a great extent, its original basic life style. However, the economic influence of their neighbors has begun to radically change the scenario. In spite of the contrast described earlier between the two communities included within the Refuge, Ostional has evolved from a community that illegally and indiscriminately exploited sea turtle eggs to one that now pursues a model of stainable use, combining sea turtle conservation and social development in one.

The exploitation process was possible due to an addition of a clause to the Marine Fishery and Game Law # 190. This new addition states that "it is forbidden to kill captured turtles and commerce with their eggs, except in the OWR, in which commerce of olive ridley sea turtle eggs is permitted, as long as this commerce is done according to a management program based on scientific knowledge that justifies this action". Since 1986 and up to the current date the Management Program has been applied and the community of Ostional has fully respected every regulation.

Only olive ridley eggs are subject to harvest, while all other sea turtle species are protected. The wide distribution and use of legal eggs has reduce poaching in other areas, an activity that once was wide spread in Costa Rica. Likewise, the egg harvesting activity at Ostional has generated social economic improvements for the locals.

The main scientific justification is the low hatching success of olive ridley nests in arribada beaches (Cornelius 1986). Moreover, the great intensity of nesting turtles, and other nest destruction factors such erosion, predation and contamination by fungi and bacteria further justify the harvest of eggs by the community of Ostional.

In 1993, through a Government decree #2551, the Refuge was extended further into the sea, in order to "ensure the viability of the populations of sea turtles, on a long term", and because "the current area that the Refuge covers does not protect the coastal areas where turtles mate, because of which the incidental capture of sea turtles by trawl fishing operations is a major contributor to the diminishing of these populations". This same decree establishes the following sectors to be included in the OWR a) the marine sector which includes the territorial waters, b) the Ostional sector, which includes the main nesting site for olive ridleys and other sea turtle species, c) the estuarine wetlands,' which includes mangrove swamps and d) the Guiones sector, which includes Pelada Beach and Guiones Beach.

LEGAL STATUS OF OWR

According to the WCL (chapter 10, article 82), three types of Wildlife Refuge exists: 1) State Property Refuges (SPR), 2) Combined Property Refuges (CPR) and Private Property Refuges (PPR). Ostional is considered a CPR in which the areas declared for protection "either belong to the State or belong in private hands. According to the WCL "the Wildlife Department authorizes the following activities within the boundaries of a CPR and PPR: a) agricultural use, b) housing development, c) recreational tourism development, d) tourist development (including hotels, cabins, lodges and other similar activities), e) commercial use (restaurants, shops and others), f) industrial use (including extraction of material from quarries such as sand and stone) and g) scientific and cultural research.

The WCL also establishes certain limitations concerning activities that may or may not be carried out within a Wildlife Refuge, among which are the number of constructions (no more than 20 buildings within an hectare of land), the extension of the constructions depending on the size of the land to be developed (50% of the land for 1 hectare and 6% for properties of more than 40 hectares). Also regulated is the shape and the height (no more than one floor) of the constructions. Another requirement is the establishment of sewage treatment plants and the management of solid wastes. The regulations are very specific regarding artificial lights. No source of light may be directed towards forests or beaches.

The aspect regarding artificial lighting was also a source of conflict when the Refuge was extended to the south, because constructions already existed (such as Hotel Nosara) which were located right next to the nesting beaches and counted with artificial lighting directed towards them. This a direct contradiction with current legislation, which establishes that the lights must be "projected towards the ground and must be at height of 80 cm. above the ground.

In contrast, when Ostional was electrified in November 1993 all houses next to the beach were excluded and the possibility of public lighting was also excluded. In this sense we also consider that the fact that tourist developers are offering services with illuminated access is very dangerous.

Laws may exist, but enforcement is poor and loopholes plentiful. In many cases economical and political criteria prevail which do not respect current development models and conservation measures. In some cases we may even speak of corruption, bribe and negligence. Moreover, in many cases there is just a general ignorance of currents laws. As a result, uncontrolled tourist development could negatively impact conservation efforts, including the integrity of the Ostional people. We believe that the megaconstructions, buying and selling of lands, large scale agricultural developments, river dredging, logging, uncontrolled fishing, uncontrolled housing development and artificial lighting of nesting beaches are not compatible with sea turtle protection measures. We also believe that it is necessary to consider that in Ostional there is a very important human resource that we must struggle to protect and conserve, which is the community of Ostional. Up to date, they have proved to be capable of living with sea turtles in a harmonious way.

THE PROBLEMS AND ITS PRACTICABLE SOLUTIONS

We would like to stress the fact that we are in no way against the tourist development, which could be of great economic benefit to our country. Our point is that we must make development trends and conservation strategies coincide. On the other hand, the success of the tourist developments depend to a great degree on the follow up of precise an adequate measures to protect and conserve natural resources, as these are precisely the reason why tourists visit our nation in the first place.

In another sense, we believe that the protection of the natural resources of the OWR are not guaranteed with the sole protection of a 200 meter belt, without considering the so called buffer zone, which should be included within a protection strategy. Thus we are promoting an Integrated Management Plan which will establish the regulations in every sort of development carried out within the refuge, in the buffer zones and the marine sector.

We also want to stress the point that we are aware that it is not enough, nor is it ethical, to just criticize without offering alternate proposals and suggesting solutions to the problems. Our proposals are the following:

1) Persuade Costa Rican Government Officials to declare a BUFFER ZONE between Río Rosario and Río Montaña, in lands which are currently not included within the OWR.

2) Carry out campaigns at a national and international level in defense of the OWR and the community of Ostional.

3) Promote the creation of commissions at a national and international level to create an awareness of the problems in Ostional, the possible solutions and the implementation of measures to carry out specific objectives that guarantee the reaching of goals in such commissions.

4) Promote international interchanges to share experiences among countries with similar problems such as natural resource conservation and the regulation of developments.

5) Generate or promote the establishment of organized groups that work in each country and maintain contact, with the goal of solving common problems such as the lack of economic resources to promote research and conservation measures of sea turtles and other natural resources.

6) Generate educational material and implement publicity campaigns in order to supply complete information on research and conservation strategies to developers, politicians, economists, legislators, conservationists and the general public.

Some of these proposals have already begun to be implemented. For instance, we have formed a Commission with members of the Costa Rica Fishery Institute, the Ministry of Natural Resources, the Ostional Development Association, the Sea Turtle Program of the University of Costa Rica, and the Central American representative of Earth Island Institute's Sea Turtle Restoration Project. This Commission is working very actively to try to solve the problems mentioned here.

We also want to point out the problem of incidental capture of sea turtles by trawl nets and long line fishing. Trawling activity has been estimated to be responsible for capturing around 20,000 turtles a year (Araúz, 1990). At least for trawl mortality the problem is partly solved as the Fishery Institute is currently concerned about the problem, as well as the resent financing by AID and CONICIT of a TED project for the University of Costa Rica to Evaluate TEDs and then implement an efficient Technology transfer project.

We have also found a great willingness from certain NGO's, specifically EII who in a near future may be supporting us in the implementation of educational campaigns. We are also studying the possibility with the Central American Coordinator of EII to consolidate a Costa Rican Sea Turtle Conservation Group.

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ANATOMICAL BASIS FOR AN INTRACARDIAC BLOODFLOW MODEL IN SEA TURTLES

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INTRODUCTION

The cardiovascular anatomy of sea turtles has been scarcely studied; this is due mainly to the difficulty in obtaining proper biological material (Barragán, 1992; Barragán, 1994). Hatchlings found dead for natural causes in the nests as well as stranded adult or juvenile individuals have proved to be a valuable source of specimens suitable for anatomical studies, otherwise objectable considering the endangered status of all sea turtle species. This work summarizes the descriptions of the sea turtle heart anatomy, providing an interesting insight in how this organ works.

METHODS

The heart structure of 4 sea turtle species (Lepidochelys olivacea, Dermochelys coriacea, Eretmochelys imbricata and Chelonia mydas agassizi), in various stages of their life cycle, was described using gross dissections, microdissections and histological sections stained with Masson Trichrome technique. The anatomical characteristics were related to data from circulatory physiology studies done elsewhere (Burggren amd Shelton, 1979) in freshwater turtles.

RESULTS AND DISCUSSION

No differences in external or internal anatomy were observed between the species studied, so no distinctions are made during the following description.

The sea turtle heart has three chambers: two atria, being the right one consistently larger than the left, and one ventricle. Three great vessels emerge from the right side of the ventricle: the pulmonary artery, which carries deoxygenated blood back to the lungs; a left aorta which carries oxygenated blood to the lower part of the body and a right aorta, carrying oxygenated blood to the brain and upper limbs.

Upon section of the atrial walls, the inner wall is observed composed of large muscle bundles, or trabeculae, placed in a manner that suggests active contraction of the atria, pushing the blood to the ventricle. When the atria are removed, the atrio-ventricular (A-V) annulus is exposed. Histological sections reveal the A-V annulus formed by a muscular ring lined with a thick endocardial tissue, which constitutes the framework for the right and left A-V valves. Gross sections, as well as histological frontal sections, show a single ventricle, highly trabeculated, and with no interventricular septum dividing it. The only distinct structure seen inside the ventricle is the horizontal trabeculae, located just below the opening of the right aorta and dorsal to the intercameral foramen; this foramen communicates the main ventricular chamber with an outlet chamber from which the pulmonary artery emerges. The right aorta emerges from the main chamber and the left aorta originates just above the intercameral foramen.

Characterization of the cardiac anatomy posed the problem of trying to understand how this organ function in a living organism. Unfortunately, studies on sea turtle circulatory physiology are virtually non-existing, but some useful information was found in the work or Burggren and Shelton (1979) with Pseudemys scripta. These authors measured the O_2 partial pressure in blood from the vessels that come to and emerge from the heart of this freshwater species (Fig. 1). Their results show a significant difference in oxygen content among the 3 great vessels that emerge from the heart of P. scripta, despite the fact that turtles' hearts have a single ventricle. Since cardiac anatomy of freshwater turtles and sea turtles is very similar (Barragán, 1992), the physiological data could be used combined to the anatomical observations to propose the "preferential bloodflow model", which seeks to explain the events ocurring within the heart of turtles. This model is depicted in Fig. 2.

Venous blood, collected in the right atrium from systemic veins, passes through the right A-V valve into the ventricle, by means of the active contraction of the atrium. Aided by the large leaflet, this flow of blood is directed to the intercameral foramen. The venous blood fills the outlet chamber, and during systole (contraction of the ventricle) it is isolated from the rest of the ventricle and passes through the pulmonary artery in it's way to the lungs.

Oxygenated blood, which is pushed by the contraction of the left atrium, passes through the left A-V valve, filling the main part of the ventricular chamber. During systole, all the blood contained in the main chamber finds it's way to the right aorta thanks to the horizontal trabeculae, which deflects the blood current and directs it to the sigmoid valves of the right aorta.

A certain degree of mixture between both blood fluxes does exist, specially at the region above the horizontal trabeculae. This mixed blood comes out the heart through the left aorta.

The model just described is a theory based on the spatial relationships among the anatomical structures of the heart; nevertheless it is a plausible situation in the light of other evidence. The right aorta carries oxygenated blood to the brain, the organ in most need of oxygen in the body; likewise, the ostia of the coronary arteries are found only in the inner wall of the right aorta, indicating that the heart muscle receives an oxygen supply very similar to that received by the brain. The left aorta, which gives origin to most of the systemic arterial circulation, is located above the intercameral foramen, at the point in which the proposed blood currents would meet, mixing together. The physical separation of the pulmonary artery from the aortas accounts also for the difference in oxygen content.

It is important to note that for assessing the accuracy of the model, further research is needed using non-invasive techniques such as echocardiography of CAT scanning in living sea turtles, as well as circulatory physiology studies including breathing and diving turtles, analyzing oxygen levels in the blood. In the case that the model is confirmed, it would show an outstanding solution to the dillema of having a complex circulatory physiology within a "simple" heart construction; an alternative answer to the one achieved by crocodilians, birds and mammals with their four-chambered hearts.

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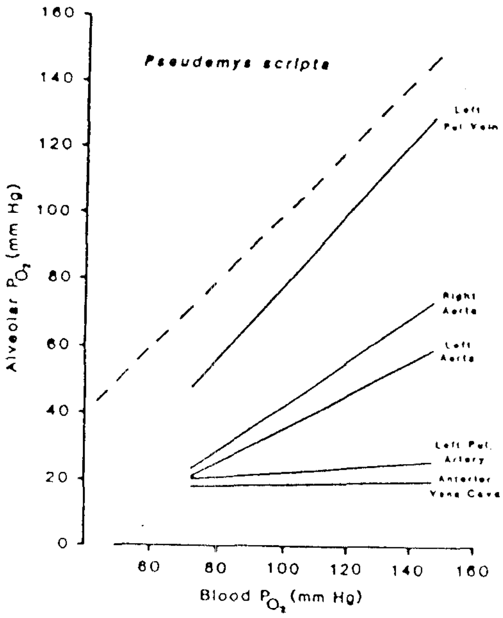

Fig. 1. Oxygen content, measured as O_2 partial pressure (PO_2) in blood from central arteries and veins in nine freely diving freshwater turtles *Pseudemys scripta*. High alveolar PO_2 correspond to periods of time during and shortly after air breathing, while low alveolar PO_2 correspond to diving periods (from Burggren and Shelton, 1979).

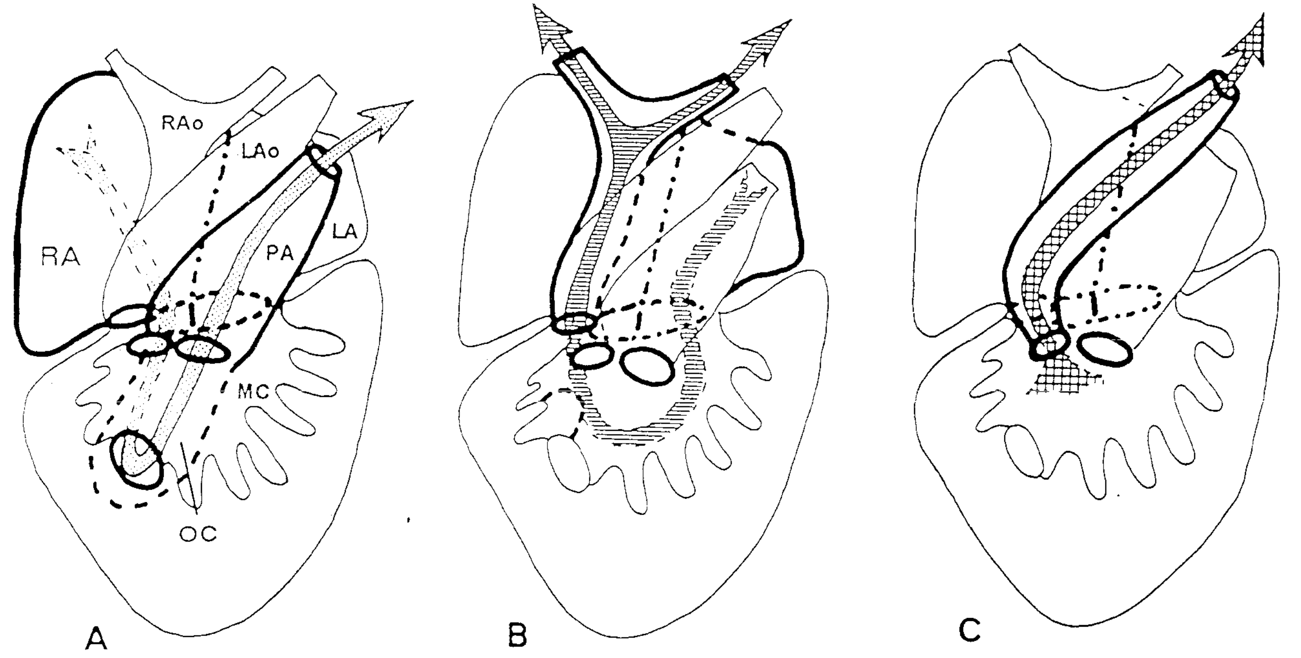

Fig 2. Diagram of the preferential bloodflow model inside a sea turtle heart. Arrows indicate the direction of the flux.
A) Deoxygenated blood flux B) Oxygenated blood flux C) Mixed blood flux (See text for details).

RA, right atrium; LA, left atrium; RAo, right aorta; LAo, left aorta; PA, pulmonary artery; MC, main ventricular chamber; OC, outlet chamber. A bold line indicates the structures participating in each case.

BEACH VEGETATION AND SEAFINDING IN HATCHLINGS

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The effect of low-lying beach vegetation on hatchling seafinding behaviour was studied at Matapica, Suriname. Groups of both green (C. mydas) and leatherback (D. coriacea) turtles were tested in two orientation arenas: one located in dense vegetation, and one in the open sand. Though both species exhibited strong seafinding behaviour in the open arena, neither oriented toward the ocean when placed in dense vegetation. Hatchlings that emerge in vegetation risk prolonged exposure to predators, and desiccation, because they spend more time on the beach. In terms of conservation, care must be taken in site selection in programmes that make use of relocation techniques.

DEVELOPMENTAL MIGRATIONS OF JUVENILE GREEN TURTLES IN THE BAHAMAS

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"Creeks" or tidal bays in the Bahamas are important habitat for immature green turtles. A long-term tagging study in Union Creek, Great Inagua, Bahamas (Bjorndal and Bolten, 1995), has provided information on the movements of immature green turtles in the Greater Caribbean. Tags placed on green turtles in Union Creek have been returned from northern Bahamas, Colombia, Cuba, Dominican Republic, Haiti, Nicaragua, Panama, and Venezuela. Mitochondrial DNA sequence analyses (in collaboration with Pete Lahanas, Sandra Encalada, Michael Miyamoto, and Brian Bowen) have demonstrated that green turtles in Union Creek arrive from nesting beaches throughout the Atlantic (Lahanas et al., in review).

Conception Island Creek in the central Bahamas supports a population of immature green turtles. Based on a tagging study conducted since 1989 in collaboration with Steve and Babbie Connett of St. George's School, we have estimated residency times for green turtles in Conception Island Creek. Conception Island is not inhabited by humans and is a Wildlife Sanctuary of the Bahamas National Trust; these factors afford the green turtle population some protection.

Tidal bays in the Bahamas, and probably throughout the West Indies, once served as refugia for small green turtles--offering abundant food; warm, quiet waters; and shallow depths that exclude most predators. Today, these areas serve as natural funnel traps. Turtle hunters visit these areas every few weeks or months and easily capture turtles that have accumulated during the interval. Conservation efforts are needed to protect sea turtles in these habitats.

ACKNOWLEDGMENTS

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SATELLITE TELEMETRY OF PELAGIC-STAGE JUVENILE LOGGERHEADS IN THE EASTERN ATLANTIC

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PROJECT OBJECTIVES

1. To conduct a preliminary study to determine the feasibility of using satellite telemetry to evaluate movements, diving behavior, and temperature preferences of juvenile pelagic loggerheads.

2. To evaluate satellite telemetry as a method to assess delayed mortality of turtles captured by long-line fisheries.

3. To develop a model to integrate data from satellite telemetry with remote sensing data to evaluate whether turtles are randomly distributed in the pelagic or are associated with currents and preferred temperatures.

Carr (1986) hypothesized that hatchling loggerheads from the southeastern U.S. become incorporated in the North Atlantic Gyre System and are carried past the Azores, Madeira, and Canary Islands before returning to the western Atlantic. Recaptures of tagged turtles have confirmed each leg of the trans-Atlantic movements (Eckert and Martins 1989; Bolten et al. 1992a,b; Bjorndal et al. 1994). The movement of Atlantic turtles into the Mediterranean has also been documented by tag returns (Bolten et al. 1992a) and confirmed by genetic analyses (Laurent et al. 1993). Mitochondrial DNA sequence patterns are being analyzed to confirm the relationships among the various pelagic populations.

Telonics model ST-6 transmitters (ST910218 software) were attached to two loggerheads with straight carapace lengths of 41 cm and 48 cm. These turtles are within the size range of loggerheads about to leave the pelagic for benthic habitats. Data are being collected on latitude and longitude, water temperature, and dive information. The duty cycle was set at 6 hours on / 6 hours off. The transmitters weighed 478 grams in air and displaced 380 grams of water. A regression equation was calculated to compute temperature from an 8 bit temperature count.

Silicone elastomer (Smith & Nephew Rolyan Inc., Menomonee Falls, Wisconsin, USA 53051) was used to construct a flat base to facilitate secure attachment of the transmitter over the turtle's central spines. The transmitter was attached using polyester fiberglass resin and cloth (Balazs et al., this volume).

The instrumented turtles were released at the site of capture. At the time of release, videos were taken to evaluate the swimming behavior of each turtle. The swimming movements of each turtle were normal.

CONCLUSIONS

1. The number and quality of transmissions received are very high because juvenile pelagic loggerheads spend long periods of time on the surface.

2. Satellite telemetry is a very useful method for evaluating movements, behavior, and survival of juvenile pelagic loggerheads and, therefore, can and should be used to assess mortality from long-line fisheries.

3. As expected, the number and quality of transmissions decline during periods of rough seas.

ACKNOWLEDGEMENTS

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MARINE TURTLE CONSERVATION IN MEXICAN NESTING BEACHES 1993-1994: BITMAR'S PROGRESS REPORT

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Background

Compilations of information on the status of marine turtle conservation in Mexico, as reported by the various research and conservation groups involved with these species have continued. The latest phase of this project, covering the summer '93- spring '94 season was carried out in collaboration with the Mexican National Commission for the Study and Use of Biodiversity (CONABIO after its initials in Spanish). This relationship has also provided a link between the marine turtle databases managed in BITMAR and the commission's nationwide Biodiversity Information Network (SNIB).

Information for this project was obtained from yearly survey questionnaires filled out by project leaders working on marine turtle conservation and research in government agencies, ngo's and universities. In some cases, data are also obtained from direct interviews or from relevant published or unpublished technical reports.

Various aspects are covered, facilitating long-term monitoring of progress in conservation activities and the status of nesting beach and the species which nest on them, and can be grouped as follows:

(1) Conservation status update- It includes a quantification of coverage and effort of conservation activities at each beach, identification of the species and the seasonality of their reproduction, an estimate of the number of nesting females, number of nests, eggs and hatchlings protected, and an appraisal of the extent of predation and direct or indirect human impact on the turtles for the season under survey.

(2) Geographic information- georeferenced data of the nesting beaches, covering its precise location and extension.

(3) Ecology- these data are periodically reviewed and identify the types ecosystems present in the nesting beach and adjacent areas, extent of anthropogenic threats to the nesting beach and/or adjacent ecosystems, besides a classification of official protection status in the cases where the nesting beach resides within a natural reserve (e.g. National Park, Special Sea Turtle Reserve, Biosphere Reserve, etc.)

(4) Bibliography database- a collection of sea turtle related citations, particularly of published or un-published literature produced in Mexico

and is periodically updated. Of major importance here is information on technical reports and student theses.

(5) Directory- this database holds information on all persons and institutions which work with sea turtles in Mexico.

OVERALL RESULTS FOR THE 1993-94 SEASON.

Out of a total of 184 localities catalogued in BITMAR as sea turtle nesting beaches in Mexico according to available reports, information for 91 was obtained for this season (49% of the total). The beaches surveyed, however, include the most prominent rookeries for each of the species nesting on our coasts.

Of the total kilometers covered by the survey, 73% of the total extension was reported as having protection programs, 13% had partial protection, 11% had no protection at all, and the remaining 3% occurred in areas sufficiently isolated so that no additional protection was required to ensure adequate conservation of the nesting turtles. The conservation programs implemented were of various types: full-time conservation camps (covering 54% of the total extension surveyed), conservation operations not based in a permanent or semi-permanent camp on the beach (30%), and beach prospections (8%). We have no information on the types of conservation program operating in the remaining protected areas (8%).

Overall results provide a general view of the extent of marine turtle nesting in Mexican beaches (see table) while data on the number of nests, eggs and hatchlings included in the table give an indication of the degree of succes from conservation activities covering the different species during this season.

On the other hand, even though information was obtained from conservation programs dealing with the most important rookeries for each of the species, it is difficult to get a clear picture of the coverage achieved with respect to the full extent of nesting beaches actually present in our coasts. Noting that we cannot presently monitor each and every nesting beach, and that nesting activities for many rookeries are very low and tend to fluctuate naturally between years, it is nearly impossible to determine the true total number of beaches used by the species every season. For the present report, an approximation of the total number of "potential" nesting beaches (PNB) was attempted for each species, however, by identifying the beaches for which some evidence exists that nestings have taken place in recent times (second column in table). With this information, the extent of coverage achieved was expressed by calculating the proportion of PNB included in the survey (third column).

The fourth column (% of surveyed beaches with <u>zero</u> nestings reported) gives a very rough but illustrative estimation of tendencies towards reductions in the reproduction areas for the species. Thus, the relatively high proportion of zero-nest beaches within the surveyed nesting areas of <u>Chelonia agassizi</u>, <u>Eretmochelys imbricata</u>, and <u>Dermochelys coriacea</u> is suggestive of a trend in this direction. On the other extreme, the lack of beaches with zero nests from <u>Lepidochelys olivacea</u> in its range would be indicative of stability, at least as far as the amplitude of its reproductive zone is concerned.

FUTURE PROSPECTS

There are various medium and long-term advantages and implications which derive from the data gathering which is being carried out. The sharing of general but vital statistics in a useful, standard and, thus, readily comparable and inter-compatible formats among Mexican marine turtle specialists is facilitated and promoted. This will promote an efficient and effective use of the information in the monitoring of the status of marine turtle populations and the effectiveness of conservation programs. In turn, multivariate key information will be provided for strategy planning, priority settings, and decision making at a national scale, be it for marine turtle-specific programs or for integral coastal management plans. The sea turtle data is incorporated into the SNIB network, where they become readily available to government decision-makers implicated in official regional planning and development. This strategy seeks to foster the implementation of adequate environmental policies. There are, however, certain aspects of BITMAR's monitoring activities which will be developed in the short term to obtain a full benefit of this approach: (1) increase the number of nesting beaches surveyed, (2) incorporate less well known rookeries into the nesting beach catalogue, (3) select key nesting beaches to be used as indicators of demographic trends for distinctive populations of each of the species and of modifications in the environmental quality. This will provide a more robust monitoring capacity which will, in the medium and long term, permit a realistic evaluation of the conservation status of the sea turtles and of Mexico's conservation programs.

BITMAR is currently analyzing mechanisms and legal issues to be defined which will allow for effective and equitable exchange of data among international institutions and nations sharing sea turtle species, with the ultimate aim of supporting regional strategies for sea turtle conservation.

OVERALL RESULTS FOR MARINE TURTLE CONSERVATION PROGRAMS IN MEXICO
BITMAR'S SURVEY FOR THE 1993-1994 NESTING SEASON

Species	Survey Coverage for this Species			Conservation Results				
sp. (distribution)	potential nesting beaches (PNB)	% of PNB surveyed	% of surveyed beaches with NO nestings observed	protected nests	number of eggs protected	average clutch size (eggs)	overall number of hatchlings	average hatching success
C. caretta (GM+C)	71	54%	11%	2,038	209,721	102.9	166,171	79.2%
Ch. agassizi (P)	43	35%	47%	634	47,450	74.8	31,861	67.1%
Ch. mydas (GM+C)	88	52%	15%	626	68,533	109.5	53,850	78.6%
E. imbricata (P+GM+C)	31	48%	40%	1,212	179,025	147.7	115,855	64.7%
L. olivacea[1] (P)	94	37%	0%	388,908 [2]	39,915,645 [2]	102.6	12,663,749 [2]	31.7%
L. olivacea[3] (P)	-	-		32,308	2,915,645	90.2	1,663,749	57.1%
L. kempi (GM)	10	80%	13%	1,287	123,168	95.7	80,829	65.6%
D. coriacea (P+GM+C)	61	46%	54%	1,935	139,163	71.9	47,313	34.0%
Overall totals	184 beaches catalogued in BITMAR	91 beaches surveyed	-	40,040 [3] 396,640 [1,2]	3,682,705 [3] 40,682,705[1,2]	-	2,159,628 [3] 13,159,628 [1,2]	-

GM= Gulf of Mexico; C= Caribbean; P= Pacific Ocean

[1] including data from Escobilla, Oaxaca

[2] information from Escobilla, Oaxaca included here was estimated by the informants

[3] excluding data from Escobilla, Oaxaca

THE REPRODUCTIVE EFFORTS OF CHELONIA MYDAS AND CARETTA CARETTA IN NORTHERN CYPRUS.

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In 1992 Glasgow University was invited by the Society for the Protection Of Turtles in Northern Cyprus to conduct a survey of the nesting beaches on the coast of northern Cyprus. Subsequently a team of students and staff from Glasgow University have been involved in monitoring of the nesting activities of the endangered green (Chelonia mydas) and loggerhead (Caretta caretta) marine turtles. In the Mediterranean there are estimated at being only 300-400 C.mydas and 2000 C.caretta females nesting annually (Groombridge 1990).

Previous to this work, a brief field study of northern Cyprus beaches by Groombridge and Whitmore (Groombridge 1988; Groombridge and Whitmore in 1989) gave minimum estimated nesting populations of 40 C.caretta and 32 C. mydas during their 28 day study. Interim surveys by members of KKKKD/SPOT had found numbers greatly in excess of these (pers. comm. I.E. Bell). In southern Cyprus the annual turtle nesting population is estimated at some 75 C.caretta and 25 C. mydas (Demetropoulos & Hadjichristophorou 1989).

METHODS

Beaches in all of the six zones (Map 1) were surveyed every three days to record nesting, hatching and predation activities. In addition, the main nesting site at Alagadi, lying 11 miles east of Kyrenia (Girne) was surveyed on a daily basis with nightly patrols throughout the nesting season.

RESULTS AND DISCUSSION

In 1992, 84 beaches were surveyed with 65 being recorded as having turtle activity and a minimum of 219 nest were recorded as laid (Godley & Broderick 1992). In 1993, 68 beaches were recorded as having turtle activity, with 571 successful nestings recorded (Broderick & Godley 1993). In 1994, on 80 beaches, 980 nests were recorded (Godley & Broderick 1994). Assuming that each female lays an average of three nests per season, the population estimates resulting from these observations indicated that in northern Cyprus, in 1992, a minimum of 29 C.mydas and 23 C.caretta nested, in 1993, 107 C.mydas females and 82 C.caretta and in 1994, 154 C.mydas and 173 C.caretta nested respectively. Although some of this increase was a result of greater efficiency in surveying methods, with the discovery of new beaches, there was seen to be an absolute increase in numbers on most of the beaches surveyed (Broderick & Godley 1993). Table 1 shows the nesting numbers recorded for each of the six zones in 1992, 1993 and 1994. If the population estimates for the Mediterranean are accurate then approximately 20-30% of the C.mydas and 5-10% of the C.caretta females of the Mediterranean population nesting in northern Cyprus. The continuation of this project is therefore vital to the overall conservation of marine turtles in the Mediterranean.

For interpretation of the results, the nesting and hatching data were divided on a weekly time scale with week 0 starting on the 29th May and week 18 ending on the 8th October. The results from the 1994 survey are used to illustrate the overall pattern and statistics of nesting and hatching.

In 1994, 2473 nesting activities were recorded, with 980 being nests (461 C.mydas and 519 C.caretta). The first nesting activities of 1994 were recorded between the 30th May - 22nd of August. Figure 1 shows the temporal spread of nesting for each species. From the data available for the rest of the Mediterranean, there appears to be great variation in the timing of the nesting and hatching season. Certainly in northern Cyprus, the 1994 season started earlier than in previous years, possibly due to the higher than normal temperatures experienced in May and June.

Of the unsuccessful nesting attempts recorded, 795 were False Crawl Attempts and 698 were False Crawl U-turns. Comparing the total activities with the total nests recorded, an overall emergence success can be calculated. This is fairly constant for each zone with a mean of 40%. This figure obviously varies a great deal between beaches, as can be seen in the detailed reports, but is useful to examine problems that females may be experiencing nesting beaches or in certain areas of beach. However an emergence success of 40% compares favourably to that of 15.5% found by Coley and Smart (1992) in Kazanli, for C.mydas.

In 1992, 18 females were tagged at Alagadi, in 1993, 25 females, and in 1994, 48 new females were tagged (30 C.caretta and 18 C.mydas). In addition 5 females (4 C.mydas and one C.caretta) of those tagged in 1992 and one (C.caretta) tagged in 1993, returned to nest. Of these returns, 2 had lost one of their 2 tags which were replaced. This gives a loss of approximately 10% pa.

Curved carapace sizes of females, inter-nesting intervals and incubation periods of laid nests at Alagadi are shown in table 2. As has been found in many other studies, C.caretta and C.mydas in the Mediterranean are generally smaller than those found in other parts of the world. There are few data available to compare inter-nesting periods in the Mediterranean, but they are comparable with those found for the two species world-wide. The incubation periods of C.caretta nests in northern Cyprus are, however lower than reported elsewhere in the Mediterranean, possibly due to high temperatures that prevail. Peters & Verhoeven (1992) quote a mean incubation period of 55 days for C.caretta in the Gŏksu Delta, and similarly Margaritoulis (1989) quotes 55.5 days in Peloponnesus. Few data are available on incubation periods for C.mydas in the Mediterranean.

Hatching in 1994 was recorded between the 20th of July - 27th September (figure 2). Again, these dates are earlier than in 1992 and 1993, because of the early start in the nesting season. Of the nests laid, 402 were recorded as hatched. These were 174 of the C.mydas, 160 C.caretta and 68 unidentified to species. Variations for Individual zones are shown in table 3 for 1992, 1993 and 1994 respectively. The parameters of the hatched nests around the whole of the survey area in 1994 are shown in table 4. Mean success of hatched nests is high in both species, however many nests failed to hatch partially due to high levels of predation and some overwash. In addition, due to the 3 day surveying and predator effects, recording of some hatched nests may have been lost.

Mean clutch size for C.mydas of 123.09 eggs compares favourably with those found in the Mediterranean and word wide, however the mean clutch size of C.caretta is low at only 70.39 eggs. Margaritoulis (1989) recorded a mean clutch size of 117.7 eggs for C.caretta nesting in Peloponnesus. It is important to note that, of the overall total number of nests laid, 163 were at Alagadi. These were 68 C.mydas and 95 C.caretta nests. In addition, at Alagadi, 123 nests were recorded as hatched, which, as a percentage of nests laid, is very high (75%). Only 7 nests were predated here, only one occurring prior to the night patrols ending.

The threats to marine turtles, in particular predation, in N. Cyprus are discussed by Godley et al in these proceedings. Further information on this work, and for individual beaches is available in the 1992, 1993 and 1994 reports (Godley & Broderick 1994; Broderick & Godley 1993; Godley & Broderick 1992). It is hoped that through the continuation of this work, with KKKKD/SPOT and the local authorities, a long term research and conservation project can be established which, as the numbers have shown, is vital to the long term prospects of marine turtles in the Mediterranean.

ACKNOWLEDGEMENTS

These findings are the result of a three year program of Glasgow University, The Society for the Protection of Turtles in Northern Cyprus (KKKKD/SPOT) and the local Department of Environmental Protection. The authors acknowledge support from Prof: J.B.S Boyd, Glasgow Vet. School and the Overseas Student Travel Award which enabled attendance at this conference. Glasgow University Turtle Conservation Expeditions were given financial support from: British Chelonia Group; British Ecological Society; Carnegie Trust for the Universities of Scotland; Cross Trust; Gilchrist Educational Trust; Glasgow University Court; Institute of Biology; MEDASSET, U.K.; Peoples Trust for Endangered Species; Royal Geographical Society; Royal Scottish Geographical Society. None of this work would have been possible without the 50 students and staff who have raised/contributed over half of all costs as well as carrying out this work.

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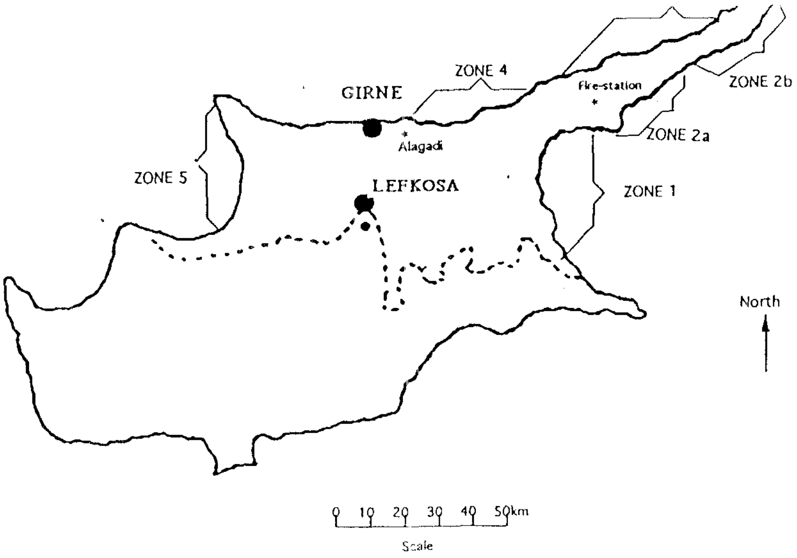

Map 1. Northern Cyprus and study zones.

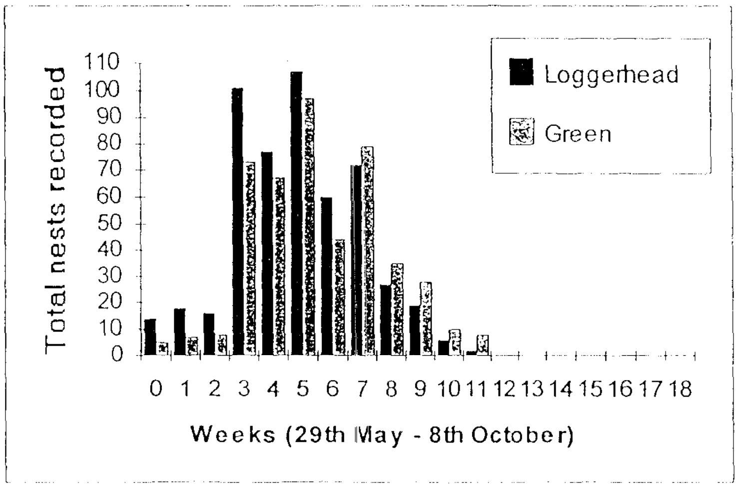

Figure 1. The temporal distribution of nests laid in northern Cyprus in 1994.

	Nesting											
COAST	1994				1993				1992			
	G	L	?	Total	G	L	?	Total	G	L	?	Total
Zone 1	3	74	0	77	1	24	2	27	1	9	4	13
Zone 2a	5	116	0	121	12	48	1	61	Not surveyed			
Zone 2b	112	62	0	174	63	30	1	94	10	10	14	34
Zone 3	162	81	0	243	117	40	2	159	17	7	19	43
Zone 4	98	168	0	266	62	84	0	146	53	39	18	110
Zone 5	81	18	0	99	65	19	0	84	Not surveyed			
TOTAL	461	519	0	980	320	245	6	571	81	65	55	200

Table 1. A comparison of the total number of nests recorded for each zone in 1992, 1993 and 1994, northern Cyprus. G - C. mydas, L - C. caretta, ? - unidentified to species.

Mean ± standard error	Chelonia mydas	Caretta caretta
Female length (cm)	96.38 0.825, n=37	72.95 0.743, n=43
Female width (cm)	86.12 1.101, n=37	64.53 0.584, n=43
Inter-nesting interval (days)	13.11 0.322, n=18	14 0.477, n=12
Incubation period (days)	51.36 0.533, n=45	47.86 0.359, n=58

Table 2. Nesting statistics for 1994 at Alagadi, northern Cyprus..

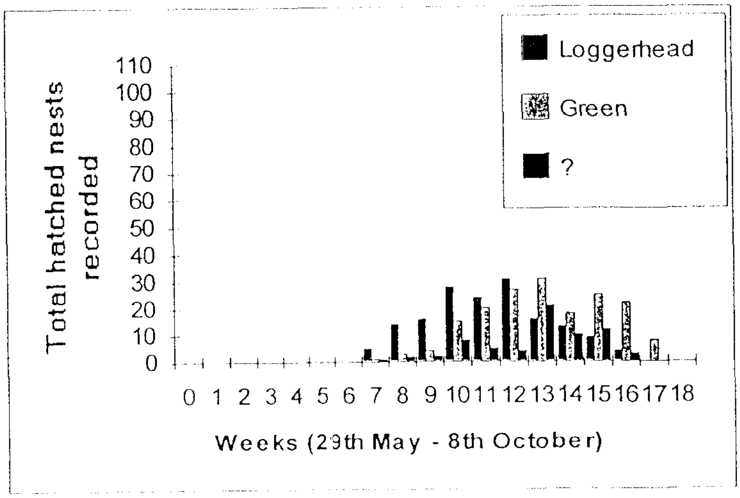

Figure 2. The temporal distribution of nests hatched in northern Cyprus in 1994.

	Hatching											
COAST	1994				1993				1992			
	G	L	?	Total	G	L	?	Total	G	L	?	Total
Zone 1	1	29	1	31	2	12	4	18	0	7	5	12
Zone 2a	0	13	6	19	4	6	1	11	Not surveyed			
Zone 2b	39	9	7	55	12	4	6	22	1	0	3	4
Zone 3	64	18	38	120	15	9	9	33	7	5	0	12
Zone 4	61	88	5	154	32	28	1	61	40	36	41	117
Zone 5	9	3	11	23	5	1	8	14	Not surveyed			
TOTAL	174	160	68	402	70	60	29	159	48	48	49	145

Table 3. A comparison of the total number of hatched nests recorded for each zone in 1992, 1993 and 1994, northern Cyprus. G - C. mydas, L - C. caretta, ? - unidentified to species.

Mean ± standard error	Chelonia mydas	Caretta caretta
Clutch size	123.09 3.042, n=127	70.39 1.903, n=128
Success of nests (%)	83.75 1.780, n=125	81.56 1.718, n=124
Depth of nest-top (cm)	69.3 1.156, n=117	38.64 0.702, n=116
Depth of nest-bottom (cm)	86.84 1.249, n=117	52.138 0.790, n=116

Table 4. Hatching statistics of unpredated nests for 1994 in northern Cyprus.

ARGOS JOINT TARIFF AGREEMENT

Terry E. Bryan

NOAA Office of Global Programs, Silver Spring, MD 20910

BACKGROUND

The Argos "Operations" Memorandum of Understanding (MOU) on cooperation between the United States and France to implement and operate the Argos Data Collection and Platform Location System on the TIROS-N series satellites allows the Centre National d'Etudes Spatiales (CNES) to recover costs associated with services provided to users. Wishing to simplify the negotiations with potentially many users, Service Argos offered the prospect of a single price to provide fair, cost-effective, and simple procedures for Government sponsored users of the system. The Agreement originally was for the United States, but has expanded to include Members of the World Meteorological Organization (WMO) and Member States of the Intergovernmental Oceanographic Commission (IOC).

TARIFF NEGOTIATIONS

The structure and means of calculating the tariff have been modified over the years as the system and needs of the users have changed. Initially, the tariff was negotiated based on the subsidized expenses of Service Argos and the amount of processing required. With the increased use of Local Users' Terminals (LUT's), a three tiered pricing structure was introduced. Subsequently, "Limited Use" and "Inactive" categories were added.

In 1985, Service Argos began operating as a non-subsidized organization. Thus, formulas were devised and modified to compute the yearly tariff, such that Service Argos would be totally self sufficient by 1990. Also, as part of the Argos MOU, CLS can recover 70% of the losses incurred from 1984 through 1990 (FF 99.37M). By agreement, participants in the JTA would be responsible for a negotiated portion of the operating expenses and repayment of one half the accumulated debt by 2000. The tariff per Platform Year (P/Y) is this amount divided by the number of P/Y committed. The remaining portion is to be funded through commercial users of the system.

In applying these rules, the estimated operating costs for 1995 are FF 55.734M of which the JTA is liable for FF 29.706M. Dividing this by the committed platform years (1,220 from 26 countries) results in a cost of FF 24,349 per platform year. The meeting decided to set the rate for 1995 at FF 26,000 and apply the total resulting surplus to the accumulated debt. This is a reduction of FF 1000 from 1994.

CURRENT CATEGORIES OF SERVICES

Under the Joint Tariff Agreement, CLS and SAI will perform the categories of services outlined in Table 1.

OTHER CHARGES

1. Supplemental:
   As an <u>average</u> per individual Agreement and per category of service there will be no more than six (6) locations or no more than ten (10) data acquisitions for a platform-day allowed without additional financial cost.

2. Charges NOT Covered by the JTA:
   The following charges will be paid by the users directly to CLS or SAI as defined in the annual price list:

   a. The modification of platform characteristics (number of sensors, calibration curves, etc.), and

   b. Special off-line arrangements made to provide processed data back to the users (e.g., periodic printouts, once per fortnight data discs, etc.)

ELIGIBILITY AND PARTICIPATION

Programs eligible for the preferential tariff under this Joint Tariff Agreement are limited to those users represented by a government signing a MOU with Collecte Localisation Satellites (CLS) or Service Argos, Inc. (SAI) and are government funded or considered non-profit. Users funded partly or entirely by private companies or organizations cannot be included in the Agreement, even if data are supplied free of charge to national or international organizations.

To negotiate and administer the Agreement, each country or group of countries has a designated Representative Organization for a Country (ROC). It is the responsibility of the ROC to determine the total number of platform years of processing required for the next calendar year since the Agreement is predicated on a guaranteed amount of processing. Thus, the ROC, in agreeing to (signing) the Terms and Conditions, is committed to paying the negotiated amount to CLS or SAI.

It is incumbent upon the user to file the necessary applications and service agreements with CLS or SAI. It is also mandatory that the users provide the ROC with an estimate, as accurate as possible, of their requirements and other requested information for the upcoming calendar year. (See Table 2.)

FUTURE CONSIDERATIONS

When considering the structure of the Tariff Agreement the JTA Meeting agreed that:

1. charging for any service should be related as nearly as possible to the actual cost in providing the service;
2. costs to the user should reflect the services actually received and perceived by the user;
3. there is a requirement for a basic charge, since any platform transmitting through the system incurs a cost to CLS or SAI;
4. any changes to existing services should be introduced over several years to give users time to adjust their programs and requirements; and
5. any changes should aim at simplifying the tariff structure as much as possible for users, CLS/SAI, and the Representative Organization for the Country.

Since CLS is charged with the responsibility to monitor, process, and promote the overall Argos System, the actual costs incurred in providing the different classes of service are essentially the same but transparent to the user. Thus, 1. and 2. above are diverging concepts, making it impractical to plan a long-term evolution of the tariff structure. Emerging problems will be addressed on a case-by-case basis.

In addition to the annual review of the existing tariff structure, the following proposals are being studied and will be considered at the JTA XV, October 23-25, 1995:

a. Incentive Tariff

A special incentive tariff rate might be applied to those users who have taken steps to work together and establish co-operative programs, since such programs most probably will lead to an overall increase in the total number of platform years committed under the Agreement.

b. Active PTT Charge

A monthly minimum use charge may be implemented for those platforms active within the Argos System, that show up randomly and seldom, therefore generating low income to CLS/Service Argos but requiring a substantial amount of work.

c. Argos ID Charge

This would be a monthly charge levied for each platform ID allocated by Argos, whether or not the ID is actually in use. The imposition of this charge would encourage users to releases surplus IDs and so ease a problem that Argos is now facing with regard to an impending shortage of IDs for new programs.

SUMMARY OF SERVICES AND TARIFFS TO USERS

UNDER THE JOINT TARIFF AGREEMENT

Processing by CLS or SAI	Category	Repetition Period	Location Computed	Data Collection and Sensor Processing	On-Line Data Access	Data Archiving	Tariff
Standard	1	≤ 120 sec	Yes	Yes	Yes	Yes	X
	2	≥ 200 sec	No	Yes	Yes	Yes	X/2
Limited Use	1 a	≤ 120 sec	Yes	Yes	Yes	Yes	*
Back-up	3	≤ 120 sec	Yes	Yes	No	Yes	2X/5
	4	≥ 200 sec	No	Yes	No	Yes	X/5
Inactive Status	5		No	No	No	No	X/6

* Users will be charged the standard data collection and location rate for actual PTT days used up to a maximum of ten per month.

Table 1

Table 2 *CY 1995 ARGOS REQUIREMENTS*

COMPUTATION WORKSHEET

NAME:

AFFILIATION: FUNDING AGENCY: GRANT/ CONT.#

EXPERIMENT NO(S).: EXP TITLE:

CATEGORY OF SERVICE (Explanation on Back)	TYPE OF PLATFORMS (Drifting Buoy, Caribou, Ship, etc.)	NUMBER OF ID'S ASSIGNED TO EXPS.	NUMBER OF ACTIVE PLATFORMS (PTTs)	A. NO. OF DAYS OF TRANSMISSION FOR ALL PTTs CY 1995	B. PLATFORM TRANSMISSION YEARS (A/365)	C. COEFFICIENT	PLATFORM YEARS (B. X C.)
1 - Standard (Loc.)						X 1 =	
2 - Standard (Data)						X 1/2 =	
1a - Limited Use				* see below		X 1 =	
3 - Back-up (Loc.)						X 2/5 =	
4 - Back-up (Data)						X 1/5 =	
5 - Inactive						X 1/6 =	
TOTALS							

REMARKS:

* FOR 1a: COUNT ONLY THE FIRST TEN DAYS OF TRANSMISSION FOR EACH PTT PER MONTH

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RESPONSES OF SEA TURTLE HATCHLINGS TO SIMULATED PREDATION

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Sea turtle hatchlings have very high mortality rates, and a significant source of natural mortality is predation. This study examined possible mechanisms that hatchlings might possess for eluding predators that have made contact. Responses to different levels of simulated predation were measured to determine the likelihood of three species of captive sea turtle hatchlings using tonic immobility as a form of predator avoidance.

METHODS

The subjects were obtained from random samples from a single clutch of hatchlings from three species of sea turtles: loggerhead (Caretta caretta), green (Chelonia mydas), and hawksbill (Eretmochelys imbricata). They were housed together by species in a 1 m X 2.25 m wooden holding tank that was filled with sea water to a depth of about 0.25 m. The tanks were located on the beach of the research site in X'cacel in Quintana Roo, Mexico on the Yucatan Peninsula.

The loggerhead and hawksbill subjects were exposed to four types of simulated predation: (1) no physical contact (NONE), (2) a light touch to the carapace (TOUCH), (3) held for 3 s and returned to the surface of the water (HOLD), and (4) held inverted for 3 s and returned to the water right side up (TURNOVER). Loggerheads received all four treatments for three days, and hawksbills received them for two days. Greens were only given NONE and HOLD treatments each day for three days. The order of treatments within days was counterbalanced to prevent order effects. The latency for the hatchlings to begin moving was recorded after each simulated predation treatment.

RESULTS AND DISCUSSION

Loggerhead hatchlings took significantly longer to begin moving after the three types of simulated predation (TOUCH, HOLD, and TURNOVER) than with when they received no contact (NONE). When given the HOLD treatment, they had the longest average latency to move - significantly longer than with TOUCH.

Green hatchlings had significantly shorter latencies to begin moving after simulated predation (HOLD) relative to NONE. Although no systematic observations were made, green hatchlings usually struggled while being held.

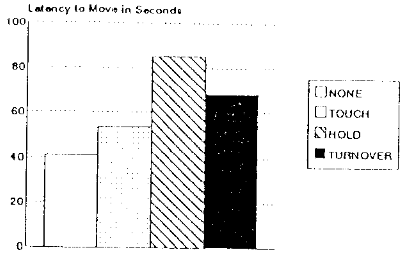
The behavior of the hawksbill hatchlings varied significantly on each of the two days of testing. On the first day of testing, latencies were short, and there were no significant differences in average time to begin moving among conditions (NONE, TOUCH, HOLD, and TURNOVER). On the second day latencies were much longer than on the first day. Also, the TURNOVER treatment resulted in a shorter average latency to begin moving than in NONE and TOUCH conditions.

Differences in responses to simulated predation may be related to physiological and other behavioral differences among the three species in this study. Species differences may reflect specializations for using tonic immobility as an antipredator mechanism relative to active avoidance. Differences in antipredator behavior among these species may be related in a systematic way to other behaviors (i.e., orientation, foraging and habitat selection) during the early part of the pelagic stage of development.

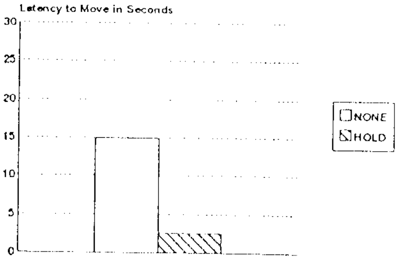
ACKNOWLEDGEMENTS

We thank our colleagues of the Centro de Investigaciones de Quintana Roo. This research was supported by NSF Grant IBN-9300264 and the Research Enhancement Program of the University of Texas at Arlington.

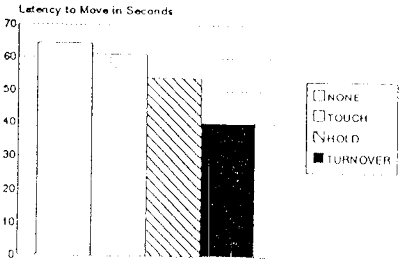
Loggerheads (*Caretta caretta*)



Greens (*Chelonia mydas*)



Hawksbills (*Eretmochelys imbricata*)



GROWTH AND MORTALITY OF HATCHLING OLIVE RIDLEYS UNDER CAPTIVITY DURING ELEVEN MONTHS.

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Between november of 1989 and january 1991 a culture of olive ridleys was carried out about at the Centro Tortuguero Playon de Mismaloya, Jalisco, Mexico, with the objective in mind to optimiz the culture techniques of the sea turtles including health, feeding and behavioral aspects on one hand, and the other estimate the turtles growth within the study period.

METHODS

A design was initiated with the objetive of maintaining in captivity 180 olive ridley hatchlings (*Lepidochelys olivacea*) during their first year of life. The holdings tanks used for the turtles were of three types: six rectangular plastic crates with a holding capacity of 60 L.; six fiberglass circular tubs with a holding capacity of 150 L., and concrete pools that measured 5 x 1 x 0.60 m, located within the six perforated plastic crates thus dividing the experimental lots.

The hacthlings were fed on three different diets a) commercial balanced feeding with 38% protein, b) fresh fish bits and c) a mixture of both above on a ratio 1:1 of the balanced food and the fresh fish bits. The total quantity offered daily was 8% of the total corporal weight of each lot after each change of marine water. As a result this gives us nine treatments each one with its respective replica in order to obtain a total of 18 lots with ten initial hatchlings in each one (Table 1).

In order to obtain data on their growth a record of their weight and size was kept (C.L), the first being every 15 days and keeping in mind the adjustments in the quantity of nourishment given to the hatchlings and the second one monthly. The mortality data was acquired directly from the growth count of the organizms that were taken during registered treatments. This records initated in January 1990 .

RESULTS AND DISCUSSION

Growth

An analysis of variance was done betwen the original and the replica lots in their treatments and it was found that there wasn't any significant differance in 91% of the analysis which prompted us to proceed with a two ways analysis between the treatments used, both results indicated that in the 91 % of the cases there existed a significant difference due to holding tanks and nourishment.

In table 2 are found the monthly averages of weights and sizes of the hatchlings *Lepidochelys olivacea* that were obtained throughout the study period.

The results indicated that the best growth in weight and size were in 1) the crate with fresh fish feedings, 2) the tub with mixtured feedings and 3) the concrete pools with fresh fish feedings. However, the tub-mixture resulted in a better optimum growth of the hatchlings.

Since this treatment presented a greater growth we proceeded to describe the weight-size relationship (figure 1) during the confinement time (Pauly 1983), the equation that adjusted was:

$$Y = \mathrm{Log}\ -1.00581 \times X^{2.67616}$$

with $r = 0.9860$

The aproximity of the parameter B (2.67616) having a value 3 suggests the growth of the organizms in this treatment have a tendancy to be isometric (Erhardt 1981).

The olive ridley is a species that in its natural environment nourishes itself generally through animal organizms, which makes it possible that due to this they wouldn't accepted completly the balanced feed. Still if the nourishment is not consumed within the two hours after its is proportioned it soaks and disolves in the water which is not completely utilized by the hatchlings. Contrary to this the fresh fish nourishment was consumed immediately or shortly thereafter. It is worth mentioning that the caracteristics of the three holding tanks could have influenced the general behavior of the hatchlings.

<u>Mortality</u>

To perform the analysis of mortality we used chi square (Table 3), where by we observed that in five out of the nine treatments there were significant differences between the original lot and its replica.

In the graph analysis we can see that in the treatments that presented less mortality were those of the tub-fresh fish and tub-mixture (figure 2). The chi square in this treatments show no significant differance between the lots.

On the other hand the lots that had higher mortality were those treated in the tank crates with balanced nourishment, the tub-balanced and the concrete-balanced (figure 3). It is quite posible that these findings are related to palliative undesirability or a poor diet.

The percentage of mortality at the end of the study was 38%.

It seems that the type ef tanks and food used during the captive time of the sea turtles are important factors in the growth of its hatchlings as well as in their health and consequently in the mortality of the same.

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TABLE 1. General design of the culture, treatments with their respective replicas.

	HOLDING TANKS		
DIET	CRATE	TUBS	CONCRETE
BALANCED	lot 1 lot 2	lot 1 lot 2	lot 1 lot 2
FRESH FISH	lot 1 lot 2	lot 1 lot 2	lot 1 lot 2
MIXTURE	lote 1 lot 2	lot 1 lot 2	lot 1 lot 2

TABLE 2. Weight (gr) and size (cm) average that was obtained from the hatchlings olive ridleys during the study time.

a)

MONTH	TREATMENT								
	CRATE			TUBS			CONCRETE		
	balanced	fresh	mixture	balanced	fresh	mixture	balanced	fresh	mixture
1	26.98	35.25	37.00	25.03	33.77	36.06	26.84	26.88	26.76
2	31.30	52.70	60.45	30.71	53.41	58.73	32.01	38.52	35.86
3	36.92	68.79	85.70	37.00	74.08	85.91	42.26	56.09	53.90
4	51.59	102.60	109.59	42.07	101.83	115.96	49.80	75.68	72.22
5	61.62	134.25	149.60	53.49	134.80	164.92	54.42	102.01	94.45
6	83.22	182.88	208.92	73.92	190.94	236.68	62.98	131.09	118.31
7	110.36	229.68	245.23	103.95	230.50	290.20	94.33	147.00	146.13
8	184.05	321.97	335.63	163.40	304.36	407.40	145.73	212.16	196.11
9	286.65	427.82	460.37	291.27	430.44	541.93	258.34	308.29	348.10
10	366.66	594.16	588.20	413.54	540.04	740.71	427.50	380.29	396.20
11	572.90	774.61	764.78	529.01	735.86	946.80	486.11	496.24	450.23

b)

MONTH	TREATMENT								
	CRATE			TUBS			CONCRETE		
	balanced	fresh	mixture	balanced	fresh	mixture	balanced	fresh	mixture
1	5.07	5.56	5.78	5.17	5.65	5.85	5.32	5.24	5.15
2	5.46	6.60	6.69	5.40	6.60	6.57	5.57	5.80	5.77
3	5.90	7.01	7.62	5.65	7.13	7.46	6.20	6.54	6.42
4	6.47	8.05	8.38	6.09	7.84	8.29	6.30	7.17	7.07
5	7.81	9.12	9.57	6.65	8.97	9.75	7.36	8.63	8.61
6	8.03	10.48	10.88	7.59	9.99	11.06	7.09	8.60	8.45
7	8.63	10.55	11.00	8.45	10.43	11.43	8.29	9.52	9.55
8	10.43	12.78	12.93	10.18	12.21	13.71	9.82	11.17	11.06
9	12.03	14.19	14.76	11.91	13.92	15.68	12.27	12.68	13.30
10	13.92	15.75	15.80	13.92	14.68	17.04	13.71	13.69	13.77
11	15.51	16.63	17.05	16.00	16.33	18.32	15.08	15.06	15.34

TABLE 3. Ji square of mortality between lots of each treatment

DIET	HOLDING TANKS		
	CRATE	TUBS	CONCRETE
BALANCED	X =3.40 gl 10	X =7.81 gl 10	X =8.81 gl 10
FRESH FISH	X =5.79 gl 10	X =0.66 gl 10	X =12.37 gl 10
MIXTURE	X =4.94 gl 10	X =0.72 gl 10	X =1.76 gl 10

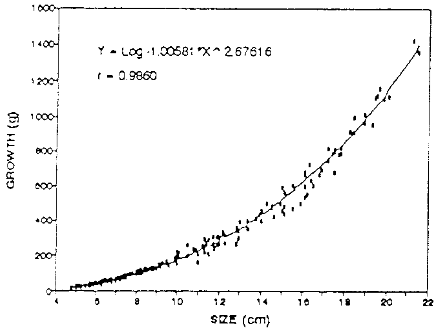

FIGURE 1. The relationship weigh-size as treated tub mixured

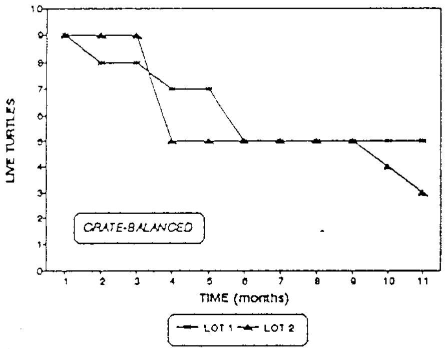

FIGURE 2a. The highest index of mortality as presented in the crate-balanced.

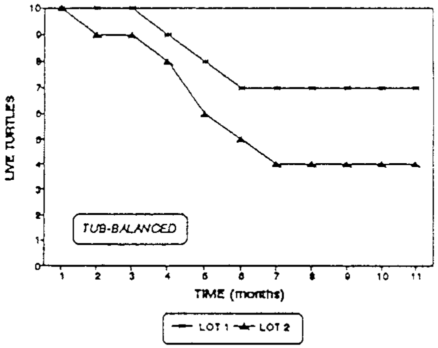

FIGURE 2b. The highest index of mortality as presente In the tub-balanced.

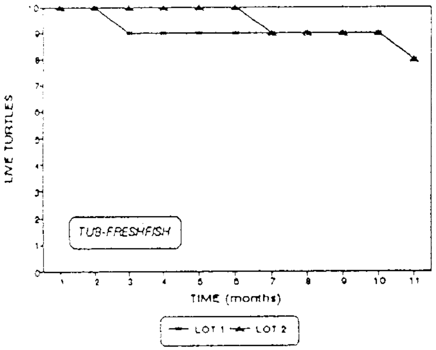

FIGURE 3a. The lowest index of mortality as observed in the tub-freshfish.

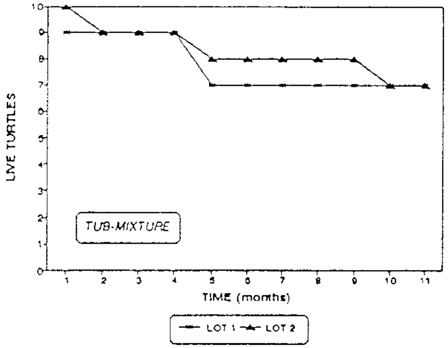

FIGURE 3b. The lowest index of mortality as observed in tub-mixtured.

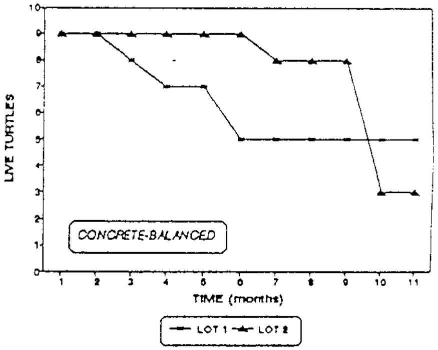

FIGURE 2c. The highest index of mortality as prese In the concrete-balanced.

ESTABLISHMENT OF THE INDIGENOUS COMMUNITIES AND MISKITO CAYS BIOSPHERE RESERVE IN NICARAGUA

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Miskitu Indians have been harvesting marine resources such as fish, marine turtles, shrimp and lobster for food along the Atlantic coast of Nicaragua for several hundred years. More recently these resources also provide a source of income. Commercial harvest of shrimp and lobster along the Atlantic coast has been increasing. This increased harvest by both traditional and commercial interests threatens the conservation of these resources and the ecosystems on which they depend making it necessary to manage harvest activities. The Indigenous Communities and Miskito Cays Biosphere Reserve (Reserva de Biósfera de las Comunidades Indígenas y Cayos Miskitos) has been established in part to manage the harvest of natural resources and maintain the biodiversity of the region.

The establishment of this reserve began in the 1980's and received legal recognition in 1991. It covers approximately 12,000 km^2 which includes 38 indigenous communities along a 20 km wide coastal fringe and numerous uninhabited offshore cays, reefs and shoals in northeast Nicaragua. The Miskitu Indians have been involved in the decision making process as part of the bottom-up approach that has been employed throughout the development of the reserve.

Community based meetings were conducted to solicit the concerns and needs of the indigenous population with regard to the current harvest of natural resources. Although marine turtles are an important resource to the Miskitu Indians, the availability of this resource was not identified as an area of concern by the local people. The reason for this is probably because there is no competition for this resource between the communities and commercial fishing interests.

However, local people have recently been employed to collect data on the exploitation rate of marine turtles. This information has been compiled and presented to the communities harvesting turtles. As a result people are better informed about their use of this resource and therefore, they can better assist in managing their resources. We believe this bottom-up approach will be more successful than a traditional approach to resource management. The people dependent on marine turtles will assist in regulating themselves and through compromises will ensure the long-term survival of this resource on this important foraging ground.

RESEARCH ON L. OLIVACEA IN LA FLOR, RIVAS, NICARAGUA, 1993 TO 1994

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Introduction

On Nicaragua's Pacific coast there are two beaches, Chacocente and La Flor, which are visited each year by the paslama turtle (*Lepidochelys olivacea*). Research has been carried out at Chacocente for many years. In La Flor, however, the first attempts at research were made just two years ago. This work has been continued with the financial support of the Sea Turtle Restoration Project in partnership with the Central American University (UCA).

During these years (1993, 1994 and the first trimester of 1995), research has been done in two ways: first, Central American University professors have been involved principally in monitoring, marking and recapturing nesting turtles; second, students of the school of ecology have studied the turtles as part of their thesis work. Two theses have been written: 'The influence of nesting density on the birthrate of L. olivacea,' and 'Nesting density and the effects of tides on the birthrate of L. olivacea.'

In addition to this research, MARENA (the Ministry of Natural Resources) counts the total number of nesting turtles that arrive at this beach each day. Several rangers are posted from July to December to do this task, while in the remaining months of the year, a reduced staff (3 people) is maintained.

Study Area

The La Flor wildlife refuge is located in the southwest of San Juan del Sur, in the department of Rivas.

Rock formations reaching over 50 mts. above sea level are located at each end of the beach, at Punta Brasilito to the north and Punta La Flor to the south. The beach is 1,600 mts. long, with a sandy texture and many stones of sedimentary origin, narrow and unstable.

The native vegetation covering has been heavily altered, with grasses and secondary shrub vegetation (Hyptis suaveolens, Crescentia alata and Cliricidium septum) to the north, a tamarind crop (Tamarindus indica) in the center and mangrove forests dominating the south.

Background

La Flor has been used for livestock, and is internationally known for the Creole variety of cattle "Reina Cow" developed here.

Since 1992, the Nicaraguan Institute of Natural Resources and the Environment (IRENA, now known as the ministry MARENA) has taken on the protection of this biological reserve. It is important to note that La Flor beach has no legal protection.

Activities Carried Out

(1993-1994)

1. Monitoring nesting turtles:

An arribada was defined as a number equal or greater than 50 turtles, using the Cornelius and Robinson (1982) procedure to make the count. The beach was divided into 16 areas, placing plots of 10 m^2 in each, marked by small flags, within which the count was done.

Among the activities considered important in the monitoring were turtles laying eggs, walking, opening the nest and burying the eggs- Each of these activities took place in each of the 16 plots during each monitoring pass, which lasted approximately 15 to 20 minutes.

2. L olivacea nest density and birthrate in La Flor beach, Rivas:

A total of 16 plots were established on the beach, along the vegetation line. Nest markers were made with wooden sticks to which a piece of garden hose had been tied, which was in turn tied to a 30' nylon cord. During arribada season the nests were marked individually.

After each arribada the location of each nest was determined using Cartesian coordinates. After approximately 45 days of incubation, metal baskets were placed over the nests in anticipation of the hatching.

Preliminary results-

Live birth rates were proportional with nest density where the density was greatest, this was not true in areas of low density. Among all the parcels studied, nesting turtles showed a preference for three parcels located in the northern part of the beach.

(1994-1995)

3. Monitoring nesting turtles:

Based on the information gathered in the previous year, We did a recount of nesting turtles using the Cornelius and Robinson method, with certain adjustments to improve effectiveness, including the redefinition of the beginning of the arribada at the moment in which 10 turtles simultaneously reach the beach.

Preliminary results:

The largest estimates of nesting turtles corresponded to the months of October and November. These findings differed from those of MARENA, which reported that the largest arribadas took place in the months of August and September, 1994.

Something very interesting was observed in January: the arribada was small and closest to MARENA's calculations. It may be that Cornelius'formula is most accurate for arribadas of less than 1000 turtles.

4. Nest density and the effects of the tides on L. olivacea birthrates:

Based on the results of last year's study (live birth rates of turtles), it was determined that the most suitable place to locate the altitudinal sub-plots was between the 2nd and 5th plots. Sub-plots of 5 m^2. were defined within each of these, and within each, three altitude levels were defined, which we called the upper, middle and lower echelons.

Plots were delimited according to the Cornelius and Robinson (I 982) procedure, with 0.1 5 altitudinal mts. between subplots, clearly delimited by little white flags.

The fieldwork was divided into two phases:

First phase:

Visit to the beach during the arribada period in order to mark nests in each sub-plot. This involved putting the wooden stick tied with nylon cord in the distal extreme opposite the turtle's head, so that the piece of hose would remain on the surface, and the nylon cord would be placed under the fin during laying and buried when the nest is closed.

Nests were consecutively marked from the beginning to the end of the arribada.

At the end of each arribada, the Cartesian coordinates were measured, so that they would serve as guides during the hatching.

Second phase:

Visit to the beach during the hatching period. In order to count the total number of live newborn turtles, metal baskets (Cerna and Quintero) with their respective numbers were used. The baskets were placed at the beginning of the hatching period.

Arribadas have usually lasted from 6 to 8 days. Once the hatching period is over, the baskets and markers are removed.

Preliminary results:

Nesting and hatching success was greater in the upper altitudinal echelon (next to the vegetation) than in the middle or lower echelon, which was null.

5. Marking and recapture methods:

Through the University of Costa Rica's Sea Turtles Program, we received a donation of Monel type metal tags to be used from 1993-94.

In 1993, two tags were placed on each turtle in each of its forefins, in the second scale from the posterior edge.

In 1994 marking was done in a somewhat different way, two markers were still placed on each turtle, but one was placed on the interscale area of the posterior right fin, while the other was placed on the second scale of the posterior left fin.

Preliminary results:

In 1993, 850 turtles were marked and 24 were re-observed, which represents 3% of the total. Of the turtles that were re-observed, all but three had been marked on the La Flor beach.

In 1994, 1,038 turtles were marked and 11 were re-observed, almost all of which had been marked on La Flor.

The total number of turtles marked during both years which returned was possibly greater than the number observed. To increase the effectiveness of the method, however, special attention must be given exclusively to monitoring turtles marked in previous years.

6. Other Activities:

The thorough monitoring of nesting turtles that arrive at La Flor is carried out by MARENA's contracted personnel, in work which parallels ours. They patrol the whole beach daily, in shifts of 4-6 hours. The carry out similar patrols during the hatching period.

Preliminary.results-.

Turtle behavior varied with respect to the timing of the largest arribadas, since the months with the largest visits were October and November in 1993, and September and October in 1994. This clearly shows that the behavior of L. *olivacea* differs both between arribadas and between years, and is inconstant and unpredictable.

We observed that the distribution of arribadas was concentrated in the northern part of the beach (in an area represented by a total of 6 plots), although within this area there were fluctuations. For example, in the month of December, the arribada was concentrated in the I st and 2nd plot, while in November, it was concentrated in the 3rd and 4th. There were also differences between arribadas with respect to the time of emergence from the sea: in September and October the turtles emerge during the day and night, while in other months, they emerged only at night.

Preliminary Results:

I A clear nesting preference is shown by L. *olivacea* for the northern half of the beach.

2. The method of Cornelius and Robinson (1982) is most effective for arribadas with fewer than 2000 nesting turtles.

3. The upper altitudinal echelon (nearest the vegetation) showed the greatest success rate for nesting.

4. The live birth rate was higher in 1993 than in 1994.

5. 1,868 nesting turtles were marked and 36 turtles re-observed during 1993 and 1994.

6. The turtles' behavior differs in different months, which includes fluctuations in the time at which they emerge from the water.

What Are Our Goals?

1. To determine the optimal nesting density on the beach.

2. To define the sustainable exploitable density.

3. To determine the most important predator.

4. To include a social component by involving neighboring communities.

We are concerned about the construction of a dry canal: one possible route would affect the La Flor refuge.

ROBUST STATISTICAL MODELLING OF CHELONIA MYDAS GROWTH RATES - SOUTHERN GREAT BARRIER REEF

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Size- , sex-, and age-specific somatic growth rate models for the southern Great Barrier Reef (SGBR) green turtle (Chelonia mydas) stock were developed using a large data set derived from a long-term capture-recapture study. The capture-recapture program is described in Limpus (1992).

Green turtle somatic growth must be considered as comprising separate growth compartments - (1) an epi-pelagic feeding phase and (2) a benthic feeding phase. These distinct growth compartments are likely to have different growth characteristic. This study considers only the benthic feeding phase (≥35 cm CCL). Therefore, age is estimated as years-at-large since recruitment to the benthic phase. Turtles <35 cm CCL have never been recorded from this locality so the functions presented are not applicable to the epi-pelagic phase (5-35cm CCL) - a separate growth function is needed.

METHODS

The data set comprised complete records for 1037 green turtles (principally from the SGBR genetic stock) tagged with titanium tags in the SGBR feeding grounds. Capture-recapture profiles recorded for each turtle included the following metrics - curved carapace length (CCL) at first capture and recapture, sex determined from visual examination of gonads using laparoscopy, year of first capture, and time-at-large since first capture. Only turtles with recapture intervals ≥12 months were included.

Instantaneous growth rates were derived from these capture-recapture profiles - the growth rate metric being the standard first order size-specific differential form (dCCL/dt), not to be confused with per capita, relative or specific growth rate (1/CCL.dCCL/dt). Both negative and zero growth rates were included in the analysis since there is no statistically valid reason to do otherwise.

We analysed the functional relationship between growth rate and structural covariates (eg., mean CCL, sex, recapture interval) using recent advances in regression modelling known as generalized additive modelling or GAM (Hastie and Tibshirani,1986;1987). GAM enables robust analysis of regression models with both nonlinear covariate form and nonnormal error terms - it is a recent major extension of the well established generalized linear modelling approach (McCullagh and Nelder, 1989)

RESULTS AND DISCUSSION

GAM regression analysis showed that three covariates nested within sex (maturity class, year, mean CCL between recapture interval) had a significant conditional influence on growth rate in the benthic growth compartment (Figure 1, top panels = female growth rate functions, bottom panels = male growth rate functions). The nested GAM models used identity link, robust quasi-likelihood error and cubic spline smoothers to model covariate functional form (Hastie and Tibshirani,1986; McCullagh and Nelder, 1989). Recapture interval was not found to be a significant factor influencing growth rate so it was excluded as a covariate.

The size-specific growth rate functions for either sex in the benthic feeding phase are clearly non-monotonic rising from an initial recruitment size of >35cm to a maximum growth rate around 60-65 cm CCL and declining slowly towards undetectable growth about 100 cm CCL (Figures 1c,1f) - female growth rate function is statistically different from the male growth rate function. Growth rate was also found to be year dependent with rates higher in specific years - especially for immature females.

The smoothed growth rate function for each sex was extracted from the GAM analysis using separate cubic B-splines (see Figure 2a = females, 2d = males) and then integrated with respect to time-at-large using a finite difference equation and a 4th order Runge-Kutta integration method with extremely small time step. We refer to time-at-large because we are modelling only the benthic growth compartment without knowing the mean age of turtles when recruiting into this phase of the life cycle.

The integrated form of the smoothed growth rate function is an empirical solution of the time-at-large to size curve for each sex (see Figure 2c=female time-at-large to size curve,2f=male time-at-large to size curve). SGBR green turtles increase in size rapidly from 35-40 cm CCL (0 years-at-large) to an estimated asymptote of about 106 cm CCL (>75 years-at-large) for females and about 99 cm CCL (>75 years-at-large) for males. Figure 2 suggests that both females and males in the SGBR green turtle stock must be at least 30-35 years-at-large before reaching sexual maturity - if the epi-pelagic feeding phase lasts for say 5 years then these turtles must be ≥35-40 years of age before sexual maturity.

The integrated spline functions (Figures 2c,2f) were differentiated with respect to time to yield time-specific growth rate functions (Figure 2b=females, 2e=males). Maximum growth rate for females occurs at 10 years-at-large (60cm CCL) for females and 12 years-at-large (63 cm CCL) for males.

The time-at-large to size functions based on integrated cubic B-spline curves (the empirical solution) was then modelled with a system of two nonlinear simultaneous equations with cross-linked growth parameters to provide an analytical solution to the time-at-large to mean size curve for each sex. These weibull-type growth equations have extremely good statistical properties unlike most growth equations used and fit the empirically derived smoothed growth data well. These growth models and their capture-recapture equivalent formulation will be presented elsewhere.

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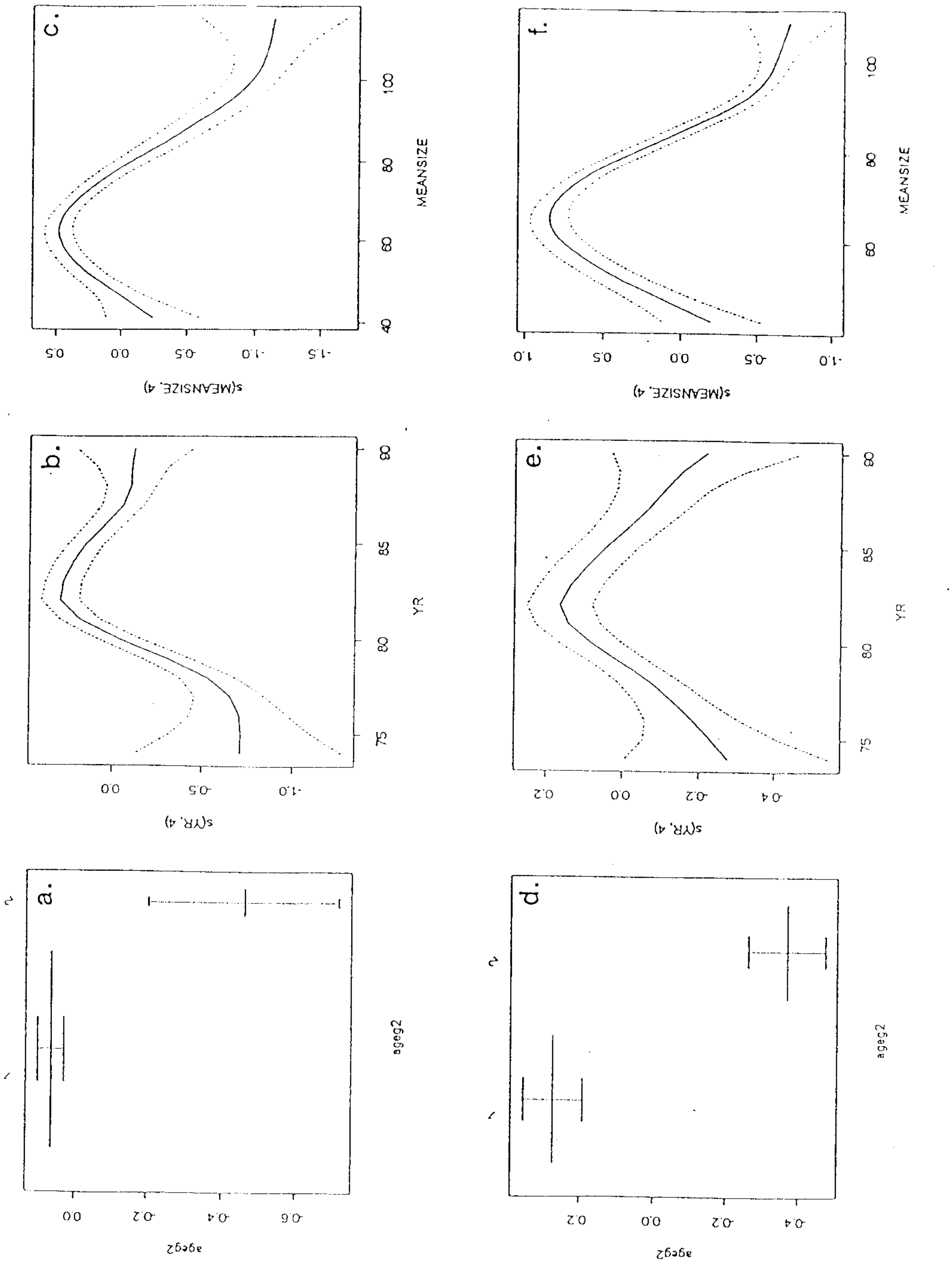

Figure 1

GAM model results for 3 covariates nested within sex. Females in panels a-c, males in panels d-f. The response variable (growth rate) shown on y-axis is in a scaled form peculiar to GAM models (decoded form shown in Figures 2a,d). The predictor variables shown on x-axis. The covariates other than sex were (1) maturity class (discrete factor; ageg2:1=immature, 2=mature), (2) year (continuous cofactor; YR=1974-1990) and (3) mean size (continuous cofactor; mean CCL between first capture and last recapture). The width of the mean factor response is proportional to sample size and the 95% confidence interval (panels a,d) shown by cross bars. Solid curves represent the smoothed functional responses conditioned on all other covariates using a GAM regression model and cubic spline smoothers. Dotted curves are the 95% confidence curves (panels b,c,e,f).

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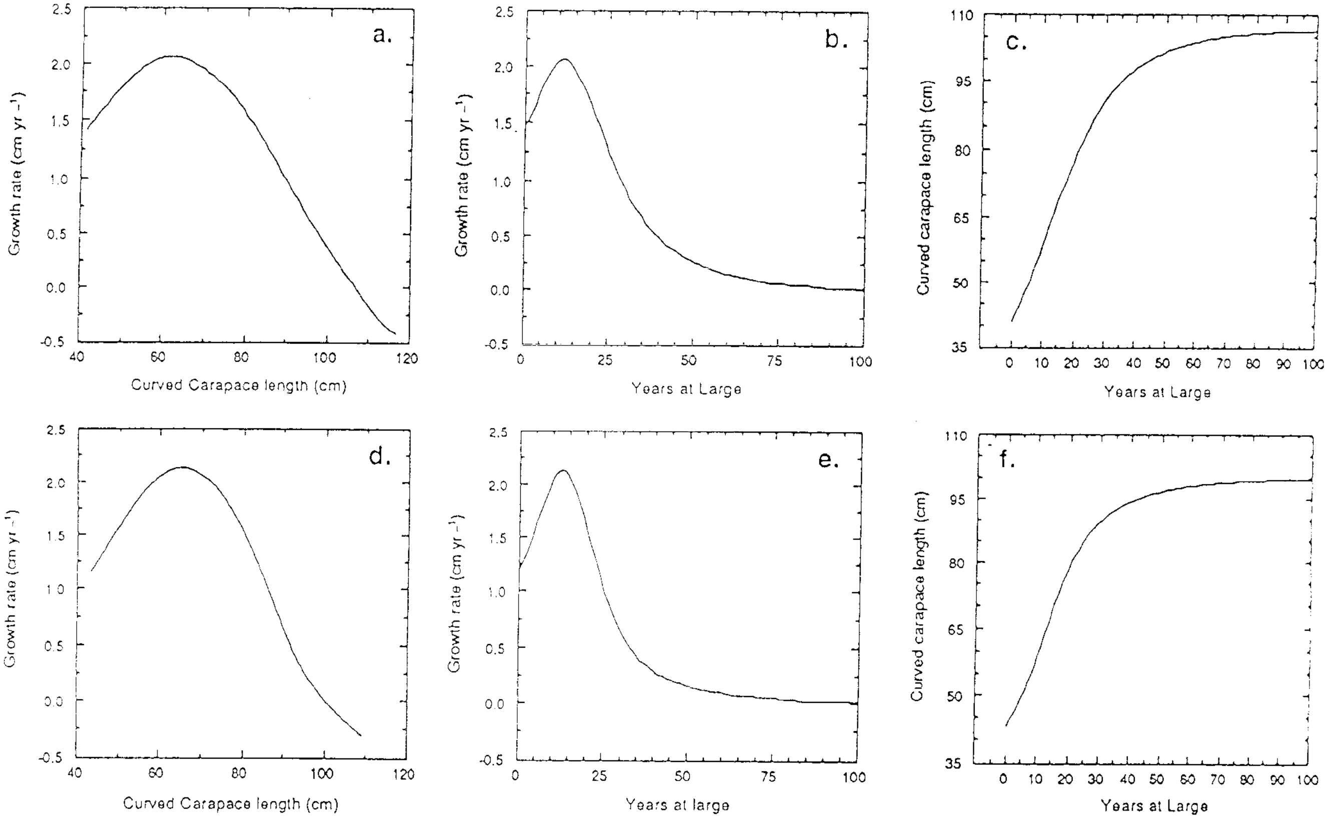

Figure 2

Growth rate functions. Females in panels a-c, males in panels d-f. Panels a, d reproduce the response functions shown in Figures 1c,1f that were integrated to give the size to years-at-large functions shown in Figures 2c and 2f. The integrated functions in Figures 2c and 2f were then diffentiated with respect to time to give the growth rate to years-at-large functions shown in Figure 2b and 2e.

HEURISTIC MODELLING OF CHELONIA MYDAS POPULATION DYNAMICS - SOUTHERN GREAT BARRIER REEF

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We are developing stage-classified simulation models of the population dynamics for green turtles (Chelonia mydas) comprising the southern Great Barrier Reef (SGBR) genetic stock - these system models consider both feeding and breeding ground components of the stock. The models are used as an analytical tool to develop a better understanding of the complex dynamic nature of sea turtle demography and to support the design and testing of sea turtle conservation policy options.

METHODS

A conceptual map of the sector-based scheme underpinning the modelling construction is shown in Figure 1a. The models are based on inter-related sector-based systems of finite difference equations linked with dynamic vital rates characterised by nonlinear, dynamic feedback, time variant, distributed lag and stochastic properties. Stochastic forces in the model involve environmental and demographic sources. Integration involves a high order Runge-Kutta integration method.

We present preliminary results of a simulation model (CHELONIA4) based on this conceptual scheme- it is one of several models designed with various degrees of complexity to explore specific questions about sea turtle population dynamics. For instance, density-dependent processes are not included in CHELONIA4 because of insufficient empirical information - such processes derived on a theoretic basis are included in other CHELONIA models but require extensive validation.

CHELONIA4 comprises a stage-classified demography (see Manly 1990; McDonald and Caswell 1993) comprising both age-based and reproductive status-based stages linked by feedback loops (see simplified life cycle diagram in Figure 1b). Age-based stage durations are derived from extensive growth rate modelling (see Chaloupka and Limpus elsewhere in these proceedings).

The demographic and environmental data used in CHELONIA4 were derived from a long-term research program on Australian sea turtles (Limpus 1993; Limpus et al.,1994; Limpus and Nicholls 1994). Mortality rates and hence survivorship functions are based on a combination of sources - (1) published data for various parts of the life cycle for this particular stock (eg., Limpus et al.,1984; Gyuris 1994), (2) published data for other turtle stocks, (3) theoretically derived estimates. Theoretical estimates were based on the assumption adopted in CHELONIA4 that the underlying hazard rate is a discrete bath-tub hazard function represented by piece-wise stage-specific hazard functions.

RESULTS AND DISCUSSION

We used CHELONIA4 here to investigate the potential impact of major egg harvesting on the long-term viability of the SGBR green turtle stock at all stages of the life cycle. There is empirical evidence indicating that sustained annual egg harvesting will result in a major reduction in future egg production. But a reduction in annual egg production might not mean a major reduction in the mature breeding stock - this is implied in a number of important stage-based projection matrix models of loggerhead population dynamics (see Crouse et al.,1987; Laurent et al.,1992).

Given the assumptions and parameter estimates incorporated in CHELONIA4 we modelled the impact of a major annual egg harvest on the SGBR stock as follows. Firstly, we let the model equilibrate for 100 years. Then we applied an arbitrary 70% egg harvest starting in year 110 and concluding in year 200 - a 70% harvest rate is a nominal value used here for heuristic purposes only.

The results are shown in Figure 2 showing the long-term outcome of sustained annual egg harvesting on the SGBR stock. For instance, despite harvesting from year 110 the impact isn't evident for >50 years because of delays and stochasticity (see Figure 2a,b). Continuing the simulation long after harvesting has ceased shows that egg production takes a very long time to recover (Figure 2c). The potential breeding stock is also seriously depleted (Figure 2d) - eggs matter and are no less important than any other life cycle stage. Meanwhile, we recognise that the stock recovery rate might well be accelerated if density-dependent factors operate - other CHELONIA class models address this issue.

Sensitivity analysis using parameter perturbation and fractional factorial sampling design (Steinhorst et al.,1978) suggests that CHELONIA4 was sensitive quantitatively to changes in hazard estimates and hence survivorship but that qualitative inference was little changed. We also found that the system was quantitatively and qualitatively sensitive to changes in the proportion of females in the feeding grounds preparing to breed each year, which is a function of stochastic environmental factors and post-breeding return time - this finding supports the critical importance of conducting feeding ground studies as underway for the SGBR stock (Limpus et al.,1994).

The CHELONIA class models are subject to a continuous process of research and development to improve their heuristic capability and our insights into the population dynamics of sea turtle stocks. We stress that these dynamic simulation models are heuristic not predictive tools. Alternatively, statistical modelling is a powerful predictive tool but enables limited insight into the complex dynamic nature of an ecological system.

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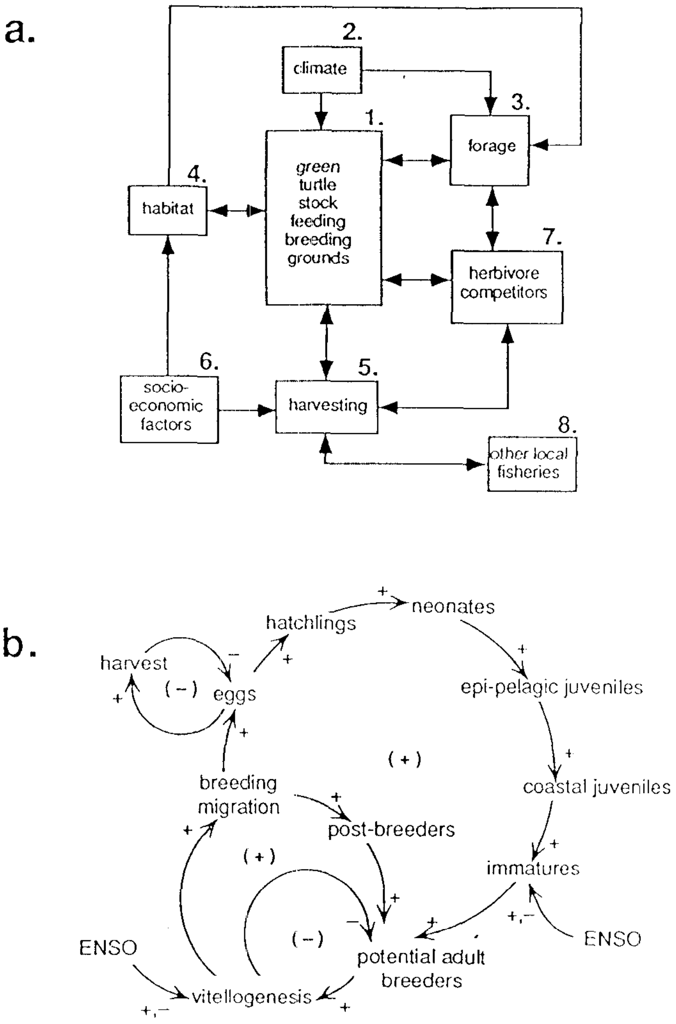

FIGURE 1:

Panel a. shows the conceptual map of the integrated sector-based CHELONIA MYDAS population model -- the specific simulation model presented here is CHELONIA4 derived from parts of Sectors 1, 2 and 5. Panel b. *shows a simplified life cycle diagram of the main demographic structure in* CHELONIA4 -- stages are either age-based or reproductive status-based. CHELONIA4 comprises a system of coupled difference equations linked with dynamic vital rates and nonlinear, feedback, time variant, distributed delay and stochastic properties.

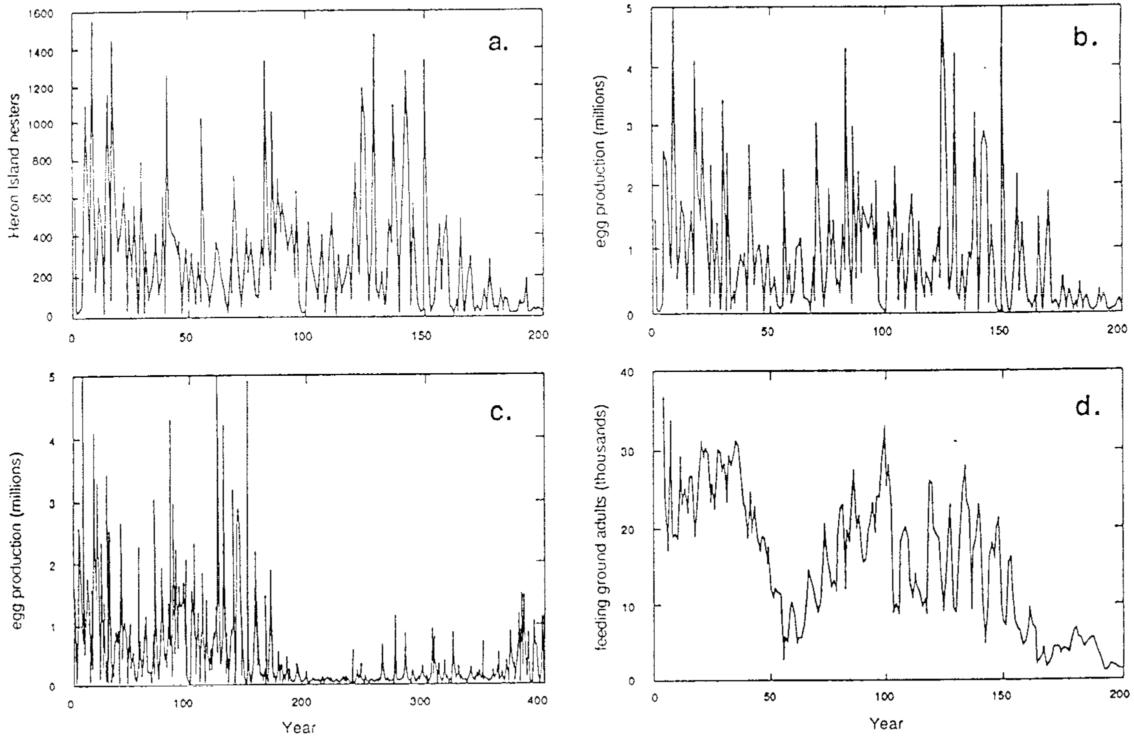

FIGURE 2:

Simulation output using the CHELONIA4 dynamic population model showing long-term effects of heavy annual egg harvest starting in year 110 and stopping in year 200. Panel a. shows simulated annual census of female green turtles nesting on Heron Island (SGBR). Panel b. shows total annual SGBR egg production over the 200 year simulation period subject to heavy annual egg harvesting (years 110–200). Panel c. shows total annual SGBR egg production over a 400 year simulation period with no egg harvesting since year 200. Panel d. shows SGBR mature adult stock in feeding grounds not breeding in that year but potential breeders.

GREEN TURTLE RESEARCH IN TAIWAN

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There are 5 species of sea turtles in Taiwan, the green sea turtle, Chelonia mydas, the loggerhead sea turtle, Caretta caretta, the hawksbill sea turtle, Eretmochelys imbricata, the olive ridley sea turtle, Lepidochelys olivacea, and the leatherback sea turtle, Dermochelys coriacea. Among them, the green turtle is the most abundant one. Due to the decades of over-exploitation and incidental catches, the populations of sea turtles in Taiwan are declining to the endangered status. Nowadays, only the green turtle can still be found nesting on a few remote beaches. The declining status arose the concerns of Council of Agriculture and enacted a research project to investigate the current status of sea turtles in Taiwan since 1992. Under this project, aspects of the breeding ecology of the green turtle were investigated, mainly on the Wan-An Island, Peng-Hu Archipelagos where most sea turtles are nested.

From 1992 till 1994, green turtles were found nested on 9 of 11 beaches on the island. The numbers, however, were small; 8 in 1992, 12 in 1993, and 14 in 1994. The nesting season lasts from the end of May till the end of October each year. The average inter-nesting interval was 14.9 days. A tight relationship between the first re-emergence time and the tidal cycle was found.

The mean straight carapace length of the adult female was 96.7 cm. Female turtle produced 6 clutches on average, with the average clutch size of 113 eggs. The mean egg size was 46.9 mm in diameter, and 22.7 g in weight. The average incubation period was 49.3 days. The average hatching success was 70%. Hatching success increased from 1992 (62%) to 1994 (84%). This result might be related to the practice of conservation of sea turtle on the island. The average size of the hatchling was 46.98 mm in straight carapace length and 22.7 g in body weight. Satellite biotelemetry studies in the summer of 1994 showed that the female green turtle migrated northward after the nesting season at Wan-An Island.

On the basis of three year's field studies, refuge beaches for the nesting green turtle on the Wan-An Island were established by the end of 1994. The growing public familiarity of the green turtle resulted in the increasing awareness of the need for the domestic wildlife conservation. The recent donation from the private industries to the sea turtle researches ensure a wider application of the sea turtle conservation in Taiwan.

ANNUAL VARIATIONS IN MARINE TURTLE NESTING AND IMPLICATIONS FOR MONITORING BEACH NOURISHMENT PROJECTS

Paul W. Davis, Paul S. Mikkelsen, Layne Bolen, Kristine Hahn, Jennifer Homcy

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METHODS

Data from three (3) survey areas are analyzed for the years 1991-1994. The three areas are Tequesta, Jupiter/Carlin and Jupiter/Juno; all located in Northern Palm Beach County, Florida. Tequesta is located one mile north of Jupiter Inlet, Jupiter/Carlin is located immediately south of the inlet extending 1.56 miles south and Jupiter/Juno is 5.25 miles long and located immediately south of Jupiter/Carlin. Nesting surveys for Tequesta and Jupiter/Carlin are conducted by Palm Beach County Department of Environmental Resources Management and those for Jupiter/Juno are conducted by The Marinelife Center of Juno Beach.

Each survey area is subdivided into reaches or zones. The length of the zones in Tequesta and Jupiter/Carlin are variable based on upland features and the zone lengths in Jupiter/Juno are consistent lengths (0.5 mile) with the exception of Zone 11 (0.25 mile). The lengths of each survey area are shown in Table 1. Data from 1991-1994 were evaluated for Jupiter/Carlin and Jupiter/Juno. The period evaluated for Tequesta was 1992-1994.

Nesting and Hatching Data

A beach nourishment project is scheduled to be constructed at the Jupiter/Carlin survey area and the data was partitioned into treatment (Jupiter/Carlin Reaches 1-6) and control beaches (Jupiter/Carlin Reaches 7-9, Jupiter/Juno, and Tequesta) to determine pre-constuction baseline values for the nourishment project for comparison with nearby control areas.

Nest surveys begin in March and end in October and include virtually all nests laid during the season. Nest counts for each reach/zone and species were converted to nest density (# nests/mile) to allow comparisons between zones of unequal length. Nest success for each zone and species was calculated by dividing nest count by the total number of crawls. Nest counts, nest density and nest success for loggerheads are summarized in Table 2.

Hatch data was collected from 8.3% (428/5182) of the nests. Hatching success and emergence success for loggerheads are summarized in Table 3. These data are for in situ nests only; all relocated and predated nests were eliminated from analysis to provide baseline hatching information.

Statistical Analysis

The annual counts, means, standard deviation and variance were calculated for loggerhead nest density and nest success. Nest density and nest success were analyzed using 2 way ANOVA and Student-Newman-Keuls multiple comparisons test. Green and leatherback data was not evaluated due to the relatively lower nest counts.

RESULTS

Nest Density

Figure 1 shows annual variation in nest density at each of the survey areas. The data was examined for differences between years and differences between beaches. For all years nest density was highest at Tequesta and lowest at Jupiter/Carlin Reaches 7-9. Interestingly, there was no significant difference between years except when comparing nest density of 1992 with 1994 at Jupiter/Carlin Reaches 1-6 and Tequesta (2 way ANOVA, p=0.044). Analysis was performed comparing the beach nourishment project area (Jupiter/Carlin Reaches 1-6) with the adjacent beaches to determine how well the pre-construction baseline conditions compare between control and treatment. Differences in nest density between the project beach (Jupiter/Carlin Reaches 1-6) and data pooled for the 3 control beaches were not significant except between 1992 and 1994 (2 way ANOVA, p=0.025).

Nest Success

Figure 2 shows annual variation in nest success at each of the survey areas. Examining the graphs, nest success at Tequesta and Jupiter/Juno has been constant but Jupiter/Carlin reaches 1-6 appears to be increasing (40% to 54%). However, there was no significant difference in annual variation of nest success. There was a significant difference in nest success between two survey areas (Jupiter/Carlin reaches 1-6 and Tequesta) for the years 1992 and 1994 (2 way ANOVA, p = 0.025). For the years 1991 through 1994, there was a significant difference between Jupiter/Juno and both of the Jupiter/Carlin survey areas (Student-Newman-Keuls, p=0.05).

Figure 3 is a graphical representation of significant differences in nest density and nest success based on analysis by Student-Newman-

Keuls. Figures 4 and 5 depict the annual variation in hatching success and emergence success. There were no trends apparent for Jupiter/Carlin (all reaches) and Tequesta appeared to be slightly decreasing. Statistical analysis has not yet been performed on these data.

DISCUSSION

Beach nourishment has the potential to impact reproductive success of marine turtles by changing the physical characteristics of the incubation medium (Nelson and Dickerson, 1989; Ackerman et al, 1992). Permits for construction of beach nourishment projects require pre- and post-construction monitoring. Frequently, pre-construction monitoring is gathered over a relatively short period of time and compared to a longer period of post-construction monitoring data. Conclusions based on a limited skewed data set will be invalid. For example, if data for nest density was used for 1993 (a low year) and compared to 1994 (high years) it could be argued that a particular project has beneficial effects on nesting. Conversely, if data were used from 1991 and compared to 1992 the conclusion may be that there was a negative impact when in fact it may have been a result of natural annual variation. Limited pre-construction monitoring reduces the ability to detect annual variations in nest and hatching parameters due to annual variations in breeding, long term population trends, and factors affecting the availability/suitability of the nesting beach such as upland development, erosion, coastal armoring, etc.

Delays in the construction of the Jupiter/Carlin beach nourishment project have allowed for the collection of 4 years of pre-construction sea turtle data. A better understanding of the annual variation in nesting and hatching parameters has been obtained that will allow for a more meaningful comparison of pre-construction and post-construction conditions.

RECOMMENDATIONS

A long term monitoring program should begin when a beach nourishment project is determined to be feasible for construction. It would be desirable to have a consistent monitoring program at all beaches that have been determined to be "critically eroded". It is recommended as a minimum that the State and Federal agencies make implementation of a detailed sea turtle monitoring plan a requirement for receiving funding for beach nourishment or other shore protection projects. This could provide an incentive to establish permanent monitoring programs that will provide more meaningful information and allow for more effective management of the shoreline.

ACKNOWLEDGEMENTS

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TABLE 1- SURVEY AREA LENGTH

REACH/ZONE #	TEQUESTA	JUPITER/CARLIN	JUPITER/JUNO
1		0.14	0.50
2		0.13	0.50
3		0.25	0.50
4		0.11	0.50
5	0.04	0.18	0.50
6	0.15	0.25	0.50
7	0.09	0.19	0.50
8	0.13	0.20	0.50
9		0.05	0.50
10		0.09	0.50
11			0.25
TOTALS	0.41 MILE	1.59 MILE	5.25 MILE

TABLE 2- NESTING PARAMETERS

NEST COUNTS (C. caretta)

BEACH			YEAR		MEAN
	91	92	93	94	
TREATMENT					
JUP/CAR R1-R6	799	952	899	827	869
CONTROLS					
JUP/CAR R7-R9	298	389	292	372	338
JUP/JUNO	5424	5301	3778	5385	4972
TEQUESTA	NA	520	343	452	438
ALL CONTROL BEACHES	NA	6210	4413	6209	5611

NEST DENSITY (C. caretta)

(COUNT/MILE)

BEACH			YEAR		MEAN
	91	92	93	94	
TREATMENT					
JUP/CAR R1-R6	754	898	848	780	820
CONTROLS					
JUP/CAR R7-R9	677	884	664	845	768
JUP/JUNO	1033	1010	720	1026	947
TEQUESTA	NA	1268	837	1102	1069
ALL CONTROL BEACHES	NA	1018	723	1018	920

NEST SUCCESS (C. caretta)

(%)

BEACH			YEAR		MEAN
	91	92	93	94	
TREATMENT					
JUP/CAR R1-R6	40	43	51	54	47
CONTROLS					
JUP/CAR R7-R9	40	46	42	46	43
JUP/JUNO	57	57	56	52	56
TEQUESTA	NA	46	47	43	45
ALL CONTROL BEACHES	48	50	48	47	48

TABLE 3- HATCHING STATISTICS

HATCH SUCCESS (C. caretta)

(%)

BEACH			YEAR		MEAN
	91	92	93	94	
TREATMENT					
JUP/CAR R1-R6	NA	89.28	75.75	82.47	82.50
CONTROLS					
JUP/CAR R7-R9	NA	61.60	86.91	89.53	79.35
JUP/JUNO	NA	NA	NA	NA	NA
TEQUESTA	NA	76.18	77.90	72.39	75.49
ALL CONTROL BEACHES	NA	68.89	82.41	80.96	77.42

EMERGENCE SUCCESS (C. caretta)

(%)

BEACH			YEAR		MEAN
	91	92	93	94	
TREATMENT					
JUP/CAR R1-R6	NA	84.10	74.11	80.23	79.48
CONTROLS					
JUP/CAR R7-R9	NA	59.73	84.89	84.25	76.29
JUP/JUNO	NA	NA	NA	NA	NA
TEQUESTA	NA	74.36	76.00	70.45	73.60
ALL CONTROL BEACHES	NA	67.05	80.45	77.35	74.95

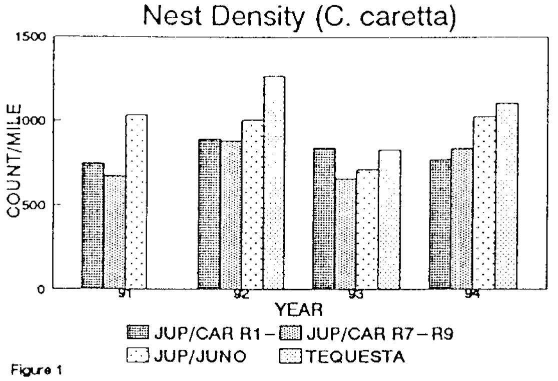


Figure 1

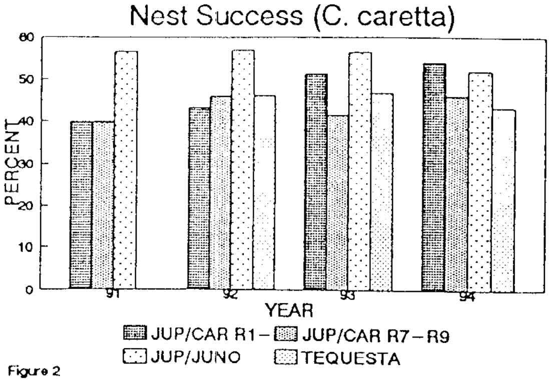
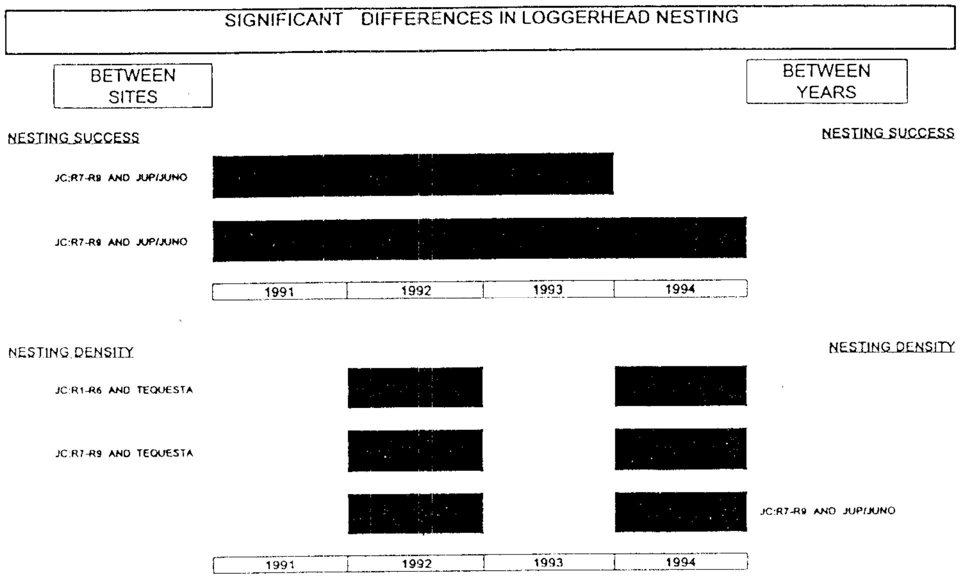


Figure 2



SIGNIFICANT DIFFERENCES WERE NOTED WHEN EXAMINING (ANOVA) THE DATA FROM YEARS CONNECTED WITH BARS

KEY: ■ = DATA FROM WHICH SIGNIFICANT DIFFERENCES WERE NOTED
JC:R1-R6 = JUPITER/CARLIN, SURVEY REACHES 1 THROUGH 7, COMBINED
JC:R7-R9 = JUPITER/CARLIN, SURVEY REACHES 7 THROUGH 9, COMBINED
JUP/JUNO = JUPITER (SOUTH OF JUPITER/CARLIN SURVEY REACH 10) AND JUNO BEACH
TEQUESTA = MARTIN/PALM BEACH COUNTY LINE, SOUTH THROUGH CORAL COVE PARK

FIGURE 3

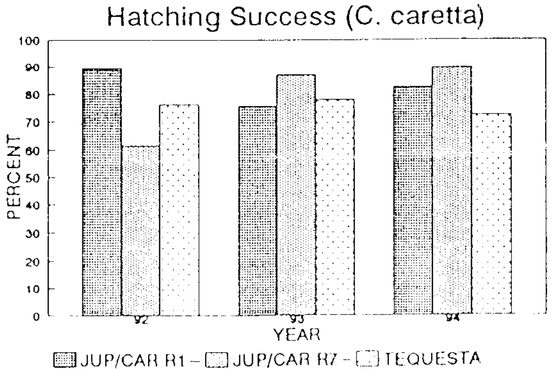


Figure 4

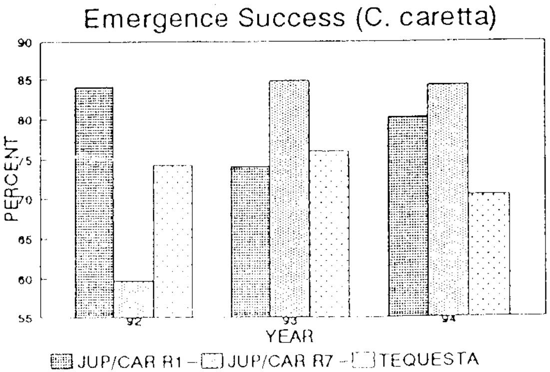


Figure 5

FORAGING ECOLOGY OF HAWKSBILL TURTLES AT MONA ISLAND, PUERTO RICO

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For the past three years we have been studying hawksbills on the feeding grounds of Mona Island, Puerto Rico. This work has yielded new information regarding many aspects of ecology and population dynamics of this relatively large hawksbill population. Mona Island is one of the few known remaining locations in the Caribbean where hawksbills occur with considerable density. This paper presented the preliminary results of our studies related to the foraging ecology of juvenile and sub-adults hawksbills. Specifically, the results of the following studies were discussed: 1) food items selected by hawksbills; 2) identification and description of feeding areas; and 3) observations on the foraging behavior and habitat use.

PROJECT SUPPORT
Japan Bekko Association
Departamento de Recursos Naturales de Puerto Rico
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Netherlands Foundation for the Advancement of Tropical Research

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HAWKSBILL NESTING ON MONA ISLAND, PUERTO RICO: RESULTS FOR 1994

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Mona Island has been recognized as an important nesting site in the Caribbean for sea turtles, specially for hawksbills (*Eretmochelys imbricata*). The island isolation, unhibited status as a Natural Reserve and inaccessibility have contributed to the endurance of a sizeable nesting population.

METHODS

Daytime surveys were conducted on all beaches to count number of nests and "false crawls". Beaches were visited once a week. Hawksbill nest productivity was measured and examining the contents of hatched nests. Nest inventories were classified according to four categories: (hatched) eggsshells, unhatched eggs, live and dead hatclings. Live hathclings found trapped inside nests were released inmediately at the sea or when appropriate, held for later release.

RESULTS AND DISCUSSION

Surveys were conducted from July 28 to November 19 on weekly basis. During this 114 day period, a total of 308 nests and 346 false crawls were counted (see figure 1).

At least twenty nests were counted between November 20 and year's end by the Department of Natural Resources personnel. No turtle nest loss due to predation by pigs was observed. At least three nests were affected to varying degress of disturbance by digging turtles intent on nesting.

Nest productivity was calculated to be lie between 73.9% and 78.1% (see figure 2). Mean nest size was 147.9 eggs (range 78-194). Between 33 600 and 35 500 hawksbill hatchlings emerged from nests laid July 28 to

November 19.

The 1994 hawksbill nesting season on Mona demonstrated a marked increase in activity compared to previous years. Taking into account that some nesting occurs outside of the surveyed period, it is very likely that the 1994 nesting season resulted in over 350 hawkbill nests. Direct comparisons with previous surveys is complicated by the fact that surveys dates varied widely and continuity of coverage during the survey periods was incomplete in some cases. The observed increase may be due to one, or a combination, of the following factors: 1) nesting periodicity, 2) conservation effort, and 3) research effort. Nesting studies at Mona Island need to be continued on a longterm basis to be able to asses population trends of this important hawksbill rookery.

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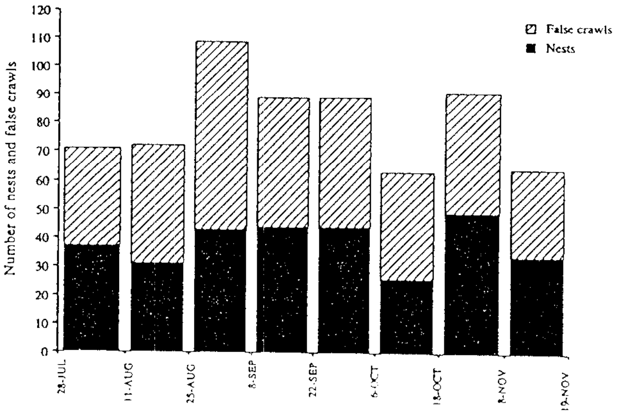

Fig 1. Number of nests and false crawls registered in biweekly intervals at Mona Island

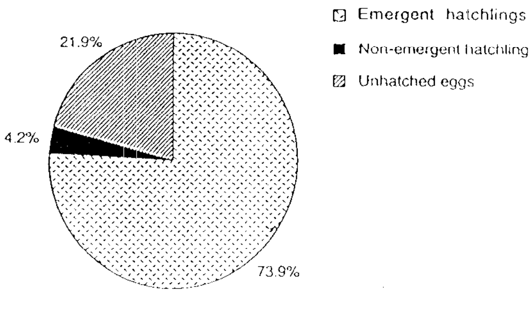

Figure 2 Hawksbill reproductive success at Mona Island in 1994.

THE OSA SEA TURTLE STUDY: A 14 MONTH STUDY ON SPACIAL DISTRIBUTION, PREDATION, AND SEASONALITY

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This 14-month study, begun in September 1993, examined marine turtle nesting activity and predation frequency on the Osa Peninsula, Costa Rica. Nests of olive ridley (*Lepidochelys olivacea*), black (*Chelonia mydas agassi*), leatherback (*Dermochelys coriacea*) and hawksbill (*Eretmochelys imbricata*) turtles were recorded during daily beach monitoring of 4 beaches (20 km total) south of Corcovado National Park. A total of 4119 nests were recorded. Of these, 30% were excavated and 7% hatched. Nesting, nest predation and hatch frequency were concentrated on a 6 km section known as Playa Rio Oro. For instance, we observed seventy-two percent of all recorded nests, 66% of excavated nests, and 83% of hatched nests at this location. Human-related predation of marine turtle nests constituted 92% of all excavated nests. In addition, high nesting and hatch activity correlated with the rainy season.

SIMPLE BIOPSY TECHNIQUE FOR SAMPLING SKIN FOR DNA ANALYSIS OF SEA TURTLES

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PROCEDURE

Disks of skin 6mm in diameter were sampled from live green turtles, as well as frozen dead turtles. In addition, skin plugs were taken from a frozen green, leatherback, and loggerhead that had died from various causes and were being held for eventual necropsy. All samples were rapidly and easily taken using an Acu-Punch 6mm biopsy punch available from Acuderm, Inc., of Ft. Lauderdale, Florida 33309.

The plastic handle of the punch was held by the thumb and index finger, with the circular surgical blade resting against the smooth skin located immediately dorsal to the turtle's hind flipper. The turtle was placed on its back to facilitate access to this biopsy site. A circular cut 2-4 mm deep was rapidly made by rotating the tool once or twice while gently pressing down. After withdrawing the blade, the resulting disk of tissue was removed with forceps and stored in 20% DMSO saturated with salt. In the case of live turtles, the skin was cleaned with 90% alcohol prior to sampling. Virtually no bleeding occurred following biopsy, and a suture was not deemed necessary, upon the advice of a consulting veterinarian.

DNA ANALYSIS

Extraction of DNA from each of the 0.02-0.04 g tissue "plugs" was carried out using the proteinase K digestion protocol of Maniatis *et al*. (1982) as modified by Hillis and Davis (1986). All samples yielded visible DNA pellets which were washed in ice cold 70% ethanol and resuspended in sterile water. The d-loop region of mtDNA was amplified by the polymerase chain reaction (PCR) (Innis *et al*., 1990) and resulted in a single-band product of the correct size. PCR products were sequenced on an Applied Biosystems automated sequencer to confirm the fragment was from the correct region of mtDNA.

This work demonstrates that DNA can be obtained of sufficient quality and quantity for PCR analysis from small skin tissue biopsies of sea turtles, using a quick, simple, and relatively non-invasive sampling procedure. Small biopsy punches (down to 1.5mm) are also available and could be used for hatchlings without creating undue tissue trauma.

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NATAL HOMING; DO LEATHERBACKS DO IT TOO?

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The control region of mitochondrial DNA (mtDNA) was sequenced in order to determine whether the population genetics of leatherbacks, Dermochelys coriacea, is consistent with the theory of natal homing. Seven nesting populations were surveyed, including French Guyana/Suriname, Trinidad, Costa Rica, Florida, St. Croix and a population on the Pacific coast of Costa Rica. Eight haplotypes were identified. A unique haplotype was found at relatively high frequency (33%) in the St.Croix population. Another rare haplotype was found in the Trinidad population at relatively high frequency (33%). The Fst value calculated for the Atlantic populations suggested some degree of population sub-structuring, consistent with the natal homing scenario, however, the migration rate between Atlantic populations (2.0) was higher than that found in green turtles (Allard et al. 1994) and hawksbills (Bass, pers. comm.), suggesting that fidelity to natal beaches is not as strict in leatherbacks. A preliminary study based on small sample sizes (n=4, per population), presented at the 1994 Sea Turtle Workshop (Dutton et al. 1994) failed to reveal any population structure within the Atlantic. The findings presented here are based on larger sample sizes (n=18-22).

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MARINE TURTLE NESTING AT ARCHIE CARR NATIONAL WILDLIFE REFUGE IN 1994: ANOTHER RECORD-BREAKING YEAR FOR LOGGERHEAD AND GREEN TURTLE NEST PRODUCTION.

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The UCF Marine Turtle Research Group studied the distribution and extent of loggerhead and green turtle nest production in central and south Brevard County, Florida, for the 13th consecutive year, in 1994. The 40.5 km stretch of beach between Patrick AFB (on the north) and - Sebastian Inlet State Recreation Area (on the south) is subdivided into

0.5 km sections. The areas designated "Archie Carr NWR" (ACNWR or simply "Carr Refuge") and "Central Brevard Co." are, respectively, 21 km and 19.5 km long. All nesting and non-nesting marine turtle emergences were identified as to species and enumerated during surveys conducted at dawn by trained workers traversing the beach on small all-terrain vehicles.

RESULTS AND DISCUSSION

TOTAL NEST COUNTS

LOGGERHEADS

During the 1994 survey period 5,781 loggerhead nests were recorded in the Central Brevard Area and 14,730 in the ACNWR. In the Carr Refuge area, for which there is a twelve-year "track record" (Figure 1), this total exceeded the previous high (1990) by ca. 3%; it exceeded the "long-term average of the 1980's" by 57%; and it exceeded the comprehensive twelve-year average (1982-1993) by 41%. By any measure it was an exceptional, prodigious year for loggerhead nest production. These results and those of the past four years may be viewed as cause for cautious optimism about the recovery of the loggerhead turtle but it is still true that it may take another 10 years or more to determine just what the loggerhead trend line is doing in modern times. Populations of animals with long generation times, such as marine turtles, do not lend themselves to the cursory assignment of validity to numerical trends. Also, it is easy to devalue the level of loggerhead nesting activity in the busy, commercialized Central Brevard area, especially when it is viewed in light of the truly extraordinary nest production seen in the adjacent ACNWR. One should recognize, however, that the numbers observed here in 1994 translate to a density of just under 300 nests per kilometer; a figure that rivals the densities seen on all but the very best loggerhead nesting beaches in the Western Hemisphere.

GREEN TURTLES

After a season of relatively meager green turtle nesting activity in 1993 (Figure 2) it was reasonable to predict that nest production by that species would rise considerably in 1994, but no one would have predicted the salient increase to 1309 nests over the combined study areas. Of those, 1107 occurred in the Carr Refuge area and that constituted an increase of 61% over the largest number (686) seen previously, in 1992. Our expectations for the 1994 season were based on the cyclic nature of green turtle nesting that we have observed in the Carr Refuge area during the previous twelve seasons (Figure 2). There is a clear and striking pattern in the data presented in Figure 2. It allows one to predict that the 1995 season will be a relatively "poor" one for green turtle nesting activity but that nest production may very well be considerably greater in 1996. Just how much greater, it seems to us, is much less predictable. One is tempted to presume that the stepwise increases seen in alternate years since at least 1988 will continue and, further, that this pattern indicates a significant increase in the breeding stock of Florida green turtles in recent times. We believe that both presumptions are unwise. Twenty years from now we may well look back at the nest production of the early '90's and realize that it was nothing more than an aberration on an otherwise flat or declining trend line. As noted above for loggerheads, it takes a long time for genuine trends to develop and be detected in populations of species with long generation times. The survey work on major nesting beaches must continue in order to determine if what we think we see is real.

SPATIAL DISTRIBUTION OF NESTING

LOGGERHEADS

The spatial distribution of loggerhead nests over the Central Brevard/ACNWR continuum is exhibited in Figure 3, in which the division between Central Brevard and ACNWR is at 5.0S. Of those nests, 28.2%

occurred in in the Central Brevard area. This is within the range of the proportion of nesting occurring in Central Brevard from 1989 through 1993. Over the last five seasons Central Brevard has accounted for 26.9% to 31.5% of the loggerhead nest totals. The data given in Figure 3 represent an overall mean of 296 nests /km in the Central Brevard (474/mile) and 701 nests/km (1122/mile) in the Carr Refuge area for the 1994 season. The single 1-km section with the greatest nesting activity was that from 12.0 to 13.0 in ACNWR with 894 loggerhead nests. Several others nearby had in excess of 850. The very best extensive stretch of loggerhead nesting that we observed in 1994 occurred from 8.0 through 19.0 km in ACNWR. This stretch averaged 821 nests per km. This is generally where the best nesting occurs in our study areas perennially.

An examination of Figure 3 shows that the areas with the greatest density of loggerhead nesting in Central Brevard were at the northern and southern boundaries of the study area. Kilometers 2-3 S, 3-4 S and 4-5 S had the highest nesting densities with 434, 483 and 499 nests per kilometer respectively. Sections 14-13 N and 13-12 N, where there is a relatively undeveloped, lightly disturbed stretch of dune land on the northern margin of Satellite Beach, had 393 and 342 nests. The half kilometer at the northern boundary, 14.0 to 14.5 N, had 163 nests. The increased nesting at the southern boundary is to be expected as it grades into the more heavily nested ACNWR. The undeveloped area on the north is relatively dark and has less human activity at night compared to the 13 km stretch of beach immediately to the south. In most previous years the very busy, well-lighted "boardwalk" at Indialantic (1.0 - 0.5 N) had the least nesting, but that tendency did not prevail in 1994. Instead, the half kilometer from 6.5-6.0 N, which is dominated by two high-rise motels and other commercial development, exhibited the smallest number of loggerhead nests (67).

GREEN TURTLES

The distribution of green turtle nests throughout Central Brevard and ACNWR is graphed in Figure 4. The pattern is quite similar to that seen in all other years, but with one small difference. Typically the distribution of green turtle nesting in the Carr Refuge area is bimodal, with peaks in those areas that now correspond to the northernmost and southernmost refuge core areas in Brevard County. We have generally attributed the trough between the two peaks to the greater abundance of dwellings, businesses, lights, etc. in the two more highly populated areas known as Melbourne Shores and Floridana Beach. Nesting density did indeed adhere to that pattern in that the two sections with the least green turtle nesting (13.0-14.0S and 17.0-18.0S in Figure 4) are at the centers of those two villages, where disturbance and illumination are greatest. It is interesting to note, however, that there is a third, minor peak between those two population centers which corresponds pretty well to the middle refuge core area (the smallest of the three). It is in a relatively undeveloped, undisturbed area just north of Floridana Beach. There has been a suggestion of this third small peak in the spatial distribution of green turtle nesting in previous years. In 1994 there was so much nesting by this species overall that the peak became more visible. This is, in essence, another graphic demonstration of the way in which the nesting of this timid, wary species is affected by development on the dunes above the beach. Commercial and residential development is rapidly encroaching on the relative serenity of the Carr Refuge area. Each new shopping center, each new restaurant, each new dwelling and housing development brings with it lights which add to the "sky shine" or "urban glow" over the barrier island. To the extent that this continues, the suitability of the Carr Refuge beach as a green turtle nesting ground will diminish.

LEATHERBACKS

Not many leatherback turtles nest on the beaches of central and south Brevard County and it is doubtful that very many ever did. The greatest number of <u>Dermochelys</u> nests seen in any previous season was three; the normal expectation is one or two. In 1994 there were four leatherback nests deposited in the overall area, two in Central Brevard and two in ACNWR. The timing was such that we can be sure that at least two different individuals were involved.

EPILOGUE

It was an extraordinary year for marine turtle nesting activity at the Carr Refuge, with both loggerheads and green turtles setting new records for nest production. The results of this work in 1994 impart further credence and urgency to the Carr Refuge concept and underscore the imperative for rapid acquisition of refuge lands.

ACKNOWLEDGEMENTS

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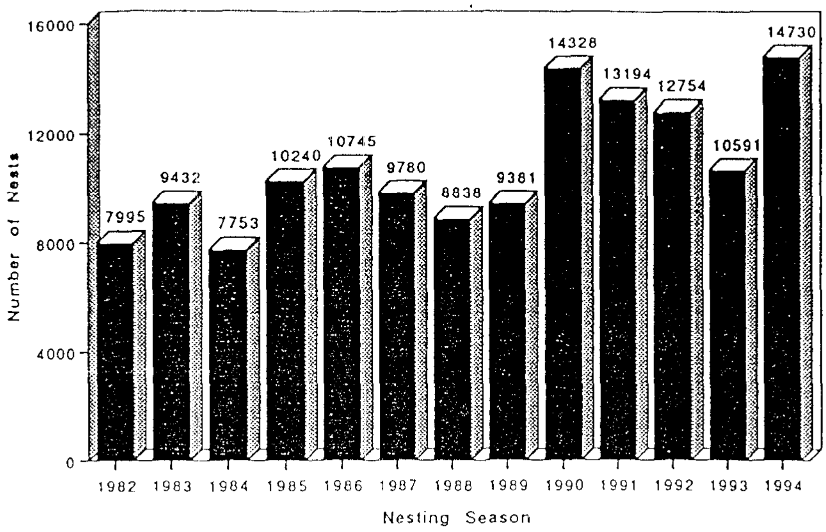

Figure 1. Loggerhead nest totals in the South Brevard study area, 1982 through 1994.

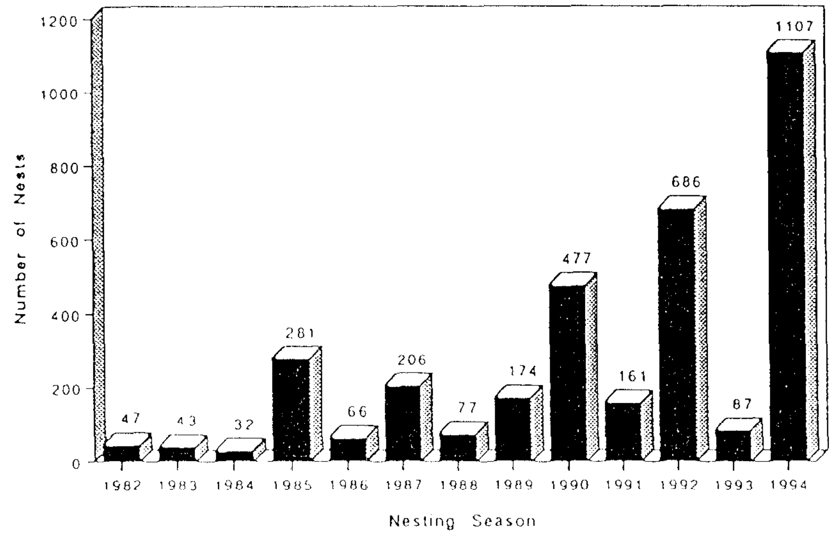

Figure 2. Florida green turtle nest totals in the South Brevard study area, 1982 through 1994

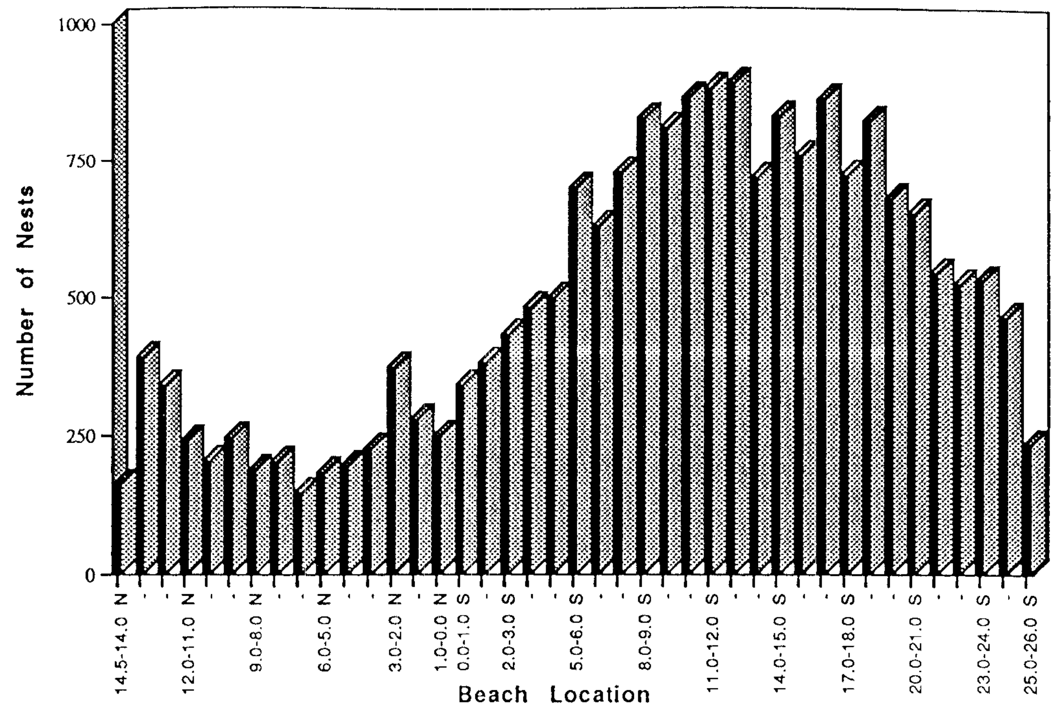

Figure 3. Spatial distribution of loggerhead nests deposited in the Central and South Brevard study areas in 1994.

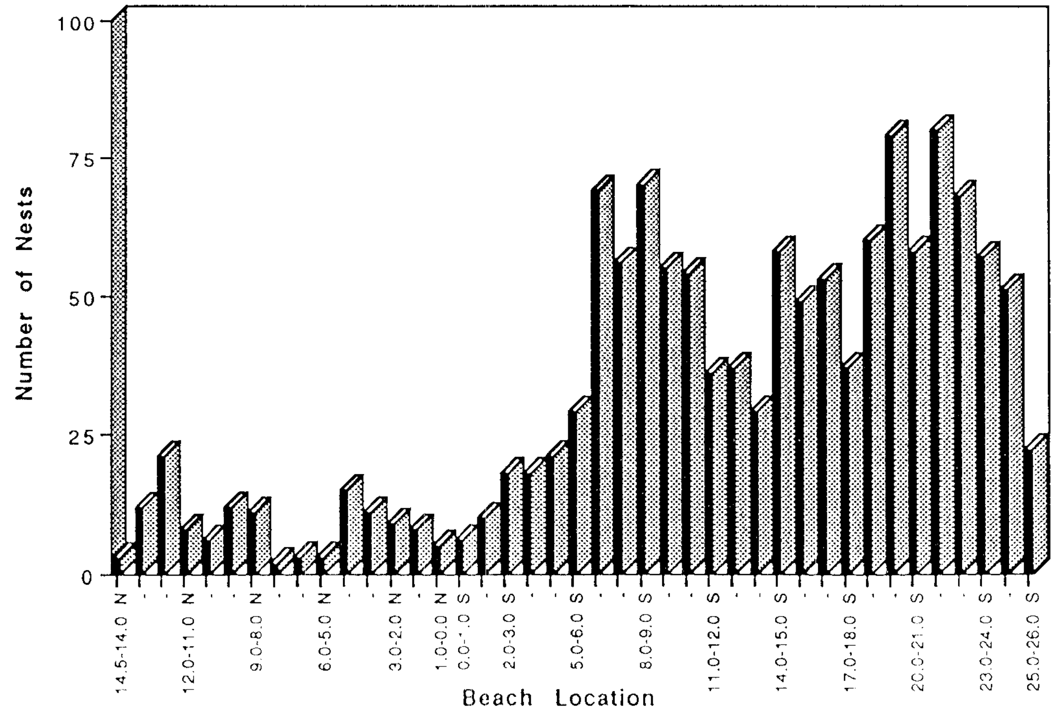

Figure 4. Spatial distribution of Florida green turtle nests deposited within the Central and South Brevard study areas in 1994.

APPLICATION OF SONIC TELEMETRY FOR IDENTIFICATION OF CRITICAL HABITAT OF SEA TURTLES

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INTRODUCTION

Recent reviews cite the need for information on spatial and temporal distribution and the use of shallow waters by juveniles and subadult sea turtles as a critical research priority (Magnuson et al. 1990; Thompson et al. 1990; Species' recovery plans). The goal is to assess the role of various habitats in supporting sea turtles, particularly juveniles and subadults, and possible conflicts with anthropogenic practices. Protection of juvenile and subadult life stages is critical for ensuring the survival of loggerhead sea turtles in the South Atlantic Bight (Crouse et al. 1987), and likely for the recovery of other sea turtle species (Magnuson et al. 1990).

NMFS research showed that North Carolina's inshore waters are important to various life stages of three sea turtle species, and delineated general seasonal and distribution patterns in the Pamlico-Albemarle Estuarine Complex (Epperly et al. 1995a, 1995b). Densities of sea turtles in Core Sound are especially high (Ibid.). How these inshore waters are used by the inhabiting sea turtle species is not known. Habitats in Core Sound are diverse and within a short distance include shallow muddy tidal creeks and bays along the western shore, channels in the open sound, and a broad shallow shelf to the east which contains large expanses of submerged, rooted vascular plants (SRV, e.g. seagrass). SRV habitats in Core Sound are being mapped; in 1988 they accounted for 6637 ha of the subtidal land in Core and Back Sounds, or about 35% of the subtidal area (Ferguson et al. 1993).

The concentration and overlapping distribution of immature Kemp's ridley, green, and loggerhead sea turtles in the Pamlico-Albemarle Estuarine Complex offers a unique opportunity to examine all three species simultaneously and compare their inshore habitat requirements. The purpose of this study was to determine whether turtles' preference/avoidance of habitats could be determined from positional information obtained while the turtle was at the surface.

MATERIALS AND METHODS

Three immature loggerhead sea turtles (Caretta caretta) were obtained from local fishermen. A telemetry package was attached to each animal by tethering it with 120 lb test nylon coated stainless steel wire to the postcentral scutes. The tether was approximately one-half the straight line carapace length (SCL) of the turtle, and contained a short (<3 cm) break-away link of 25 lb test monofilament line and stainless steel ball bearing swivels at each connection site. Each telemetry package consisted of a Telonics MOD-50 radio transmitter with marine helical antenna, inserted into the end of a torpedo buoy for flotation, and a Sonotronics XTAL-87L sonic transmitter suspended below the float. The animals were released in the vicinity of their capture site. We used a Telonics TR-2 receiver and Sonotronics USR-91 narrowband receivers with directional hydrophones to monitor the animals. The radio receiver used an AVM Yagi antenna with a null-peak system.

The animals were tracked simultaneously from two small boats, anchored with a 3-point system to stabilize the boats' movements. Each position of the boats was determined by averaging 40+ differentially corrected Global Position System (GPS) readings collected at 15 sec intervals. Synchronized sonic bearings to the turtle were recorded every 5 min. Additional bearings were taken every time the animal surfaced (determined by the reappearance of a radio signal). Personnel on the boats were in radio contact and compared each bearing to ensure bearing angle between the boats and the turtle was between 45° and 135°; if the turtle moved outside of this range, one or both boats relocated.

System bias for each set of equipment and for both observers was determined using the methods of Collazo and Epperly (1995) and Braun et al. (in review). Individual bearings to the turtle were corrected for system bias. The location of an animal was determined by triangulation using the synchronized corrected bearing pair and the known locations of the boats. Circular error polygons (50% and 95%) were constructed about these points. This error polygon is described by the radius of a circle which encompassed 50% or 95% of the location errors (distance between estimated location and known location) in system test data sets. Because location error is largely a function of geometric mean distance ($\underline{D}_g$) between the boats and the turtle (Collazo and Epperly 1995; Braun et al. in review), the radius of the error polygon can be predicted by a linear model (e.g 50% error = $18.87 + 0.18\underline{D}_g$; Braun et al. in review). The turtle positions and their error polygons were related to depth and to the presence of SRV habitat using ARC/INFO GIS version 7.0. SRV habitat data were from 1988 (Ferguson et al. 1993); depth data were from 1995. The results from one of the turtles follow:

RESULTS

A 56.0 cm SCL, 27.4 kg loggerhead was tagged and released on 2 Sep. 1994. It was monitored between the hours of 0945 and 1545 EST on 7-9 Sep. in Back Sound. During 17 h of monitoring, 206 positions were obtained at $\underline{D}_g$'s of 66-1,095 m median=314 m). The distances between subsurface positions, perceived as movement by the turtle along the bottom during a 5 min observation interval, significantly deviated from a normal distribution: the median distance moved was 52 m (25% quartile=35 m, 75% quartile=91 m). The distribution of location errors associated with the subsurface positions also was not normal: the median distance of 50% location errors was 78 m (25% quartile=63 m, 75% quartile=117 m) and the median distance of 95% errors was 178 m (25% quartile=133 m, 75% quartile=299 m).

Study area

Submerged rooted vegetation accounted for 27% of the available habitat in the 287 ha study area, defined as the area bounded by the extremes of the 206 turtle positions. Depths in the area generally were less than 2 m, but a narrow channel with depths up to 7 m occurred to the north.

Relation between turtle positions and available habitat

(Based on underwater positions of the turtle)

The loggerhead turtle never was detected in SRV habitat on 7 or 9 Sep. This avoidance (0% occupation) was significantly less than would be predicted based on a random distribution model (χ^2 test, $p<0.05$). The turtle occupied some SRV habitat on 8 Sep. (8% of the positions); the distribution of positions on this day was consistent with the hypothesis that there was neither preference nor avoidance of vegetated and non-vegetated habitats (χ^2 test, $p>0.05$).

The loggerhead turtle did not randomly associate with depths on 7 or 9 Sep. Instead, it preferred depths greater than widely available, but avoided the depths of the channel (χ^2 test, $p<0.05$). The turtle never was detected in the channel despite occupying the southern rim of the channel for most of 7 Sep. The turtle's distribution on 8 Sep. was consistent with the hypothesis of no preference or avoidance of depth (χ^2 test, $p>0.05$).

Comparison between surface and bottom positions

Sixty-nine positions were obtained during surfacing events. Each surface position was compared to the bottom position acquired immediately before and/or immediately after the surfacing event to determine if classification of habitat (vegetated vs. non-vegetated) differed. The turtle did not appear to leave the area of its berthing habitat or to alter its course to surface. The classification of the surface position differed from adjacent bottom positions in only three of 100 comparisons. In each of the three cases, the turtle had moved some distance before surfacing, but was still well within the 50% error polygon about an adjacent underwater position.

CONCLUSION

Past studies have shown sonic telemetry to be a feasible tool to evaluate habitat use studies in Core Sound (Collazo and Epperly 1995; Braun et al. in review). Use of specialized tags, such as LORAN tags, which function only when the animal is on the surface, have been of uncertain application for sea turtle habitat studies because it was not known how far a turtle moved laterally from its submerged "berthing" location before surfacing. If the movement is significant, then sonic telemetry, used when the animal is underwater, is the only means to conduct habitat utilization studies. If the lateral movement is insignificant, then LORAN or UHF tags could be used to monitor and classify the habitat at a turtle's location. These mid-range tags afford a more cost effective method to collect positional data on a large number of turtles for habitat utilization studies because the data can be acquired remotely.

In the relatively shallow waters of Back Sound, lateral movement between underwater "berthing" positions and surfacing positions of a loggerhead turtle was insignificant. Furthermore, the turtle did not alter its behavior to surface. We assume the results from this single turtle are applicable to other turtles in most of North Carolina inshore waters, because these waters are relatively shallow and without deep channels, and a turtle has to traverse but a short water column to surface. We conclude that technologies which identify the position of a sea turtle when it is on the surface can be used to conduct habitat utilization studies when the turtle is in relatively shallow inshore waters, provided accuracy and precision are within acceptable limits. During 1995, we will evaluate the accuracy and precision of positional data obtained from LORAN tags.

ACKNOWLEDGMENTS

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THE BREEDING MALES OF BOUNTIFUL, RAINE AND HERON ISLANDS: WHAT FEMALE INHERITED MARKERS CAN TELL US ABOUT MALE REPRODUCTIVE BEHAVIOUR.

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Among the mysteries of marine turtle biology are the largely unknown journeys of the male turtles. Research has indicated that Chelonia mydas males display fidelity to both breeding and feeding grounds and that their breeding migrations may be more frequent than females (Balazs 1980, Limpus 1993). However, the question remained as to whether male fidelity was to their natal regions as has been reported for several female nesting populations (Bowen et al. 199, Meylan et al. 1990, Broderick et al. 1994, Norman et al. 1994). Genetic studies using anonymous nuclear loci (Karl et al. 1992) have suggested that moderate levels of male-mediated gene flow occur among regional populations on a global scale and the authors speculated that matings might occur on overlapping feeding grounds, along migration corridors or at non-natal rookeries.

To address questions about male behaviour and male-mediated gene flow, we integrated a comparative genetic approach with an extensive tagging effort of males at both feeding and breeding grounds in Queensland (Limpus 1993). Initially we analysed green turtle populations throughout Australia for allelic diversity at 4 highly variable microsatellite loci found within the nuclear DNA (FitzSimmons et al. 1994). We found significant genetic divergence in nearly all pairwise comparisons between the four regions tested: Southern Great Barrier Reef(SGBR), Northern Great Barrier Reef (NGBR), Gulf of Carpentaria (GOC) and Western Australia, with the single exception of no significant divergence between the NGBR and SGBR populations. These results indicated that males may exhibit similar regional fidelity to breeding regions as demonstrated for females (Norman et al. 1994), but that some male-mediated gene flow was likely occurring between certain regions, namely NGBR and SGBR.

We looked more closely at natal fidelity by comparing the frequencies of mitochondrial DNA (mtDNA) haplotypes of breeding males to those of nesting females (Norman et al. 1994) in three locations: Heron Island (SGBR), Raine Island (NGBR), and Bountiful Island (GOC). Our results indicate that the haplotype frequencies in each region were the same for both males and females. Thus, males are mostly breeding in their natal regions, as was previously found for females (Norman et al. 1994).

In conclusion, male-mediated gene flow between regions is probably not as prevalent as previously suggested (Karl et a. 1992), though it likely occurs between some regions, such as observed between the NGBR and SGBR. The extent to which male-mediated gene flow occurs is unknown at this stage. The lack of heterogeneity seen at the nuclear level between the NGBR and SGBR populations may be due to opportunistic matings between turtles from these populations during breeding migrations, and to low levels of 'imperfect' natal homing by both males and females.

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EFFECTS OF GLOBAL TEMPERATURE INCREASE ON THE VIABILITY OF LOGGERHEAD SEA TURTLES (CARETTA CARETTA) AT MELBOURNE BEACH, FLORIDA

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Global climate change and its potential effects on biodiversity can no longer be ignored. Among the likely consequences of an increase in greenhouse gases are global mean surface warming, global mean precipitation increase and rise in global mean sea level (Gates 1993). Due to their temperature dependent sex-ratio and terrestrial nesting habit, sea turtles are particularly vulnerable to increases in temperature. A skewed mean surface temperature during nest incubation could lead to a skewed sex ratio in the entire population. Current management and conservation practices often do not take into account this very sensitive factor at the time of controlling temperature in artificial hatcheries (Mrosovsky & Yntema 1980; Morreale et al. 1982), thereby damaging the very population they are attempting to protect. This paper models the effects of the predicted increase in mean global temperature on the natural nests of loggerhead (Caretta caretta) sea turtles at Melbourne Beach, Fl.

For the purposes of this study, Schneider's (1990) temperature change projections are assumed to be linear annual increases: the best case scenario has a temperature rise of 0.006°C per year, the middle scenario represents a 0.03°C increase and the worst case scenario shows a 0.08°C yearly increase. As a worst case scenario, I assume a 1:1 linear relationship between the predicted increase in average air temperature and the corresponding increase in nest incubating temperature. As new evidence is uncovered, modifications to adjust nest temperatures to a slower rate of increase may be necessary, since nests are believed to maintain a more constant temperature than air. In addition, there are factors such as yearly temperature fluctuations, seasonal changes (Mrosovsky et al. 1984) and metabolic heating within the nest which may affect temperature to some degree. Due to the impossibility of quantifying such variation, I assume that these factors do not significantly affect the average incubating temperature.

METHODS

A Leslie matrix, derived by Crouse et al. (1987) and modified by Crowder et al. (1994), is used to project the Caretta caretta population of Melbourne Beach, Florida 240 years into the future. It is assumed that the current sex ratio is 1:1 and, therefore, the average nest temperature over the nesting season is 30°C. The base year, 1990, was extraordinarily productive: 1,622,858 eggs were laid, with 967,548 hatchlings produced, an average clutch size of 113 and a hatching success rate of 59.62% (Owen et al. 1992). Although survivorship and fecundity data used by Crowder et al. (1994) was calculated for Little Cumberland Island, Georgia, and it is not certain whether it can be directly applied to the Florida population, it appears to be the best and most complete available data for loggerheads.

Stochasticity was introduced by establishing the degree of variation around the mean temperature at Melbourne Beach over the three peak nesting months of June, July and August. This standard deviation was found to be 0.646°C and was used in conjunction with the mean predicted temperature increases of 0.08°C, 0.03°C and 0.006°C. The mean global increase and its standard deviation were added to a mean nest temperature of 30°C and its standard deviation of 1.4°C (Morreale et al. 1982) to determine the predicted nest temperature for each year, and thus the predicted proportion of males and females. Values were extrapolated from the sex ratio-temperature relationship by Mrosovsky (1980) so that, a temperature of 28°C or below would yield 0% females, 29°C would yield 25% females, 30°C 50% females, 31°C 75% females and 32°C or above 100% females. The reverse percentages were assigned to the proportion of males.

Lack of accurate evidence on special parameters pertaining to males and not to females (i.e. multiple clutch paternity, allee effects, breeding sex ratios, mating behavior), makes it impossible to quantify the potential differences between a male and a female matrix in this population model. However, two projections were run concurrently for the male and female populations. Total population, stable age distribution and lambda were determined for each of 240 years. Next, all three global warming scenarios were modeled, as well as a scenario without global warming and a lambda of 0.95. The model was run both deterministically (using mean values) and stochastically (using 1000 iterations on a Lotus@Risk spreadsheet), to assess the average expected value after 240 years and the percentage of the iterations which led to extinction.

RESULTS AND DISCUSSION

Despite a relatively high initial total population of 3,402,215 individuals (males or females), loggerheads at Melbourne Beach will reach extinction by the year 2163, assuming a 5% rate of decline (Crowder et al. 1994) even without an increase in mean global temperature (Fig. 1). The total population of males or females was then plotted for each year for the three warming scenarios (Fig. 2). It can be noted that the best case scenario deviates only slightly from the scenario without global warming, since sex ratios become skewed relatively late, when population numbers have already decreased significantly. The worst warming scenario, on the other hand, shows that the female population decreases much less steeply than any of the others, while the males in the same populations go extinct almost immediately. The middle scenario also shows females surviving past 240 years and males going extinct at an intermediate time. In summary, all scenarios lead to the extinction of males (61, 80 and 150 years) while only the no warming scenario and the best case scenario (0.06°C increase) lead to the extinction of females, at 190 and 173 years respectively (Table 1).

Results incorporating stochasticity (Table 2) are only slightly less catastrophic. The mean expected values from 1000 iterations after 125 years decrease going from best to worse case warming scenario in males and increase in females. The opposite is true for the percentage of iterations which lead to extinction: more iterations go extinct in the case of males in the highest temperature increase than those in the lowest temperature increase and vice versa for females. Note that all of the extinction percentages for females are at or below 50%, and male extinction probabilities range from 54 to 72%.

Several factors are not taken into account by the model, including variation of pivotal temperature with latitude and shifting of the nesting range to lay eggs in cooler regions as temperatures increase. On the other hand, the use of a large and relatively healthy population such as that of Melbourne Beach, as well as an unusually good year as the initial year, assures us that the results of the model are actually an optimistic prediction, perhaps the best scenario given the options. Unfortunately, this also means that most other nesting beaches probably present an even more dismal picture. Despite the money and effort being placed in the conservation of sea turtles around the world, it is clear that it will all be futile unless we are able to cease the production of greenhouse gases. Changes in temperature beyond 2°C would be unprecendented in the era of human civilization (Schneider 1990) and the consequences are likely to be disastrous. Species such as the sea turtles, already endangered by high human-induced mortality, have little chance of survival in the face of drastic climate change.

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Table 1. Results from the deterministic population projections of the loggerhead sea turtle population of Melbourne Beach, Florida with and without global warming through 240 years (i.e. 2230). Year Extinct indicates the year at which the male or female population reaches extinction, while Number at 240 indicates the remaining number of individuals by the year 240.

	Females		Males	
	Year Extinct	No. at 240	Year Extinct	No. at 240
0.08 rise	-	366,226	61	0
0.03 rise	-	65,813	80	0
0.006 rise	190	0	150	0
No warming	173	0	173	0

Table 2. Results of Lotus @Risk, 1000 iterations of the Melbourne Beach, Florida loggerhead population, projected over 125 years for three global warming scenarios and for conditions without a temperature increase. Mean Remaining is the average number of individuals remaining in the population after 100 iterations and Percent Extinct is the percentage of iterations which resulted in extinction of the population. The significant difference evident between warming and non-warming number of remaining individuals might be attributable to the influence of the large standard deviation used in the calculations.

	Female		Male	
Global Warming	% Extinct	Mean Remaining	% Extinct	Mean Remaining
0.006 increase	52	340631	54	313525.2
0.03 increase	47	395467.9	61	247158
0.08 increase	37	539404	72	148258.3
No Warming	0	5607.9	0	5607.9

Figure 1. Loggerhead (male or female) population projection without global warming. With no temperature increase and assuming a 1:1 sex ratio, the loggerhead population of Melbourne Beach, Florida is expected to reach extinction by the year 2163 (i.e. 173 years from year 0). Survivorship and fecundity values used in the calculations (Crowder et al. 1994) assume a 5% rate of decrease (Lambda equals 0.95).

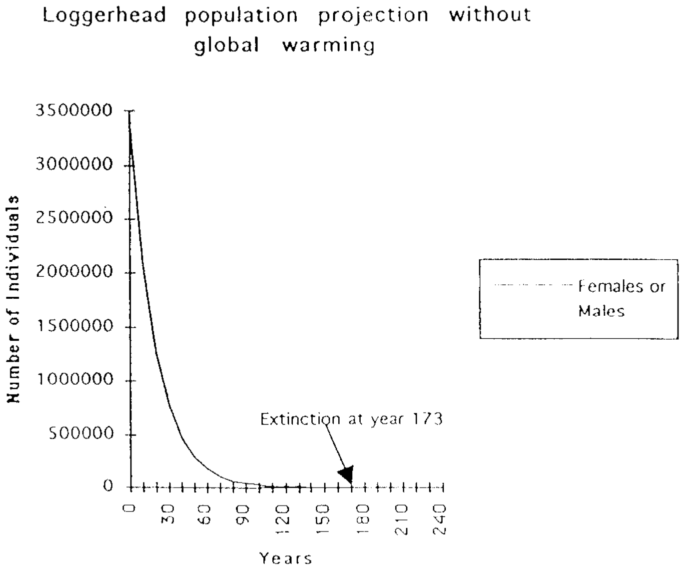
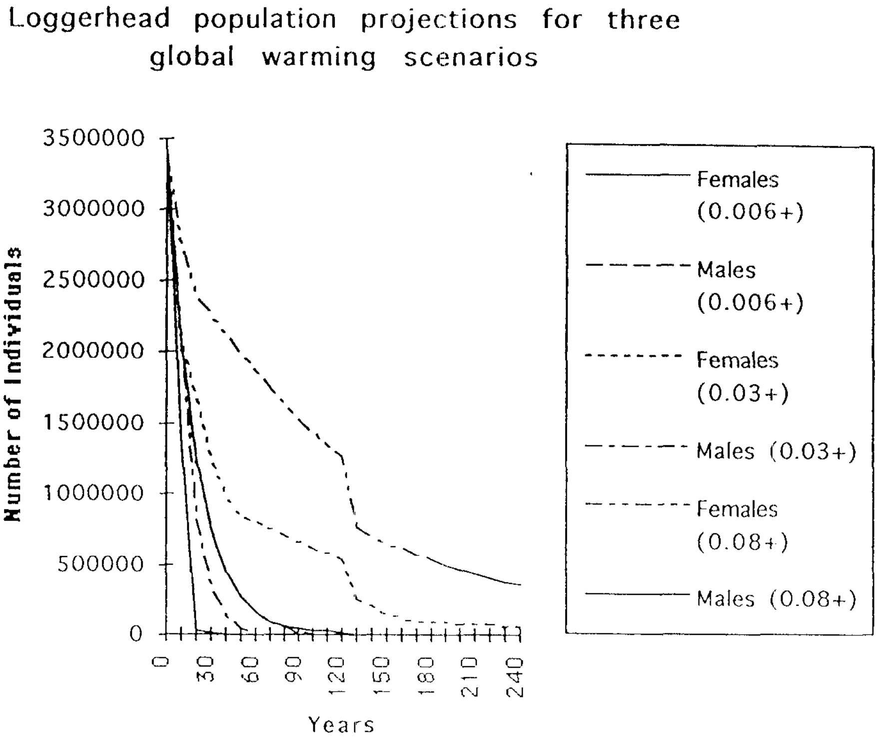


Figure 2. Loggerhead male and female population projections with predicted global temperature increases of 0.08°C, 0.03°C and 0.006°C. The latter scenario is remarkably similar to the scenario without global warming. The other two scenarios do not lead to the extinction of females within 240 years (Table 1) but they lead to the relatively quick extinction of males, which essentially means that the females will be unable to reproduce. Calculations are based on values from Crowder et al. (1994).



MARINE CHELONIPHILES AND SUSTAINABLE DEVELOPMENT

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The concept of "sustainable development" (susdev) is highly relevant to those of us who specialize on marine turtles. The term has become a major social phenomenon, and is one of the most influential contemporary concepts/logos dominating national and international policy with respect to the human condition; business actions and initiatives; national and international policies and actions; and the planning and funding of science and biological conservation, including marine turtles and their habitats. Sustainable development has become a growth industry, and the term "sustainable" ("S.") is used as a fashionable modifier for countless concepts and phenomena. A selection includes: S. use (S. utilization) (S. extraction); S. agriculture; S. forestry; S. fisheries and aquiculture; S. ecosystem; S. ecology (Ecological Sustainability); S. landscape; S. tourism; S. enterprise; S. economy; S. industry; S. life; S. improvement in quality of life; S. society; S. future; S. planet; U.S. Sustainability.

Furthermore, susdev has become institutionalized. A few examples include: Virginia Eastern Shore Sustainable Development Corporation; President's Council on Sustainable Development ("PCSD") (USA); International Institute for Sustainable Development (Canada); Business Council for Sustainable Development (BCSD) (Switzerland); and U.N. Commission for Sustainable Development. The PCSD has heavy representation of, and direction by, Corporate America and the BCSD is made up of the heads of multinational corporations (Willers 1994).

WHAT IS SUSTAINABLE DEVELOPMENT?

There is no standard definition of this term. An ordinary dictionary definition of "development," the noun, includes: the act of developing, which is to de-envelop, remove an envelope, to remove limitations, to grow; it also means "to exploit the natural resources of a region" and "to cause to grow, especially as in a business;" it is synonymous with modernization and industrialization. "Sustainable," the adjectival modifier, comes from sustain, to hold up, support, supply for.

SOME ROOTS OF THE TERM "SUSTAINABLE DEVELOPMENT"

The term "sustainable development" has been used in several very important documents which have had immeasurable affect on conservation planning and policy. Robinson (1993) and Willers (1994) review some of the more important publications.

In the World Conservation Strategy (IUCN/UNEP/WWF, 1980), "conservation" was defined as the "greatest sustainable development to present generations while maintaining its potential to meet the needs and aspirations of future generations." It was explicitly explained that in susdev, the actions of conservation and development are mutually dependent.

After the U. N. meeting in Stockholm, Our Common Future (known also as the "Bruntland Report") defined susdev in the same terms as "conservation" had previously been defined in the World Conservation Strategy. Furthermore, this Report called for the international economy speeding up world growth and a 5 to 10 fold increase in manufacturing output. It acknowledged that under this policy "Only relatively few of the more spectacular and important" species will be saved" (World Commission on Environment and Development, 1987).

In 1991, Caring for the Earth: A Strategy for Sustainable Living was published by IUCN/UNEP/WWF. This persuasive document defined susdev as "improving the quality of human life while living within the carrying capacity of supporting ecosystems." Robinson (1993) has characterized its goals as utopian and unattainable.

The same year another influential, international document (McNeill et al., 1991) stated that the basic needs of the world population require large appropriations of natural resources, and given the aspirations and the rapid growth of the human population, "even more" natural resources will be required. It was explicitly stated that "The maximum of sustainable development is not 'limits to growth;' it is 'the growth of limits.'"

The following year Clinton and Gore (1992) wrote "We will renew America's commitment to leave our children a better nation...whose leadership for sustainable global growth is unsurpassed."

Even leading conservation organizations are jumping in; the Nature Conservancy's bulletin stated "Sustainable development's goal: Balancing economic growth with biodiversity preservation." (Watson, 1994).

In summary: 1) the definition of the term "sustainable development" has gone through a rapid and dramatic transformation; 2) there is great confusion about what susdev is; 3) it frequently refers to some form of economic growth; and 4) in the end it "has come to mean whatever suites the advocacy of the individual concerned" (Pearce et al., 1989).

WHAT IS THE CONTEMPORARY SITUATION WITH WORLD DEVELOPMENT?

It is important to understand the present situation in relation to world development. The exhaustive analysis published by the UNEP (Tolba et al., 1992) provides a wealth of information:

The world human population is presently estimated to be 5,500,000,000. Within this mass of people, the examples of extreme poverty are overwhelming: 25 % has no potable water; 36 % has no basic sanitary conditions; 27 % is illiterate.

Predictions about the world human population are equally startling: the present human population will double by 2050, and 97 % of this increase will occur in "Third World" (where 36% of the population is less than 15 years old).

Patterns of resource consumption and waste production are no more consoling. It is commonly estimated that 20 % of the world population consumes 80 % of the resources, and 20 % of world population produces 80 % of global contamination. Clearly, most of the heavy consumers/contaminators are in overdeveloped countries, but it is imperative to understand that in underdeveloped countries there is also a minority of the citizens who are rich and heavy consumers and contaminators by world standards.

International activities related to "development" are also astounding. Consider "foreign aid." Over the past few decades thousands of millions of US$ have been spent under the category of "foreign aid;" in 1986, US$ 49,000,000,000 was spent in "foreign aid," ostensibly to alleviate problems of poverty and underdevelopment (Frazier, 1990).

The results of these "development activities" are cause for deep concern: the human condition has not improved, but gotten worse; the number of "very poor" in the world was estimated to be 944 million in 1970, 1,156 million in 1985, and it is likely to be 1,300 million in 2000. The number of malnourished people in the world has also grown: 460 million in 1969-70 and 512 million in 1983-85.

The results of development activities in relation to the environment are only too well known. Something as fundamental as the atmosphere has shown a dramatic increase in CO2, SO2, NO2, NO etc. - all related to human activities. Water supplies are also a grave concern: more than 30 countries will have a marked reduction in water available during the next decade or two.

In summary, the results of contemporary development activities show clearly that: consumption patterns are UNsustainable; contamination patterns are UNsustainable; and population growth patterns are UNsustainable.

Sustainable development may have been a good idea, but it has been contorted and converted into dogma. It is now distorting the way in which science, conservation and development are planned and funded.

For contemporary Western Society to continue - without a collapse - it will have to be REdeveloped.

QUESTIONS FUNDAMENTAL TO DEFINING SUSTAINABLE DEVELOPMENT

As long as susdev is in wide and continual use, it is imperative to define it in clear terms, so that it can be measured and evaluated by objective methods. A number of basic questions must be asked - and answered.

What is being developed? For whom is it being developed? Who is developing it? How is it being developed? How are development goals to be measured and evaluated?

What is being sustained? For whom is it being sustained? By whom is it being sustained? How is it being sustained? How are the goals of sustainability to be measured and evaluated?

Is there a form of sustainable development which is approved by local communities, ecologists, social workers and industrialists?

Is there a form of sustainable development which is approved by the poor and also by the wealthy?

SOME DOUBTFUL/FAULTY ASSUMPTIONS UNDERLYING SUSTAINABLE DEVELOPMENT

- There is a "balance of nature."
- Undisturbed ecosystems exist at equilibrium.
- There is Man (and Woman) and nature, as separate entities.
- Humans have the scientific knowledge and political ability to manage resources and the environment on an indefinite basis.

- Technology solves problems, and solving more problems means developing more technology (i.e., technology has no limits).
- "Development" (industrialization/modernization) is an essential goal for ALL humanity.
- Continual growth is both necessary and practical.
- Sustainable use, and sustainability, are always possible, it is just a question of how?
- "Sustainability" is a universal necessity.

SOME FUNDAMENTAL CRITICISMS OF SUSTAINABLE DEVELOPMENT

- It is not just business as usual, but often a ploy.
- Calling something "sustainable" makes it fashionable and acceptable.
- Susdev is utopian, and unattainable.
- Susdev is not limiting growth, but growing limits.
- Susdev is code for perpetual growth.
- Since in living systems, unlimited growth is extremely rare, and most characterized by cancer, susdev is comparable to cancer.
- "Sustainable development is one of the most insidious and manipulable ideas to appear in decades" (Willers, 1994).

WHAT TO DO?

For all "sustainability" proposals it is important to:
- Insist on clear and objective definitions;
- Insist on frequent, objective evaluations of both the actions being carried out and of the environmental context in which they are carried out;
- Develop efficient mechanisms for changing plans and actions in response to evaluations;
- Insist on full accountability of people and organizations involved.

As viable alternatives to the susdev dogma, it is necessary to explain and emphasize that what must be sustained are life support systems with the capacity to develop and the capacity to evolve and change with needs. We must explain that living systems are dynamic and often unpredictable and that many aspects of our world - fundamental to our survival - are outside of our control.

In regard to marine turtles, it must be explained that the long generation times and complex life cycles make these animals ideal "index species" for assessing international conservation and development activities. Sustainable use of turtles (IF it is possible) can only be accomplished once the marine and terrestrial environments critical to these animals are managed in ways appropriate to these long-lived species.

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AN EVALUATION OF NATURAL VERSUS HUMAN INDUCED MORTALITY IN SEA TURTLES IN THE NEW YORK BIGHT

Eileen Gerle, Samuel S. Sadove

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USA

Sea turtle stranding data for the New York Bight was analyzed for the period 1980 through 1994 to evaluate the incidence of natural versus human induced mortalities. A total of 914 reported strandings involved 821 turtles of which 465 (56.6%) were moribund. Of the 266 turtles for which a cause of death could be determined, 62% of these mortalities can be attributed to natural causes, ie. hypothermia and disease. Human induced mortalities such as boat collisions, entanglement in fishing gear, and ingestion of marine debris account for the remaining 38% of mortalities.

INTRODUCTION

Four species of sea turtles regularly utilize the waters of the New York Bight for summer foraging. New York's coastal waters provide juvenile habitat for loggerheads (Caretta caretta), Kemp's ridleys (Lepidochelys kempi), and green turtles (Chelonia mydas), whereas adult and sub-adult leatherbacks (Dermochelys coriacea) frequent offshore waters (Morreale and Standora, 1993). Based on stranding data from 1980 through 1994, loggerheads are most abundant, comprising 41% of all turtles, followed by ridleys, 29%, and leatherbacks, 21%. Green turtles account for only 9% of strandings. Sea turtle distribution and abundance differs from that found in coastal waters of the United States (National Research Council, 1990) in that leatherbacks are more evident than green turtles, and hawksbills (Eretmochelys imbricata) are not indigenous to this area. Here stranding data is analyzed to evaluate the causes of turtle mortalities.

METHODS

The Okeanos Ocean Research Foundation, located in Hampton Bays, New York, USA, operates the New York State Marine Mammal and Sea Turtle Stranding Program. The Foundation maintains a comprehensive data base on all stranded animals it encounters. Okeanos also conducts an ongoing mark-recapture study with the cooperation of Long Island's commercial fishermen. Since the study was initiated in 1987, fishermen have been requested to retain any incidental catch, dead or alive, and to contact the emergency stranding team upon return to the dock. All animals are retrieved, and live animals receive double flipper tags before their release. In addition, as a result of the episodic cold-stunning event of the 1985-86 fall/winter season in which 54 hypothermic turtles stranded on Long Island shores, (Meylan and Sadove, 1986), the foundation has established and maintained a sea turtle beach patrol network. This network enlists the aid of nearly 200 trained volunteers who regularly patrol assigned beaches for stranded hypothermic turtles

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RESULTS

Since its inception in 1979, the New York State Marine Mammal and Sea Turtle Stranding Program has responded to 914 strandings and captures of sea turtles involving 821 individuals. Over half (56.6%) of these animals stranded dead or died in captivity due to hypothermia, injury or disease. A cause of death could not be determined for 199 turtles due to advanced decomposition.

Incidental Catch in Commercial Fishing Gear

The total number of incidental catches reported during the study period is 423. Methods of capture include trap net (374), trawl (25), gill net (10), long line (4) and entanglement in lobster pot line (9). Seventy one turtles were recaptured, some several times, primarily by pound net fishermen. Only 2.8% of these captures were fatal, involving 10 drownings and 2 deaths due to ingestion of long line hooks. Death by incidental catch in commercial fishing gear accounts for 2.58% of all mortalities.

Vessel Collisions

Since 1980, a total of 92 turtles have exhibited evidence of propeller wounds, 77 of which stranded dead or died in captivity as a result of their injuries. Thirteen turtles were incidentally caught or stranded cold-stunned with non-lethal boat strike wounds. Two other turtles stranded as a result of non-fatal propeller injuries. These turtles were treated at Okeanos and most have been subsequently released. Thus 83.7% of vessel collisions have resulted in turtle mortalities and account for 16.55% of all mortalities.

Hypothermia

During the study period, a total of 201 turtles have stranded cold-stunned. Of these turtles, 164 stranded dead or died in captivity due to their hypothermic condition. To date, Okeanos stranding biologists and veterinarians have successfully resuscitated and rehabilitated 37 cold-stunned turtles, accounting for an 18.4% survival rate. Mortality due to hypothermia comprises 35% of the total number of turtle deaths.

Ingestion

Stomach contents and necropsy findings indicate that 8 turtles died due to ingestion. One loggerhead ingested oil, as witnessed by its oil covered esophagus, 5 turtles suffered fatal ileocecal valve blockages, and 2 turtles died due to hook ingestion (as mentioned above). One turtle caught by long line was successfully operated on to remove the hook from its esophagus. Upon necropsy, 6 turtles had evidence of debris in their digestive tracts that was considered to be contributory to death. Although not the cause of death, stomach content analysis revealed that 6 additional turtles had ingested trash, and one live pound net captured turtle passed plastic in its fecal material. The majority of ingested matter consisted of plastic bags but also included items such as a plastic tampon inserter and a plastic coffee cup lid. Of the turtles encountered during the study period, 2.55% had evidence of ingestion and ingestion was found to be the cause of death or contributory to death in 66.6% of those animals.

Other Mortalities

In 1993, a live loggerhead turtle stranded suffering from encephalitis. The animal was treated at Okeanos but had to be euthanized as a result of the malady.

DISCUSSION

Sea turtles suffer high natural mortality during early life stages due to predation of eggs, hatchlings and juveniles by all manner of carnivorous mammals, crabs, birds and fish. Sub-adults and adults are also consumed by sharks and other large predatory fish (National Resource Council, 1990). Natural mortality can also result directly or indirectly from disease. Illnesses found in sea turtles include intestinal blockage (from crab and shell debris), encephalitis, parasite infestation, granulomas, hypocalcemia, septicemia, viral and bacterial infections, hypothermia, and cutaneous fibropapillomatosis (Walsh, 1993). Abiotic sources of mortality include destruction of nests due to physical factors such as tidal inundation and heavy rains, beach erosion and accretion, and disturbance by later nesting females (National Resource Council, 1990). Turtle mortality associated with human activities includes predation by man for meat, shells and leather, entanglement in fishing gear, ingestion of marine debris, vessel collisions, habitat destruction and removal of oil platforms (National Resource Council, 1990).

In the New York Bight, all mortality factors associated with nests, hatchlings, and human predation can be eliminated, whereas mortality due to hypothermia may be significant at these higher latitudes. Most reported cold-stunning events occur in New York (Morreale et al, 1992) and New England waters (Prescott, 1982), although severely cold weather during several recent years has yielded cold-stunned turtles in Florida (Witherington, 1989). Analysis of cold-stunnings by season (fall/winter)(Figure 1), reveals particularly high numbers of cold-stunned turtles during the 1985/86, 1986/87 and 1987/88 seasons. The variance in numbers of hypothermic turtles recovered for all seasons beginning in 1980/81 may be attributed to differences in the direction of prevailing winds during the "event" seasons (Burke & Standora, 1991). However, should these major cold-stunning events prove to be anomalous, the data for these years greatly skews the results, as seen by graphing natural versus human induced mortalities by year (Figure 2). If mortalities due to cold-stunning are removed from the data, the number of known natural mortalities would drop to a single animal, the loggerhead turtle afflicted with encephalitis. Furthermore, entanglement and ingestion would comprise 7.9% of mortalities, and boat strikes would account for 25.6% of all turtle deaths. Thus vessel collision could be a much more significant mortality factor than initial data analysis reveals.

CONCLUSIONS

In the New York Bight, human induced mortality factors, particularly vessel collisions, are significant for sea turtles, as is death by hypothermia. As the survival rate for cold-stunned turtles is low, further work needs to be done to develop more successful treatment of these animals, particularly the Kemp's ridley. Ridley's comprise a high 73% of all moribund hypothermic turtles.

ACKNOWLEDGEMENTS

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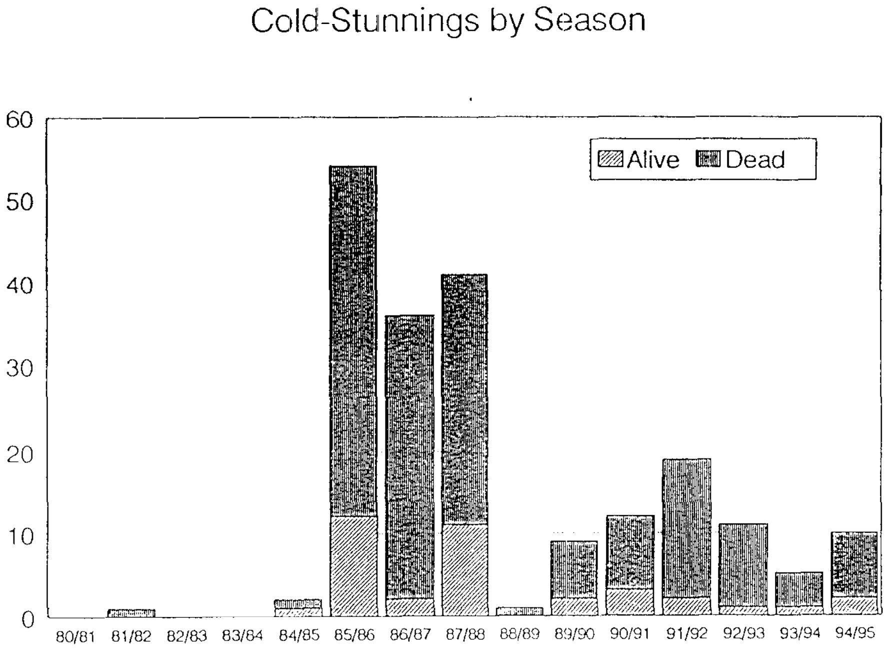

Figure 1.

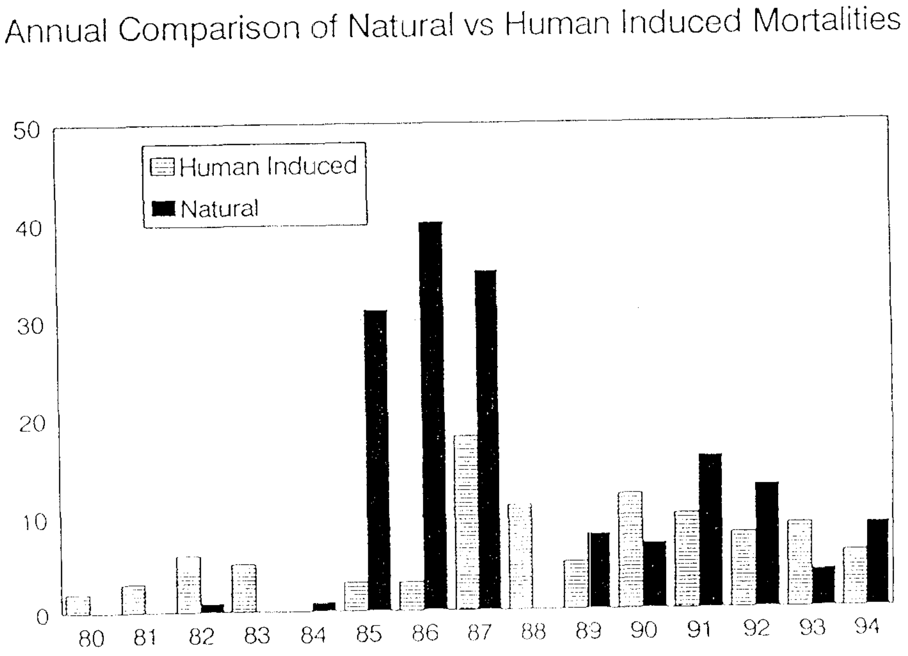

Figure 2.

SEX RATIOS OF SEA TURTLES IN SURINAME: PAST AND PRESENT

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Two species of sea turtle, green (Chelonia mydas) and leatherback (Dermochelys coriacea) nest on Suriname beaches during several months of the year. The overall sex ratio of leatherback and green sea turtle hatchlings produced at Matapica Beach in Suriname in 1993 was estimated to be 63.8 % female for green turtles and 69.4% female for leatherbacks. This was different from an earlier study in 1982 (Mrosovsky et al., 1984). For both species, a significant negative relationship was found between monthly rainfall data and monthly sex ratios. Using these relationships and data on rainfall in the past, it was possible to estimate overall sex ratios for an additional 12 years. These estimates varied considerably among different years, ranging from 20% to 90% female in the case of green turtles. Nevertheless, nests laid in April and May tended to produce some male hatchlings, while female hatchlings generally were produced in all months. Such seasonal patterns of production of different sexes have implications for sea turtle conservation programmes that involve manipulating or harvesting eggs.

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THREATS TO MARINE TURTLES IN NORTHERN CYPRUS, EASTERN MEDITERRANEAN.

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INTRODUCTION

Throughout the Mediterranean, and the rest of the world, threats to marine turtles are escalating. These have been well reviewed (Groombridge 1990; Hutchinson and Simmonds 1992). In the Mediterranean, the major issues include nesting habitat degradation due to tourism, other development, sand extraction, direct and incidental catch in fisheries, both marine and land based pollution and predation from wild, feral and domestic animals. All of these problems exist to some extent in N. Cyprus. This article reviews the relevant findings from the work carried out by the Glasgow University Turtle Conservation Expeditions to N. Cyprus 1992-94 (Godley and Broderick 1992; 1994; Broderick and Godley 1993 ;1994). This work has been carried out in conjunction with local officials and conservationists. The normal reproductive ecology of the Chelonia mydas and Caretta caretta which nest in N. Cyprus will be dealt with elsewhere in these proceedings (Broderick et al. 1995).

IMPACT OF RECREATIONAL USE OF BEACHES

In N. Cyprus many of the problems associated with recreational use have not yet reached crisis proportions. Tourism, although increasing, is still at a relatively low level. Most nesting beaches have no development, virtually no human usage and are several kilometres away from the nearest village or tarmac road. Some beaches on the east coast, near Magusa (Famagusta), and on the north coast, near Girne (Kyrenia), have been heavily developed for tourism. This has resulted in the degradation of the coastline with respect to marine turtle nesting and hatching. However, these beaches are in the minority and nesting still occurs at a low level.

Much of current beach usage is a result of recreational use by local people. The major sites where this could have a significant effect are at the two most prolific nesting beaches, at Alagadi. These are also public bathing beaches. This is where the largest number of turtles and nests come into contact with human activity and the possible associated detrimental effects. In the summer of 1994, the Department of Environmental Protection declared these beaches closed between 8pm and 8am. This has been successfully policed and enforced. One small restaurant has been built behind one of the beaches. This is only open during the day and its negative impact on sea turtle reproductive success is likely to be minimal. Hand-in-hand with this increased official involvement with the management of these two beaches has come an effective beach cleaning regime.

SAND EXTRACTION

Sand extraction on a small scale has been found to be a considerable problem at many turtle nesting beaches in N. Cyprus. In 1993, the situation worsened considerably, with approximately 100 tonnes of sand being removed from behind the Alagadi beaches on a daily basis. On occasion, vehicles were removing sand from as close as 50m above the high water mark. Successful lobbying has resulted in a cessation of these activities at Alagadi.

INCIDENTAL CATCH

There is no established turtle fishery or evidence of any trade in turtle parts in N. Cyprus. Turtles have been killed by irate fishermen following damage to nets by entrapped turtles. There are also records of turtles being shot by spear-fishermen. Each year approximately fifteen stranded turtles of various sizes are discovered. Some showed no apparent cause of death whilst others had obvious signs of trauma likely to have been due to human activities, whether through intentional killing or collision with shipping. In 1993 one juvenile _C_. _mydas_ was discovered alive and unharmed in a portion of fishing net washed ashore on one of the beaches.

POLLUTION

A vast amount of marine litter is washed on to the beaches of N. Cyprus. Much of this appears to be of south-eastern Mediterranean origin, with a large proportion being plastic and medical waste (Broderick 1994). This is not only potentially damaging to nesting and hatching turtles, but is aesthetically displeasing to local people and tourists using the beaches. The north coast of the island is particularly prone to litter deposition, due to prevailing currents (pers. comm. Professor Ilkay Salihoglu, Middle Eastern Technical University). Local authorities have made attempts to clear some beaches, however resources are lacking and these efforts would have to be ongoing to minimise possible negative influences.

PREDATION

Although adult turtles on Mediterranean beaches face little predation threat, many animals prey upon their eggs and hatchlings. No harvest of eggs by man has been observed. The terrestrial predators are foxes, feral and domestic dogs, ghost crabs and scavenging birds. In N. Cyprus, all of the above have been found to depredate turtle nests, the main predators being dogs and foxes. This is similar to findings on beaches in the south of Cyprus, where foxes can be responsible for disturbing up to 70% of nests (Demetropoulos and Hadjichristophorou 1989). This can be illustrated by the statistics from the 1994 expedition:

Beaches were surveyed every three days for signs of nesting, hatching and predation by canids. The beaches were divided into six zones illustrated in figure 1. It is expected that not all hatched nests were recorded due to the three day surveying regime. The fate of the 980 recorded nests is illustrated in figure 2. The temporal distribution of nesting, hatching and predation are shown in figures 3-5 for comparison.

From these data it is clear that the vast majority of predation is associated with hatching period. Very little predation is associated with laying. Although 9% of recorded predation by canids was associated with signs of hatching. It is likely that this is an underestimate since disturbance caused by the initial predation and secondary scavenging by birds and crabs will mask prior hatchling tracks. The spatial distribution of this predation is not uniform. Figure 6 illustrates comparative data from each survey zone.

The possible solutions to this significant problem have been comprehensively reviewed (Stancyk 1981). Control in this case is problematic because the nesting is diffuse; on over 80 beaches throughout a lengthy coastline. In 1994 a pilot screening programme was instituted, using wire and bamboo screens and was met with a degree of success. Caging is impossible since project members cannot be at all beaches every morning. The main difficulty was accurately determining the site of the clutch and therefore where to best place screens, especially in green turtle nests. Other problems encountered were screens being disrupted by nesting females and bamboo screens being destroyed by predators. In 1995, this programme will be expanded in conjunction with other control methods, including setting up a hatchery in zone 5.

ACKNOWLEDGEMENTS

These findings are the result of a three year working partnership between Glasgow University, The Society for the Protection of Turtles in Northern Cyprus (KKKKD/SPOT) and the local Department of Environmental Protection. Brendan Godley would like to acknowledge support from Prof. J.B.S Boyd, Glasgow Veterinary School and the Overseas Student Travel Award which enabled his attendance at this conference and also Dale Carnegie Training (Scotland) who financially supported his participation in the work. Glasgow University Turtle Conservation Expeditions 1992, 1993 and 1994 were given financial support from: British Chelonia Group; British Ecological Society; Carnegie Trust for the Universities of Scotland; Cross Trust; Gilchrist Educational Trust; Glasgow University Court; Institute of Biology; MEDASSET, UK.; Peoples Trust for Endangered Species; Royal Geographical Society; Royal Scottish Geographical Society. In addition none of this work would have been possible without the fifty students and staff who have raised/contributed over half of all costs as well as carrying out the work over the three year period.

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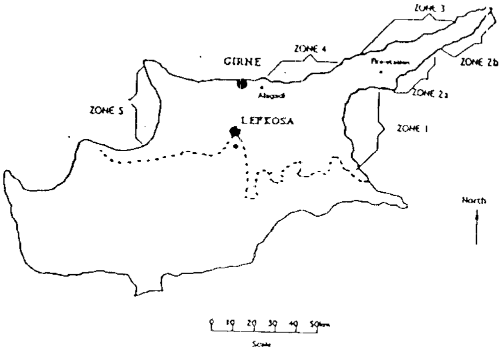

Figure 1: Map of N. Cyprus showing survey zones.

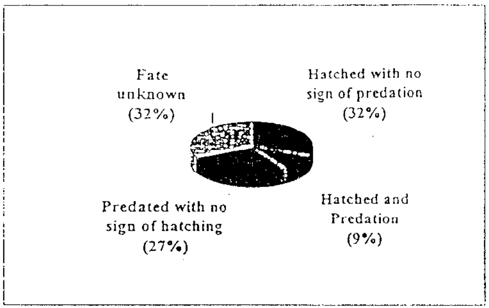

Figure 2: Fate of nests in N. Cyprus 1994.

	Predation									
COAST	Pre-hatching				Post-hatching				TP	% Laid nests predated
	G	L	?	Total	G	L	?	Total		
Zone 1	0	10	5	15	0	6	1	7	22	29
Zone 2a	2	5	26	33	0	3	4	7	40	33
Zone 2b	4	5	51	60	17	6	9	32	92	53
Zone 3	0	3	27	30	7	3	7	17	47	19
Zone 4	0	19	30	49	0	8	5	13	62	23
Zone 5	9	15	54	78	4	2	10	16	94	95
TOTAL	15	57	193	265	28	28	36	92	357	36

Table 1: Incidence of predation in N. Cyprus 1994.

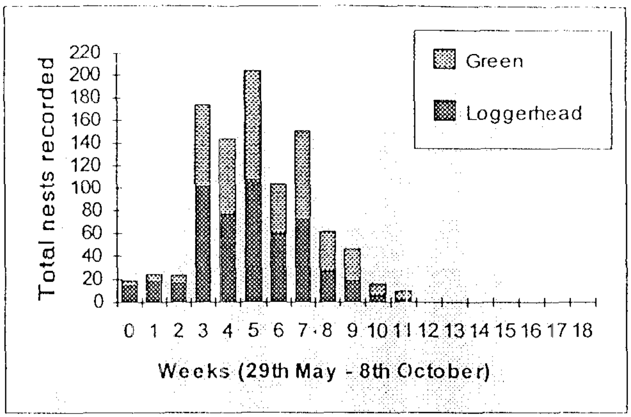

Figure 3: Temporal spread of nesting in N. Cyprus 1994.

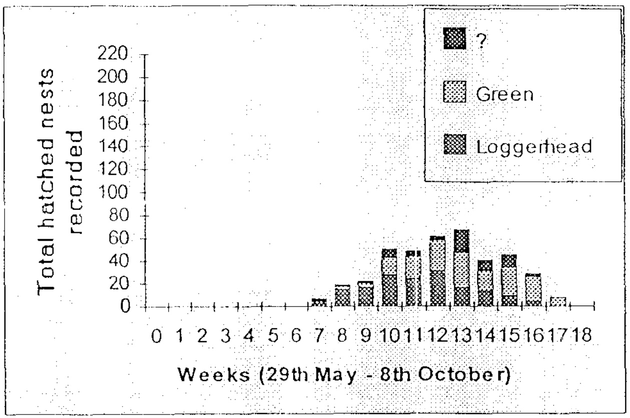

Figure 4: Temporal spread of hatching in N. Cyprus 1994.

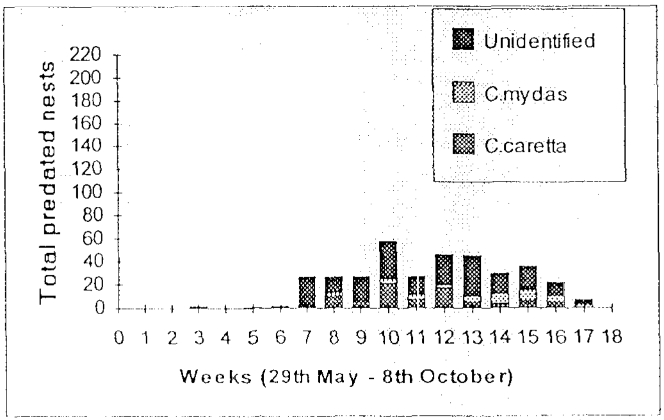

Figure 5: Temporal spread of predation in N. Cyprus 1994.

THE MAGNETIC COMPASS OF LOGGERHEAD SEA TURTLE HATCHLINGS: CALIBRATIOJN BY SURFACE WAVES.

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Hatchling loggerhead sea turtles (Caretta caretta) emerge from their nests on oceanic beaches and immediately crawl down the beach and enter the surf. Once in the water they orient into surface waves which, in shallow water, approach the beach parallel to shore. After swimming for some time, turtles ignore wave cues and instead rely on a magnetic compass to maintain their offshore direction.

Hatchlings within the nest do not possess a preferred magnetic direction capable of leading them offshore; instead, the magnetic compass needs to "calibrated" before it can function properly. One way the compass sense can be calibrated is through the process of crawling in a specific direction, as the hatchlings do when they scramble from the nest to the ocean. In this study, we explored another possibility -- that orientation into waves can also set the axis of offshore migration.

METHODS

All experiments were carried out in a wave tank located at Florida Atlantic University. Naive hatchlings were exposed to waves for a pretest period of either 15 or 30 minutes. Their orientation was then monitored during a test period for an additional 15 minutes in the absence of waves. During the test observations, hatchlings swam in either a local magnetic field or in a field which was reversed by 180°. This allowed us to determine if magnetic cues were being used to maintain the wave-guided course.

RESULTS AND DISCUSSION

Hatchlings exposed to waves to waves for a 15 minute pretest period did not show a significant orientation during their test period. However, turtles exposed to waves for 30 minutes continued to swim in the same direction (southeast) in the absence of waves. Hatchlings exposed to a reversed magnetic field after swimming in waves for 30 minutes oriented in the opposite direction (northwest).

These results suggest that the development of migratory orientation involves two sequential processes. First, turtles must perform directional locomotion which under natural circumstances, involves crawling from the nest or swimming into surface waves. Either process, separately or in combination, leads to the establishment of a directional preference for a vector roughly perpendicular to shore. The second process involves the transfer of that directional preference to a magnetic compass, used by turtles to complete their migration to oceanic current systems (where hatchlings will complete the pelagic phase of their development).

FIDELITY OF JUVENILE GREEN SEA TURTLES TO JETTY HABITAT IN SOUTH TEXAS WATERS

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Historically-abundant green sea turtle (Chelonia mydas) populations in south Texas waters were decimated by commercial harvest by the early 1900's (Doughty, 1984). Information on current status of these stocks has been limited to that gathered during random cold-stunning and stranding events and one recent study of green turtle occurrence at a small channel into Port Mansfield, Texas (Shaver, 1994).

The present study investigates the role of jetty habitat in the ecology of post-pelagic green sea turtles along the lower Texas coast. Visual observations and entanglement-net capture operations were used to characterize population dynamics and movement of young greens occupying channel and near-jetty habitat within the Brazos Santiago Pass entrance to Texas' lower Laguna Madre. Abundance, size, and behavior (submergence, surfacing and respiratory) of these greens were monitored monthly from April 1993-March 1994. The relationship of turtle size and season to their use of this jettied pass also was determined. These data revealed a strong year-round dependence of post-pelagic greens on these jetties as developmental habitat, especially in providing foraging opportunities and refuge from predators.

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A DEMOGRAPHIC MODEL FOR RELOCATION OF LOGGERHEAD SEA TURTLE NESTS

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The relocation of sea turtle nests to protected corrals is a commonly used conservation strategy around the world. Although the technique has been criticized for lowering hatching success (Limpus et al. 1979) and failing to ensure population growth (Crouse et al. 1987) or mitigate the direct causes of mortality (Frazer 1992), its use may be critical on certain nesting beaches in addition to the utilization of TEDs. This study examines the effects of nest relocation on population growth, and quantifies the level of egg mortality at which nest relocation becomes essential for the continued survival of a loggerhead turtle (Caretta caretta) population.

METHODS

The demographic model used in this study was based on the deterministic, stage class population model developed by Crouse et al. (1987) and later modified by Crowder et al. (1994). The model is based on a postbreeding census with a one year projection interval (Noon & Sauer 1992). Estimates of hatching success of in situ and relocated eggs, as well as the overall survival probability of in situ eggs (which includes eggs lost to poaching and predation) were compiled for beaches with more than 30 nests sampled (Table 1). Means and standard errors from these estimates were then used with Frazer's (1983) estimate of survival from hatching through the first year of life to obtain an overall estimate of first stage survivorship (egg and hatchling stage). Two stage-structured matrices were constructed which represented large juvenile, subadult, and adult survivorship both with and without the seasonal use of TEDs in offshore waters (Crowder et al. 1994). Population growth rate (λ) and time to extinction were then calculated using mean in situ and relocated egg survival rates (Table 1). The population growth rates were also examined for egg survival probabilities ranging from 0 to 1.

RESULTS

Hatching success of in situ eggs (mean = 0.787 ± 0.019%) was significantly greater (Kruskal WallisTest = 5.62, DF = 1, P < 0.05) than hatching success of relocated eggs (mean = 0.684 ± 0.020%). The difference between overall survival of in situ (mean = 0.442 ± 0.067%) and relocated (mean = 0.684 ± 0.020%) eggs was not significant (Kruskal

Wallis Test = 3.43, DF = 1, P > 0.05) due to the high variability in mortality rates of eggs left in situ. The rates of population growth, calculated using the mean egg survival values for each management scenario, are shown in Table 2. As previous studies have indicated, relocation alone does not cause the loggerhead population to increase (Crowder et al. 1987), although it postponed extinction by 66 years. Figure 1 illustrates the population growth rates associated with a range of possible egg survival values, both with and without the use of TEDs. The level of egg survival necessary to maintain a stable loggerhead population ($\lambda = 1.00$) with the concurrent use of TEDs is 43%.

DISCUSSION

These results indicate that the relocation of loggerhead nests to protected corrals significantly lowers hatching success. However, when loss of eggs due to poaching and predation is included in the overall estimate of in situ egg survival, relocated nests may have a much higher survival probability on many beaches. Even with the use of TEDs, nest protection will be necessary to prevent extinction if average egg survival falls below 43%. Levels of egg survival much lower than this do occur on many nesting beaches where poaching and predation rates are high (Table 1). It is difficult to predict the accuracy of these results given the uncertainty in the level of compliance with TEDs regulations internationally. This factor may raise the critical level of egg survival necessary to prevent extinction.

Although the implementation and enforcement of TEDs use should be emphasized, since the older life stages are more critical to population growth, this technology cannot be exclusively relied upon as the solution to sea turtle population declines on all nesting beaches. However, given the limited resources of many conservation programs, it is important to carefully monitor poaching and predation levels so that nest relocation is implemented only when crucial to the continued existence of the loggerhead population.

Table 1. Hatching success and egg survival data for loggerhead sea turtles (n > 30 nests).

Location	Percent Hatch In Situ*	Percent Hatch Corral**	Survival Prob. In Situ***	Source
Mon Repos, Austrailia	0.840	--	--	Limpus et al. 1979
Mon Repos, Austrailia	0.910	--	--	Limpus et al. 1983
Goksu Delta, Turkey	0.770	--	0.580	Peters et al. 1994
Litoral Central, QR, Mex	0.644	0.662	0.379	Gil 1988
Litoral Central, QR, Mex	0.815	0.739	0.694	Zurita et al. 1990
Litoral Central, QR, Mex	0.857	0.738	0.752	Zurita et al. 1993
Isla Cozumel, QR, Mex	0.854	0.643	--	Zurita and Miranda 1993
Tongaland, South Africa	0.778	--	--	Hughes 1974
Atlantic Coast, USA	--	--	0.061	Hopkins et al. 1978
Little Cumberland Isl., GA, USA	--	0.650	--	Richardson 1978
Jekyll Island, GA, USA	--	0.710	--	Wyneken et al. 1988
Canaveral Nat. Seashore, FL, USA	0.870	--	--	Wyneken et al. 1988
Melbourne Beach, FL,USA	--	--	0.596	Owen et al. 1990
Kiawah Island, SC, USA	--	0.806	--	Talbert et al. 1980
Kiawah Island, SC, USA	0.693	0.706	--	Talbert et al. 1980
Kiawah Island, SC, USA	--	0.499	--	Pinckney 1990
Kiawah Island, SC, USA	0.670	--	--	Stancyk et al. 1980
Kiawah Island, SC, USA	0.730	--	--	Stancyk et al. 1980
Cedar Island, SC, USA	0.800	--	0.034	Stancyk et al 1980
	Mean	Mean	Mean	
	0.787	0.684	0.442	
	Std. Err.	Std. Err.	Std. Err.	
	0.019	0.020	0.067	

*Percent Hatch In Situ = percent of surviving eggs that produce hatchlings.

**Percent Hatch Corral = percent of eggs translocated to corral that produce hatchlings.

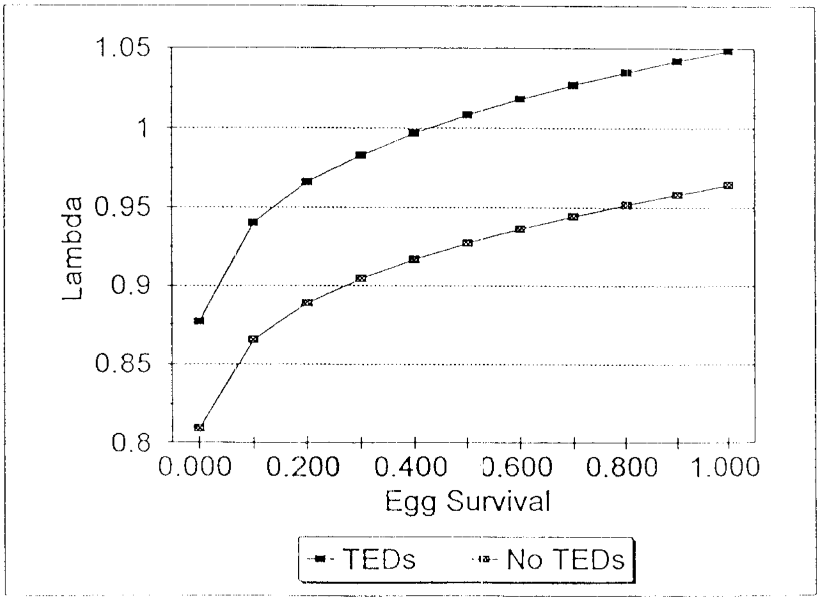
***Survival Prob. In Situ = percent of total eggs that survive and produce hatchlings.

Table 2. Loggerhead population growth rates and time to extinction for several management strategies, assuming an initial population of 1,000,000 turtles distributed according to a stable age distribution.

Management strategy	Lambda*	% change per year	Years to extinction
In situ, no TEDs	0.922	7.8% decline	162
Relocated, no TEDs	0.943	5.7% decline	228
In situ, TEDs	1.000	0.03% increase	--
Relocated, TEDs	1.024	2.4% increase	--

*lambda = 1, stable population
lambda > 1, increasing population
lambda < 1, decreasing population

Figure 1. Lambda as a function of egg survival both with and without TEDs. Egg survival probabilities were combined with the survival probability from hatching through the first year of life in order to calculate lambda.



NEST SITE SELECTION BY LOGGERHEAD TURTLES ON TOPSAIL ISLAND, NORTH CAROLINA

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Environmental cues used by sea turtles to select a suitable site for digging may include sand grain size, dune slope, compaction of beach sand, smell, moisture content, and surface temperature (reviewed by Stoneburner and Richardson, 1981). On some occasions a turtle will select a site, dig a body pit, and even excavate an egg chamber before abandoning egg-laying at that site. In this study we measured beach slope at the nest site and distance to high tide line plus both temperature and sand moisture content (humidity) at the bottom of an "egg chamber" adjacent to the chosen nest site and false crawl "nest excavations". Our hypothesis was that egg chambers rejected by loggerhead turtles (Caretta caretta) may differ in temperature and/or moisture content from those chambers where eggs were deposited on Topsail Island, North Carolina, during the 1992 nesting season.

METHODS

Loggerhead turtle nests were marked the morning afiter laying on Topsail Island, North Carolina (Figure 1), by volunteers working with the Topsail Turtle Project. Shortly thereafter, dstance to high tide was measured with a metric tape. Slope at the edge of the nest (on nearby undisturbed sand) was measured with a clinometer. One meter away (parallel to the high tide line) from the sand disturbed by the nesting turtle, a hole was excavated 50 cm deep. Temperature at the bottom of this cavity was measured and a sand sample was taken and double-bagged in plastic ziploc bags. Nest sand samples (100 g) were weighed and dried to constant mass in a drying oven at 60^0 C. Samples were reweighed to determine the amount of moisture lost. Moisture content of the nest sand was calculatted using a constant (0.205) determined for saturated sand from Topsail Island (method is that used by McGehee, 1990). In addition, temperature and moisture profiles at 50 cm depth were measured every 3 m from the high tide to a nest location.

RESULTS AND DISCUSSION

No significant differences were found between active nests and false crawls (abandoned by turtle after she excavated egg chamber) in distance to high tide, slope of beach, nest temperature (50 cm), or nest (50 cm) humidity (Table 1). Significant correlations were found between hatching success and incubation period, clutch size and incubation period, number of hatchlings emerging and incubation period, number of hatchings emerging and nest temperature, nest humidity and nest temperature, nest humidity and distance to high tide, and incubation period and distance to high tide (Table 2). All other possible correlations were not significant. Temperature (50 cm deep) varied little along the transect from the high tide to a nest site 21 m away while humidity was elevated only at high tide line and 3 m away (Table 3). Hatching success was not correlated with distance to high tide, beach slope, nest temperature, nor nest humidity.

The parameters measured did not predict why a turtle sometimes abandons an egg chamber before laying commences. We have observed that disturbance will sometimes cause a female to cease nest excavation and return to the sea. We were unable to quantify the disturbance component in this study. However, in some cases we have observed turtles abandon egg chambers only to excavate and lay a few meters away shortly thereafter (disturbance was not a factor).

We thank the hundreds of volunteers with the Topsail Turtle Project for locating nests and monitoring their success.

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Figure 1. Study site on Topsail Island, North Carolina.

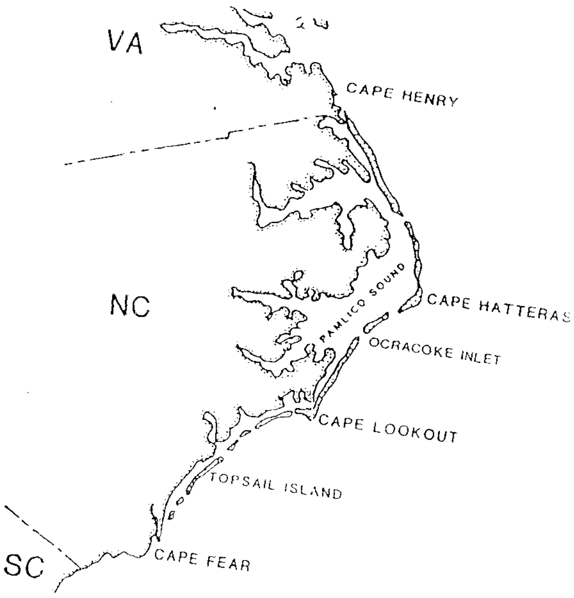

Table I. Differences between active nests and false crawls of loggerhead turtles on Topsail Island, NC. Data presented as mean ± standard deviation (sample size). Probability based on t-test.

LOGGERHEAD TURTLE

	Active Nests	False Crawls	P
Dist. to High Tide (m)	8.77 ± 5.44 (51)	10.83 ± 6.87 (15)	0.114
Slope of beach (°)	12.6 ± 8.8 (51)	15.1 ± 9.2 (15)	0.169
Nest Temperature (°C)	27.8 ± 2.1 (51)	28.3 ± 1.6 (15)	0.175
Nest Humidity (%)	16.8 ± 3.9 (51)	16.0 ± 5.3 (15)	0.739

No significant differences between parameters measured for active nests and false crawls.

Table 2. Correlations between nesting and environmental parameters at loggerhead turtle nests on Topsail Island, NC.

Correlations (Nesting and Environmental Parameters)

Parameters	n	r	P
Hatch Success vs Incub. Period	43	-0.3623	0.017*
Clutch Size vs Incubation Period	43	-0.3497	0.022*
Number Emerg. vs Incub. Period	43	-0.5309	0.000*
Number Emerging vs Nest Temp.	44	0.3235	0.032*
Nest Humidity vs Nest Temp.	51	-0.5589	0.000*
Nest Humidity vs Dist. High Tide	51	-0.2903	0.039*
Incub. Per. vs Dist. High Tide	46	0.3438	0.019*
Hatch Success vs. Dist. High Tide	45	-0.1266	0.407
Hatch Success vs Slope	45	0.0741	0.629
Hatch Success vs Nest Temp.	45	0.2433	0.107
Hatch Success vs Nest Humidity	45	-0.1317	0.388

* Denotes significant correlation at $P < 0.05$. All other possible correlations were not significant.

Table 3. Temperature and humidity profile from high tide line to nest location (50 cm deep) on Topsail Island, NC.

Location	Relative Humidity (%)	Temperature (^{0} C)
High tide (0 m)	98.0	29.1
3 meters	53.2	29.8
6 meters	21.5	31.0
9 meters	21.0	30.4
12 meters	15.6	32.0
15 meters	19.0	30.1
18 meters	17.1	30.5
21 m (nest)	17.6	29.3

LEATHERBACK TURTLE AND JELLYFISH SURVEYS ON TOPSAIL ISLAND, NORTH CAROLINA

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This preliminary study is a progress report of an ongoing study documenting the occurrence of leatherback turtles (*Dermochelys coriacea*) during May and June along the immediate shoreline of Topsail Island, North Carolina. In addition, we simultaneously censused cannonball or cabbagehead jellyfish (*Stomolophus meleagris*). Grant and Ferrell (1993) reported two stranded leatherbacks and observed leatherbacks feeding on cabbagehead jellyfish during May and June 1990 and 1991 at North Topsail Beach.

METHODS

Aerial censuses were conducted along the 41.6 km coastline of Topsail Island, NC, between about mid-April and mid-July during 1992, 1993, and 1994. Two transects parallel to the shoreline, about 500 m and 1000 m offshore, were flown in a Cessna 172 along the entire length of Topsail Island. Turtles seen on either side of the aircraft, up to about 250 m, were counted. Flight altitude varied from about 150 m to 220 m and flight speed was 140-150 km/hr. Censuses were conducted between 1000 and 1600 h for 35-55 min on days with good visibility and light winds. Two types of cabbagehead jellyfish censuses were undertaken. Two to 4.7 km of the beach of North Topsail Beach were walked. All beached jellyfish were counted and removed from the beach to avoid counting the same ones on a later census. The second census area was a 200 m x 40 m transect strip observed from Salty's Pier on North Topsail Beach.

RESULTS

A total of 45 leatherbacks were seen on 3 (23 May, 2 June, 7 June) of 9 censuses during 1992 (Figure 1). Jellyfish numbers peaked in late May also. In 1993, we saw fewer leatherbacks (16) and the abundance of jellyfish was irregular (Figure 2). Only 11 leatherbacks were sighted during aerial surveys in 1994 and jellyfish abundance was not tied closely to turtle abundance (Figure 3).

DISCUSSION

Several factors may have resulted in fewer leatherbacks in 1993 and 1994. Fewer leatherbacks may have passed through our area, some may have passed through further ofshore (we received several reports from fishermen of leatherbacks 2-9 km offshore), and the decrease in turtle sightings might be due to the patchy distribution of jellyfish. It is unlikely observers missed sighting leatherbacks during the aerial censuses.

We thank Gene Gunter for providing the planes and pilots and the numerous volunteers with the Topsail Turtle Project who helped with spotting turtles and helping with the jellyfish counts. We also thank Fritz Lenker for his very able help with the graphics.

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Figure 1. Leatherback turtle and jellyfish censuses on Topsail Island, NC, during 1992.

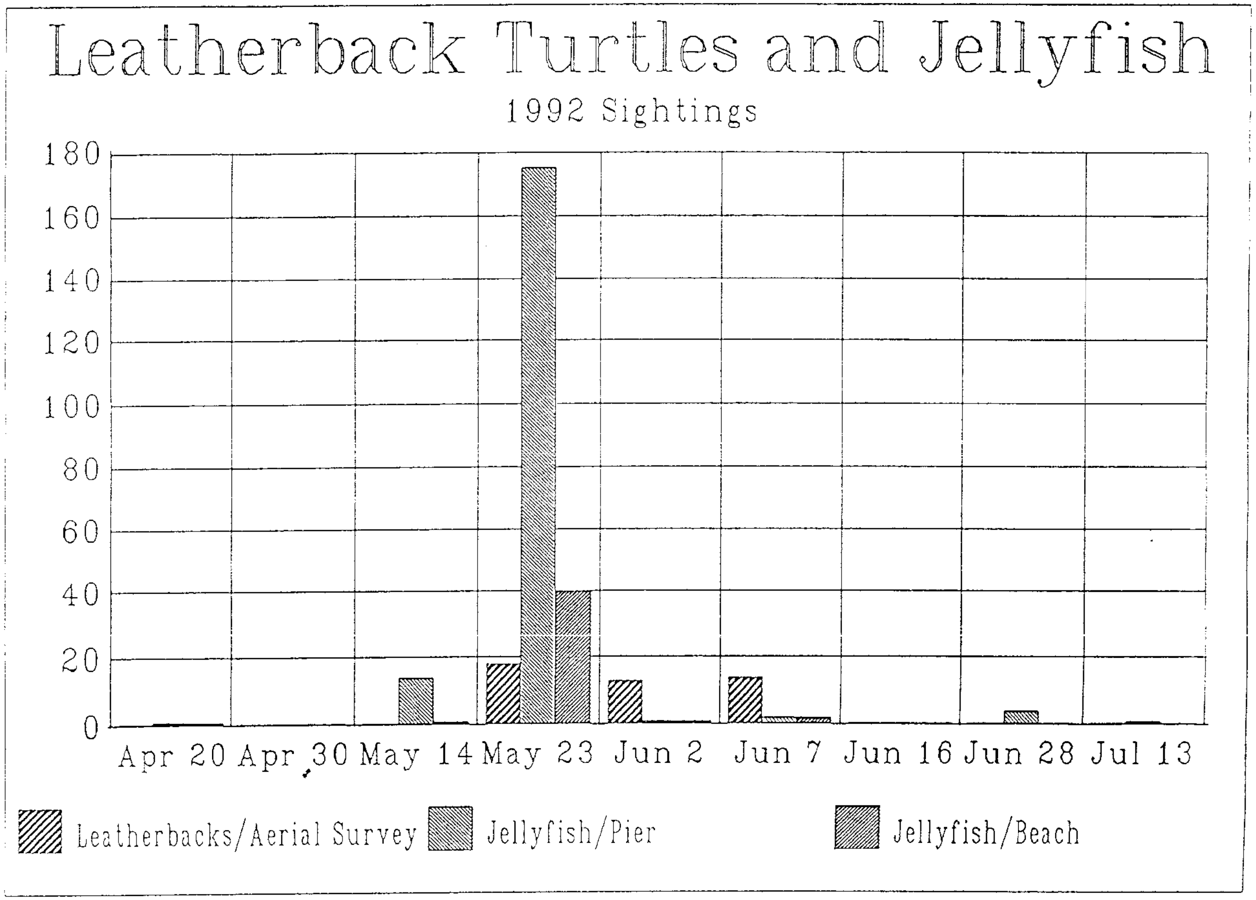


Figure 2. Leatherback turtle and jellyfish censuses on Topsail Island, NC, during 1993.

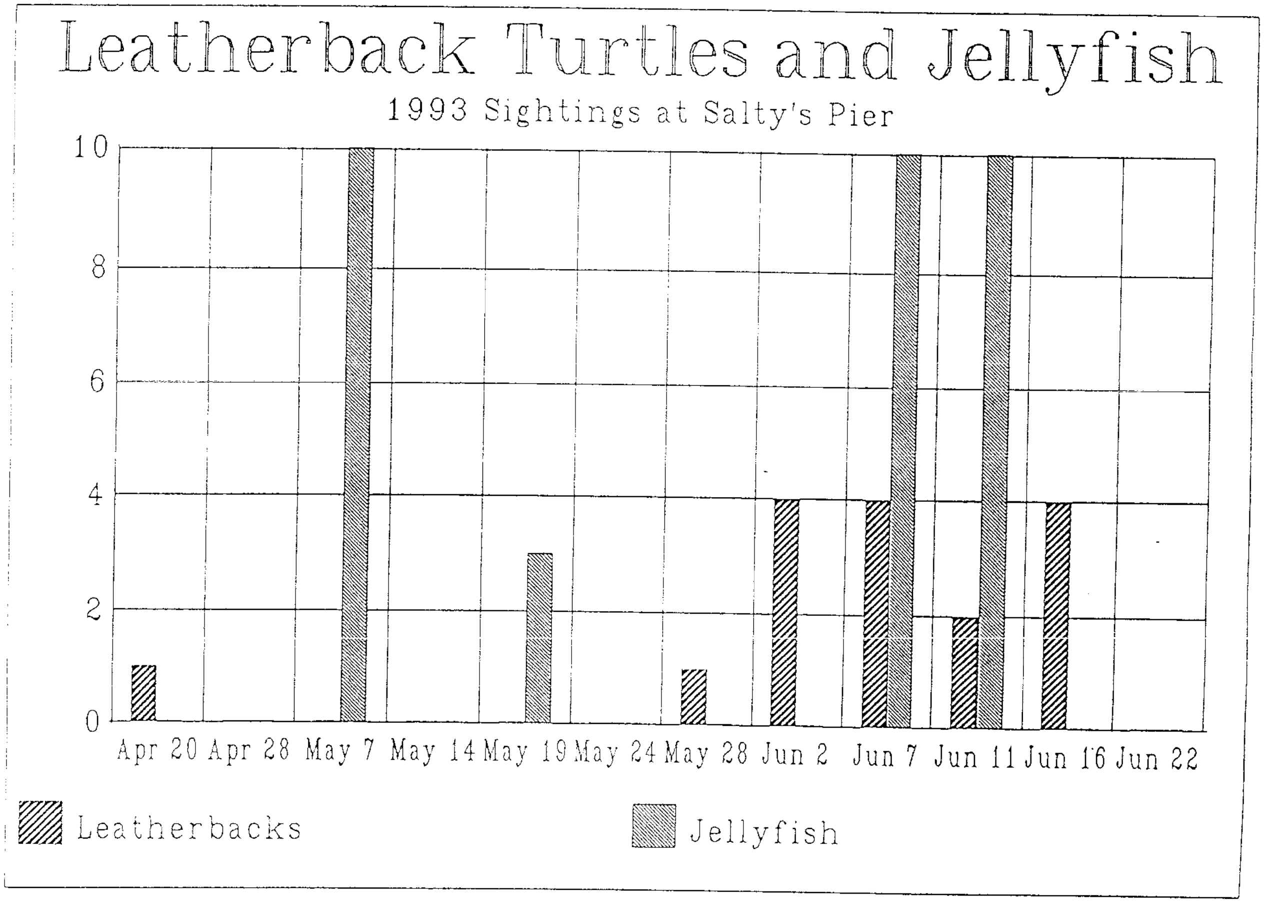
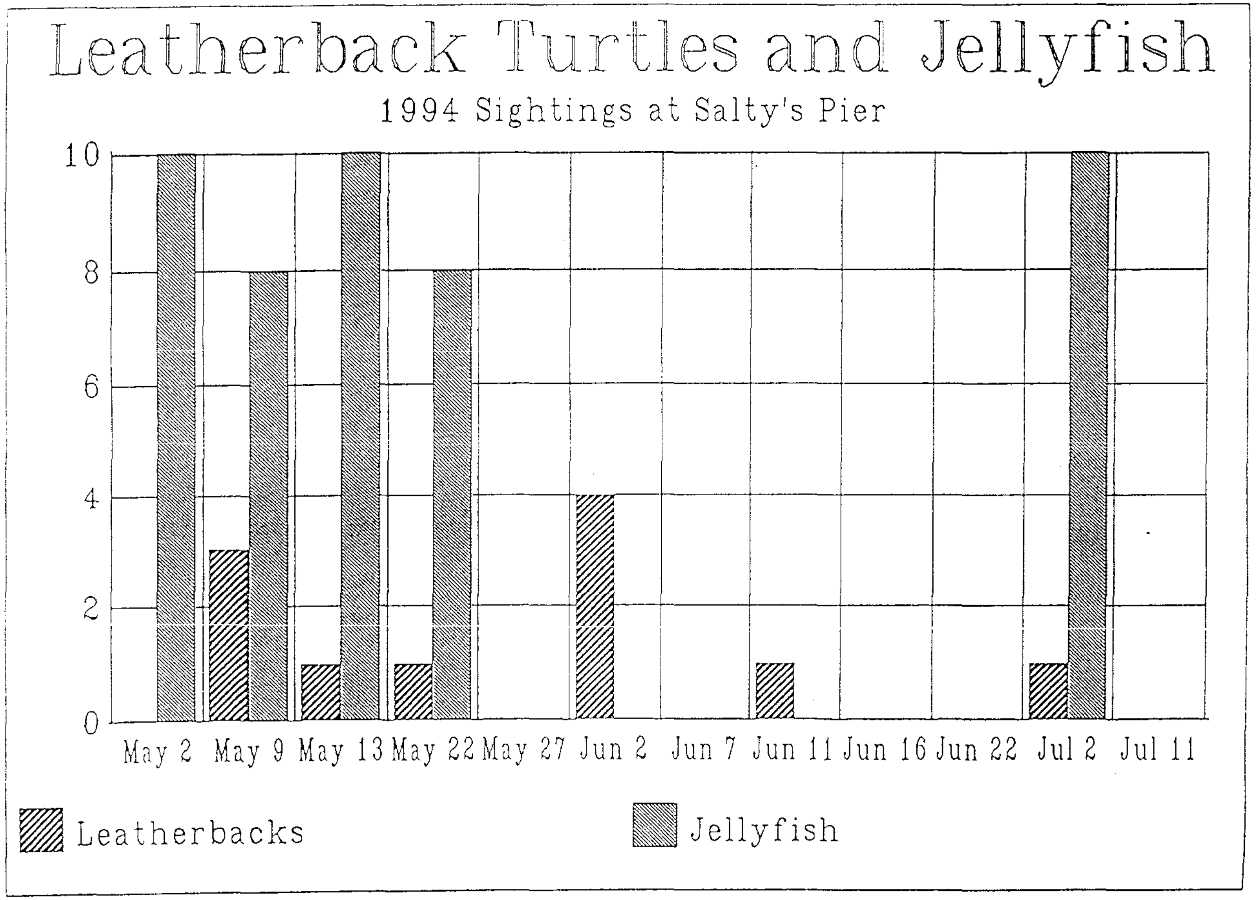


Figure 3. Leatherback turtle and jellyfish censuses on Topsail Island, NC, during 1994.



SEA TURTLES OF NORTH YEMEN (YEMEN ARAB REPUBLIC)

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In 1988 when this survey took place, the Yemen Arab Republic or North Yemen had not yet united with the People's Democratic Republic of Yemen (South Yemen) to form Yemen. The information presented in this report was part of a larger study of the marine and terrestrial ecology of the area surrounding the Yemen Exploration & Production Company (YEPC) marine terminal at the Ras Isa Peninsula in the Yemen Arab Republic. The area of investigation was located in the coastal plain from Jahar and the Island of Al Murk in the north, southward to Al Hodeidah (Al Hudaydah) (Figure 1). The shoreward area lies within the physiographic province called the Tihama. This 30-40 km-wide plain is part of the Red Sea graben that has been infilled with sediment. The Red Sea came into existence 3 to 4 million years ago when the African continent separated from the Arabian subcontinent, forming what is now a sea 2,000 km in length, approximately 350 km at its maximum width, and covering an area of about 438,000 km^2. The depth varies from the shallow passageway of the Suez Canal to over 2,500 m in some places. It is the most saline of all seas. A submarine pipeline extends from the shoreline of the Ras Isa Peninsula in a south-southwest direction for 9 km to the mooring facility of the FSO (Floating Storage and Offloading) "SAFER", which is in approximately 40 m of water.

Two species of sea turtle, the hawksbill (Eretmochelys imbricata) and the green turtle (Chelonia mydas), were encountered in North Yemen during the study. According to fishermen and personal observations, the green turtle appears to be the more common of the two. Both species were observed on the reef near the submarine pipeline. During an aerial survey of the coastline within the study area on 21 September 1988, about 50 turtles were observed in shallow water on two turtle banks near Al Hodeidah. The turtles appeared to be feeding and/or resting on the bottom. These turtle banks are known to the helicopter crews who regularly fly between Al Hodeidah and the Ras Isa Terminal (Ku, pers. comm.). Only two other turtles were observed between these banks and the terminal, and three between the terminal and Khawbah to the north. Four turtles were observed from the helicopter on 7 September 1988 on the reef between Ras Isa Village and the Smit Colombo jetty; and one was observed on the same day floating offshore between the shoreline and the FSO "SAFER".

Measurements of two subadult hawksbills caught in gill nets on a coral reef near the pipeline, and two adult green turtles caught near Kamaran Island, are presented in Table 1. The stomach of the smaller hawksbill was full of a seaweed, probably Gelidium sp., while the stomach of the larger hawksbill contained 80% Gelidium sp. and 20% (by volume) of two species of sponge. Such large amounts of algae as a food source are unusual; hawksbills normally eat invertebrates and are known spongivores (Meylan, 1984).

According to fishermen living on Kamaran Island, both the green turtle and hawksbill nest there during October, November and December. Approximately 8-10 turtles nest each night, with the green turtle being slightly more common. Both species also nest on the Makran Islands off the northwest coast of Kamaran Island, and a few green turtles nest on Rishah Island, some 10 km south of Kamaran Island. Turtles apparently do not nest on the mainland in the study area. Restriction of nesting to offshore islands is typical of turtles in many parts of the world.

Walczak (1979) found the green turtle to be the most commonly observed species in the Yemen Arab Republic, followed by the hawksbill. He also reported two other species of sea turtle from the Yemen Arab Republic: leatherbacks (Dermochelys coriacea) were observed 6.5 km offshore from Mandar village, and a dead leatherback washed ashore near Al Hodeidah in April 1976; and an olive ridley (Lepidochelys olivacea) was caught in a trawl in 26 m of water approximately 16 km northwest of Ras Katib, which is located just northwest of Al Hodeidah (Walczak, 1979). Walczac (1979) also reported turtles on the reefs around Dicno Gulf in Kamaran Bay (Kamaran Island), Rhisa, Kadaman Zaghir Island, and Isa Bay (which is just southeast of Ras Isa Peninsula).

Sea turtles are not economically important in the Yemen Arab Republic. Although both the meat and eggs, particularly of the green turtle, are eaten occasionally, no active fishery exists.

Elsewhere in the Red Sea, green turtles have been reported nesting in the Dahlak Archipelago in Eritrea (Urban, 1970). Hawksbills have been reported nesting in Sudan's Suakin Archipelago (Hirth and Abdel Latif, 1980) and in Egypt (Frazier et al., 1987). A fifth species of sea turtle, the loggerhead (Caretta caretta), has been reported from the shores of eastern Sinai in the Red Sea (Frazier et al., 1987), but is unknown in the Yemen Arab Republic. The olive ridley and loggerhead are probably strays from populations outside the Red Sea. Neither of these two species nor the leatherback is known to nest in the Red Sea.

Outside of the Red Sea, both the green turtle and hawksbill are known to nest in the People's Democratic Republic of Yemen (South Yemen) (Hirth and Carr, 1970; Hirth and Hollingworth, 1973; Ross and Barwani, 1982). Masirah Island in the Sultanate of Oman has the largest population in the world of the loggerhead turtle, as well as supporting nesting of the green turtle, hawksbill and olive ridley (Ross, 1987).

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PERSONAL COMMUNICATION

Ku, Loi Hock. September, 1988. Professional diver on board Smit Columbo, North Yemen.

TABLE 1. Measurements of selected parameters (in cm) of two subadult hawksbills (Eretmochelys imbricata) and two adult green turtles (Chelonia mydas) from Ras Isa, Yemen Arab Republic september 1988.

	Curved Carapace Length	Curved Carapace Width	Plastron Length	Plastron Width	Head Length
Hawksbill 1	46.0	41.0	32.0	29.8	9.0
Hawksbill 2	51.1	44.0	35.0	31.0	10.2
Green Turtle 1	95.0	92.6	--	--	--
Green Turtle 2	101.0	95.3	--	--	--

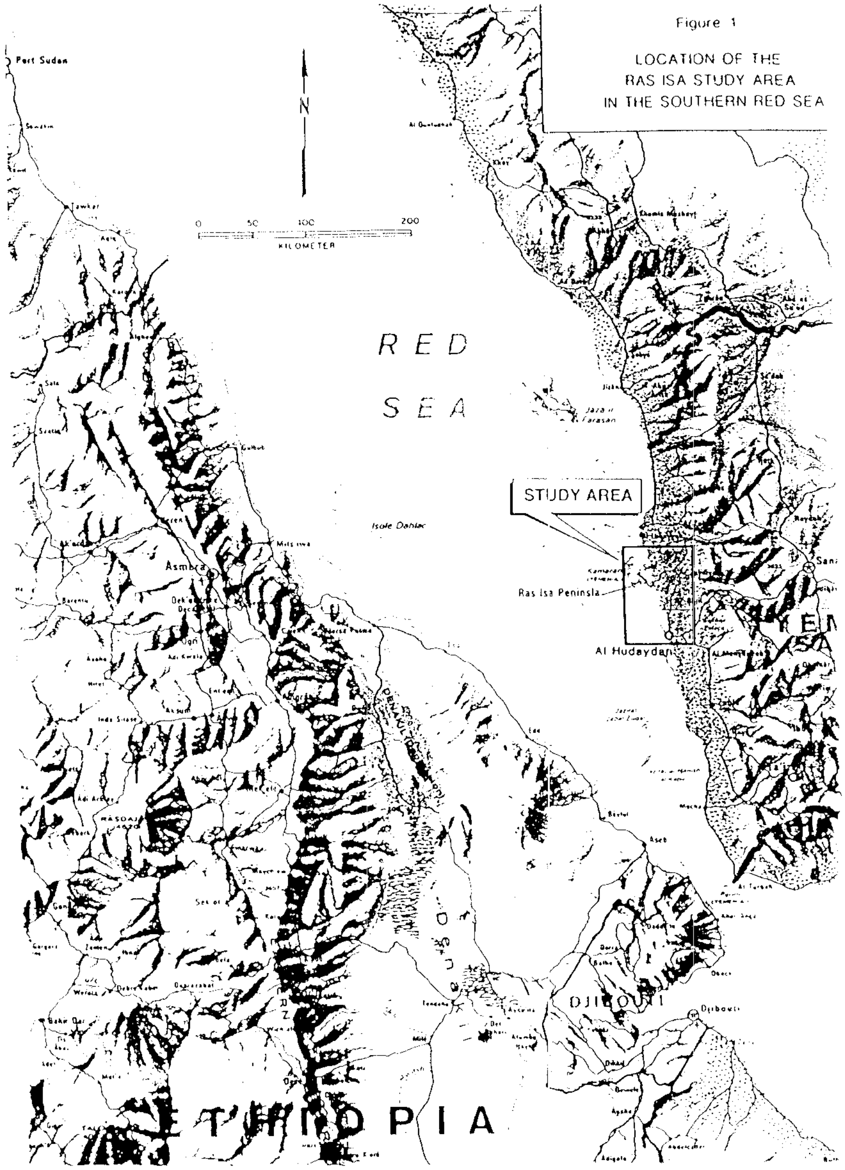

Figure 1

LOCATION OF THE RAS ISA STUDY AREA IN THE SOUTHERN RED SEA

EVALUATION OF THE RADIOIMMUNOASSAY FOR SEX DETERMINATION OF IMMATURE SEA TURTLES.

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INTRODUCTION

A major problem in sea turtle conservation and management is the inability to assess the sex of immature turtles based on external morphology. Invasive sexing techniques, such as laparoscopy, are stressful and can result in death (Wibbels et al., 1987). Owens et al. (1978) and Wibbels et al. (1988) have developed a mildly invasive sex determination method for sea turtles which involves the measurement of plasma testosterone concentrations by radioimmunoassay (RIA). This method is highly desirable because it does not require any surgical skills, utilizes a small amount of blood, and does not seem to harm the animal.

Other studies from different laboratories or utilizing different species have demonstrated varying degrees of success with this technique. The major objective of this report is to instill a sense of caution in those interested in this method of sex determination, especially for those not familiar with RIA techniques. A brief introduction to some basic features of the RIA will be reviewed followed by a discussion of several potential problems involved with RIA analyses.

RADIOIMMUNOASSAY

A major feature of an RIA is the development of a standard curve by competitive binding. Competitive binding refers to the process that occurs when a concentration of a hormone (H), radiolabeled hormone (*H), and antibody specific to the hormone are mixed together. Both H and *H molecules will randomly collide with antibody molecules and thus "compete" for binding sites on the antibody. Any unbound molecules of H and *H are removed resulting in a mixture of antibody molecules bound either to H's or *H's. This mixture is then analyzed in a scintillation counter which quantifies the radioactivity given off by the bound *H in units of counts per minute (CPM).

Keeping the above procedure in mind, we prepare ten tubes each with 200 μl of buffer, 100 μl of *H (10,000 CPM), and 100 μl of antibody. Into each tube we add 100 μl of a known concentration of H: 10, 20, 30, 40, 50, 60, 70, 80, 90, and 100 pg/ml. We let competitive binding proceed for 24 hours and then any unbound H and *H are removed from each tube. After the tubes are analyzed in a scintillation counter, a standard curve is obtained (Fig. 1). Notice that when concentrations of H are very high (e.g. 100 pg/ml), CPM are very low (e.g. 1000 CPM) and vice versa. This is because the more H molecules there are in the mixture (compared to *H molecules) the greater their chance of colliding and binding with antibody molecules. This will result in proportionately less *H molecules bound to antibody and thus less radioactivity.

As part of the validation process, a small amount of plasma from many different animals of the species of interest is pooled together and stripped of all hormones. A similar procedure as above is then executed utilizing stripped plasma instead of buffer. The validation is successful if the resulting curve is parallel to the standard curve. One might predict that the validation curve is sometimes displaced below the standard curve because there are factors not found in the buffer but present in the plasma that may reduce the affinity (attraction) of the antibody to the hormones. If the validation curve is not parallel to the standard curve or is highly displaced, then cross-reactivity is a likely problem. Cross-reactivity can occur when some unknown factor in the plasma also competes for a binding site on the antibody. Until this problem is solved, the RIA will not work properly for the species of interest.

Upon completing a successful validation, we can now take a 100 μl sample of plasma with an unknown concentration of H and mix it with 200 μl of buffer, 100 μl of *H, and 100 μl of antibody. After 24 hours, any unbound H and *H are removed from the mixture and a CPM of the remaining bound *H is obtained. A computer program can then graphically calculate the plasma concentration of H from the CPM and the standard curve (Fig. 1).

POTENTIAL PROBLEMS ASSOCIATED WITH RIA ANALYSES

One of the unique aspects of utilizing a plasma hormone concentration as an indicator of sex is that a great value is placed on the absolute concentration of hormone found in each plasma sample. The primary focus of most studies involving hormone analyses are the resulting trends of an experiment (e.g. the change of hormone levels over time), not the actual hormone concentration of each sample. Because every lab has their own method of performing an RIA, inter-lab variation is common. Variation in techniques can lead to variations in hormone values. These are usually controlled within a laboratory. However, comparing hormone values among studies from different labs can be meaningless unless certain precautions are taken.

One of the characterizations of an RIA is a mass recovery equation: $Y = b + aX$; where X = the amount of hormone added and Y = the amount of hormone measured or recovered (i.e. it is a quantification of the performance of an RIA). Table 1 depicts the % mass recoveries of a testosterone RIA from three hypothetical labs (A, B, and C). When X is constant, Y will vary according to the % recovery. For example, we give a plasma sample from an immature loggerhead to lab A for testosterone determination. Lab A determines a testosterone concentration of 30 pg/ml in the sample. The same plasma sample is given to lab C. Lab C determines a testosterone concentration of 50 pg/ml (the real concentration is 40 pg/ml). This is an example of inter-lab variability which can be controlled by knowing the mass recovery equation. Unfortunately, researchers rarely report the mass recovery equation in their methods. In addition to reporting the type of antibody, extraction efficiencies, minimum sensitivity values, cross-reactivities, 50% binding points, and inter- and intra-assay variabilities, the mass recovery equation must be reported before any meaningful comparisons of hormone values among studies are accomplished.

TABLE 1. The amount of hormone recovered (Y) from three hypothetical laboratories with different % mass recoveries.

% MASS RECOVERY	X = (pg/100 μl)	Y = (pg/100 μl)
A = 75 %	10	7.5
B = 100 %	10	10
C = 125 %	10	12.5

An estradiol/testosterone ratio (E/T) has recently been utilized for sex determination in hatchling loggerhead sea turtles (Gross et al., 1993). Utilizing an E/T can control for some of the individual variability that often occurs with hormone analyses. It can also help control inter-lab variability. For example (refer to Table 1), lab A determines that a plasma sample has 7.5 pg/ml of estradiol and 30 pg/ml of testosterone and lab C determines that the same plasma sample has 12.5 pg/ml of estradiol and 50 pg/ml of testosterone. Regardless of the lab, the E/T = 0.25.

Another type of variation in RIA analyses is demonstrated in Figure 2. Both studies examined plasma corticosterone concentrations (a stress hormone) in loggerhead sea turtles at hatching (day 0) and various days afterwards. Both used the same antibody and virtually identical techniques. Notice that the trends are similar between the studies but the actual hormone concentrations are 4-5 times higher in Study A. Is this a real biological difference or a variability in the assay? Upon examination of the standard curves from each study, the slopes were similar but the 50% binding points varied significantly (685 pg/ml and 350 pg/ml for study A and B, respectively). The 50% binding point should be the most similar point among studies using the same antibody and dilutions of standard hormone. This type of variability may be due to a dilution error or degradation of the standard H and should have been apparent in the intercept of the mass recovery equation.

Since hormone concentrations can vary with changing environmental and physiological conditions, an entire array of variables outside of the laboratory must also be taken into account when absolute values of hormones are of interest. Although no study has analyzed the effects of season and size class on plasma concentrations of sex hormones in immature sea turtles, these variable were shown to significantly affect corticosterone concentrations in loggerheads (Gregory, 1994). Testosterone concentrations have been shown to decrease below basal levels in adult male alligators after 24 hours of capture stress (Lance and Elsey, 1986). Gregory (1994) reports two of ten mature male loggerheads captured by trawl in the Port Canaveral ship channel (trawl duration < 30 min) during summer and winter had testosterone concentrations below 32 pg/ml (within the value characterized by Wibbels et al., 1987 for immature female loggerheads). Evidently, such low testosterone concentrations have been observed in other mature male loggerheads (personal communication, Wibbels). If mature male loggerheads can have such low testosterone concentrations, what is the probability of similar testosterone concentrations in immature male loggerheads?

There is evidence that testosterone concentrations in immature loggerheads may be affected by location. In Wibbels et al. (1987), a distinct bimodal distribution of testosterone concentrations was observed in immature loggerheads captured in the Indian River with all concentrations falling either below 40 pg/ml (female) or above 175 pg/ml (male). However, no such distinct separation of data occurred in loggerheads captured at other locations on the east coast. Gregory (1994) did not observe a clear bimodality of testosterone data for immature loggerheads captured at the Port Canaveral ship channel even within season (Fig. 3).

Ideally, each lab interested in utilizing hormone concentrations for sex determination should validate their assay for different size classes, seasons, and locations for each species of sea turtle. Just because E/T worked well for hatchling loggerheads from the east coast of Florida doesn't mean they will work well for immature loggerheads from the Chesapeake Bay. In addition, researchers often analyze reptilian plasma for the types of hormones found predominately in mammalian plasma. Deoxytestosterone or estrone may be the more characteristic and informative sex hormones in reptiles.

SUMMARY

A mildly invasive sex determination method involving the measurement of plasma testosterone concentration via a radioimmunoassay has received much attention among sea turtle biologists. RIA mass recovery equations can vary among laboratories and can lead to significant variations in absolute values of hormone concentrations among studies. In addition, the complex interactions among an animal's endocrine system, physiology, and environment must be considered before such a method is utilized without laparoscopic or histological verification. It is recommended that effects of season, size class, and location on sex hormone concentrations be determined for each species of sea turtle before this method be implemented without some other form of sex verification. Researchers should be comfortable with standardizing RIA methods among laboratories performing sex determination analyses. A free exchange of mass recovery equations and samples of known hormone concentrations should be implemented among laboratories utilizing RIAs for sex determination so that meaningful comparisons can be accomplished among studies.

ACKNOWLEDGMENTS

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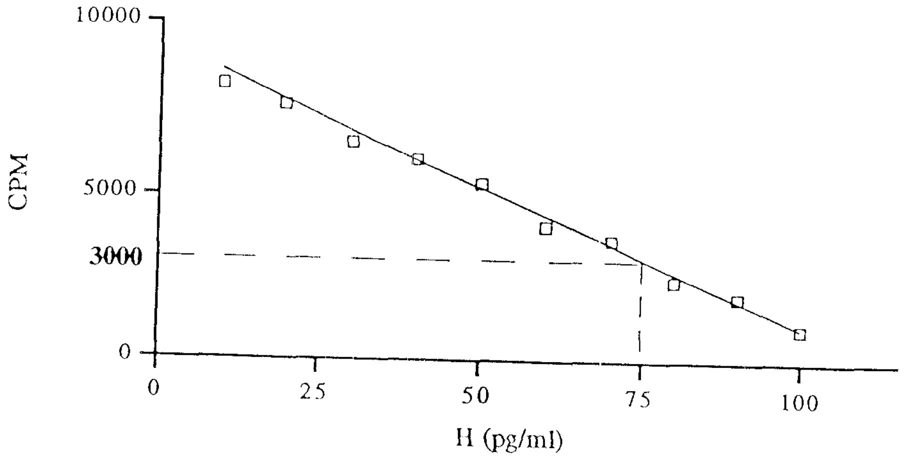

FIGURE 1. A hypothetical standard curve of a hormone with a graphical determination of an unknown hormone concentration from a known CPM.

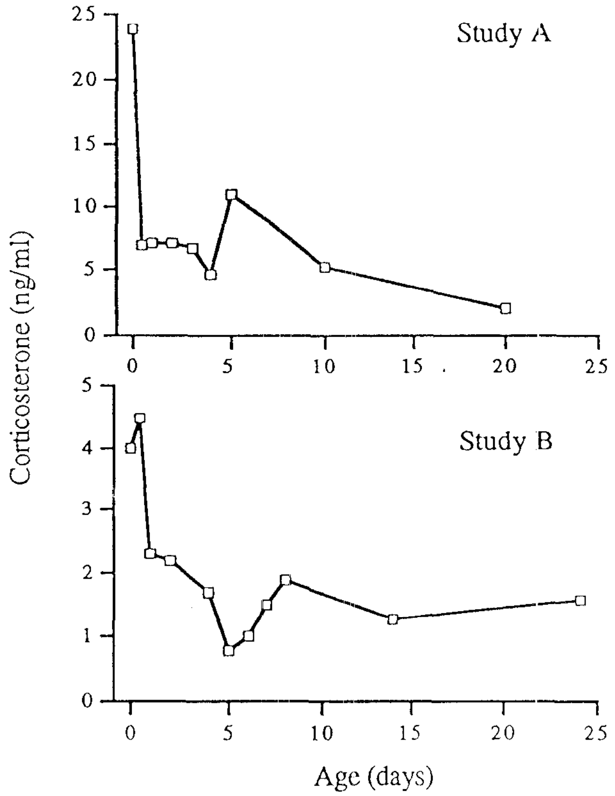

FIGURE 2. Mean corticosterone concentrations in loggerheads at hatching and in following days. Redrawn from Morris, 1982 (Study A) and Schwantes, 1986 (Study B).

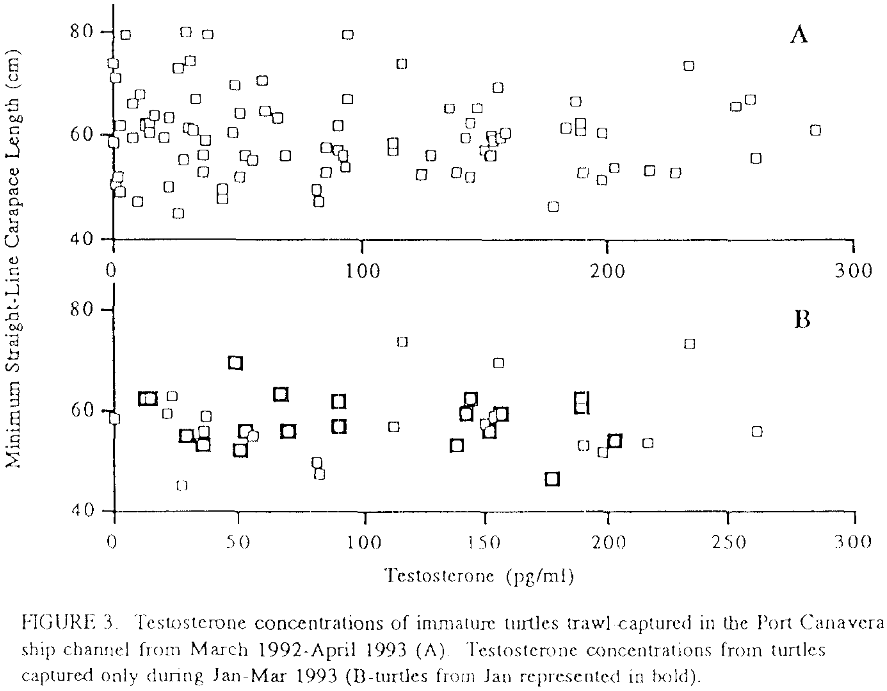

FIGURE 3. Testosterone concentrations of immature turtles trawl-captured in the Port Canaveral ship channel from March 1992-April 1993 (A). Testosterone concentrations from turtles captured only during Jan-Mar 1993 (B-turtles from Jan represented in bold).

MARINE TURTLE NEST BEACHES: A GLOBAL GIS DATABASE **IN** WORLD CONSERVATION MONITORING CENTRE

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Objectives

1. To develop a global Geographic Information System (GIS) database holding spatial information on all known marine turtle nesting beaches, linked to data on country, site name, nesting season, population levels, and reference sources.
2. To incorporate the spatial and attribute data in the WCMC Biodiversity Map Library, where it can be integrated with existing digital datasets (eg. coral reefs, marine protected areas).
3. To prepare and publish a global Conservation Atlas of Marine Turtles, with text, pictures, tables and maps showing all known nesting beaches and key feeding areas, based upon further research and collaboration with turtle experts, and completion of the existing preliminary database.
4. To make the database available on-line via the Internet, where it would be continually available as a central source of collated information, and provide a focus for new data derived from the community of marine turtle workers.

Background

The World Conservation Monitoring Centre (WCMC) is a charity jointly managed by IUCN, UNEP and WWF. WCMC has more than a decade of activity in research, information management and the preparation of technical and semi-popular documents on biodiversity. Working with a network of collaborators, field experts and in-country contacts, WCMC has compiled several IUCN Red Data Books (including the volume on turtles and crocodilians; The green turtle and hawksbill.- worldstatus, exploitation and trade; the three-volume Coral Reefs of the World, The Conservation Atlas of Tropical Forests (also three volumes), and works on wetlands, protected areas and other topics. Much information at WCMC is in digital format; these data can be made available for research or conservation applications through the WCMC Biodiversity Map Library (a library of digital environmental datasets operating in ARC/INFO with a custom-built interface).

Justification

Most marine turtle populations are now in decline or under pressure, and all species are currently recognised internationally as threatened. One aspect of sea turtle biology has particular relevance to their conservation: females tend always to return to the same nesting beach and scarcely any interchange between beaches has been demonstrated, so that once a local nesting population has been destroyed it is not replaced by migrants from other populations.

Therefore, the precise spatial location of nesting beaches is of key significance. This information is the basis for population monitoring, for coastal planning decisions in the long and short term, and for emergency response to marine and coastal accidents.

The literature on marine turtles is very large, but the data on nest site location are not collated and usually not in the most appropriate format. Spatial information is most clearly represented in maps, and use of a Geographic Information System (GIS) is the best means both to collate the data and to produce mapped outputs rapidly.

This project is thus founded on the need to collate the data needed most urgently for conservation planning, and to make them available in the most useful format. The general aim is to improve further the information service provided to researchers, coastal zone planners and users of the marine environment.

Objective 3 (Conservation Atlas of Marine Turtles) is designed to answer the requirements of users worldwide who need comprehensive and accurate maps and text, but would not need electronic access to the database or the digital maps. The Atlas would be used by local conservation activists, researchers, undergraduates, school students and concerned members of the public.

Objectives 2 and 4 are designed to meet the needs of a more technical audience, including graduate students, researchers, consultants, conservation planners, and suchlike, who would benefit from being able to access the database or to analyse several sets of data in a GIS (in preproject impact assessment, or marine emergency planning, for example).

Progress to date

The spatial information is plotted on a 1:1,000,000 scale world coastline dataset. This resolution is adequate for the intended applications. We hope it will complement current large-scale mapping activities in-country for detailed national site planning, and current GIS work on turtles at sea. Each mapped site is linked to two data tables, one with site and season information, the other with population data. Where time series data on nesting numbers (or other indicator of nesting effort) are available these have been included. The incomplete preliminary dataset is now available in the WCMC Biodiversity Map Library.

Our priority has been to identify the size and location of nesting beaches. The database has site and nesting season data entered for most parts of the Mediterranean, Africa, Arabia and the Gulf, South and Southeast Asia, Australasia and parts of the Pacific. Where readily available, nesting data have also been included for the same areas. The Caribbean and the Americas have not yet been covered. Published information on the location of feeding areas has also been mapped, but the value of this remains to be fully assessed.

For the preliminary work, significant nesting sites have been recorded without ranking or other classification; we have included a second category of 'possible nesting' to cover extended coastlines where some nesting is suspected or is sparse and sporadic. It is intended to provide indication of the relative importance of sites: we recognise that this isdifficult and controversial, but such information is vital for effective emergency response planning.

Uses of this information

The preliminary material collated has been much used in-house and by a variety of other organisations and individuals. Uses include: research expeditions, coastal zone planning, preproject impact assessment, regional and country briefing documents, media coverage of the Gulf War, marine accident response, and pollution risk evaluation.

Future directions

Objective 1 of this project is nearing completion at a preliminary level. Future developments from this point will be planned more fully after consultation with current and potential users. They will also depend on the amount of funding that can be secured. WCMC and the I UCN/SSC Marine Turtle Specialist Group have had preliminary discussion on revision and long term maintenance of the global nesting site GIS. After completing preliminary global coverage, we hope to be able to utilise the expertise of the SG and other turtle workers to refine and revise the draft work.

The Conservation Atlas of Marine Turtles: outline specification

The initial concept is for an A4 sized volume of around 100 pages. The contents are likely to comprise about two-thirds maps and illustrations, and one third text and tables. Maps will be in colour and will vary in scale between global, regional, country and sub-national; photographs will be selected to illustrate all marine turtle species (including major age, gender and geographic differences), key habitat types and a variety of actual sites. The text will give a concise and authoritative overview of marine turtles, covering their evolution, biology, and conservation status, while maps in the main atlas section will be supported by discussion of the regional context and principal nest beaches. Key data will be presented in table format. Every effort will be made to identify major nesting sites, which deserve high conservation priority, but the limitations of available data will also be noted.

1 Marine turtle history: evolution, fossils, classification.

2 Marine turtle biology: feeding ecology, reproduction and population biology, philopatry and migration, the units for conservation attention, associated species and habitats.

3 Humans and marine turtles: religion & mythology, subsistence use, international commerce, directed and incidental catch, coastal issues.

4 Marine turtles today: research and limitations of the data, distribution, population status, outlook.

5 The Atlas: organised by ocean regions, with country and larger-scale maps as appropriate.

Marine Turtle Nesting Database on-line

This Objective will be pursued (after technical evaluation of its feasibility) if sufficient interest is shown by potential users. The intention would be to promote rapid international flow of quality information that can be used in support of sound conservation and management planning. This implies both the provision of outgoing data, and the supply of incoming new data from field researchers. The new data will be used to revise the on-line database for the benefit of users. It is anticipated that if the information is found useful by sufficient people, then many will have an interest in helping keep the database adequately current. Data transfer protocols and institutional responsibilities have yet to be established

Comments & enquiries

We would be most grateful to receive comments on this project, and any relevant data on turtle nesting anywhere in the world.

THE SEA TURTLES IN ISLA DE MARGARITA, NUEVA ESPARTA STATE, VENEZUELA: PERSPECTIVES FOR THEIR CONSERVATION.

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ABSTRACT

In Isla de Margarita (10°51'50"- 11°11'06" N, 63°46'40" - 64°24'32" W) (Map 1) the evaluation of the sea turtle status began at end of the 1980's.

Buitrago (Medina et al., 1987), after an evaluation of the artisanal fisheries from 5.5 years to the north of the island, found high numbers of caught turtles in the nets from the fishermen, being Chelonia mydas as the species more frequent (Medina et al., 1987). The National Parks Service, INPARQUES, have established protection regulations for sea turtle feeding areas in the Ordering Plan of the Laguna de La Restinga National Park, an important wetland in the island. Moreover, it was added a marine area of an nautical mile to the National Park, to give some protection to the nesting females in the sand bar of the La Restinga lagoon. However, during 1994 appeared several sea turtles (Chelonia mydas and Dermochelys coriacea) stranded in the coast of the protected area (Albornoz et al., pers. comm.).

Since 1992, have been taught three "Short Courses on Sea Turtle

Biology and Conservation" in Isla de Margarita. These courses have been auspiced for several governmental and non-governmental organizations at regional, country and foreign level (INPARQUES, Universidad de Oriente, WIDECAST, CCEXU, PROFAUNA, Conservation International, Grupo de Trabajo de Tortugas Marinas). The short courses have been a highly valuable tool to motivate the realization of efforts to the sea turtle conservation in the island, as may been appreciated.

- After the courses, the Ministry of the Environment and Natural Renewable Resources (MARNR) have establish protection regulations for sea turtles in some public beaches.
- The MARNR included a brief chapter on sea turtles in a new Atlas on the Nueva Esparta State (MARNR, 1994) and it is being printed a 1995 calendar on sea turtles in Isla de Margarita (G. Hernandez, com. pers.).
- A graduate biologist and two undergraduate students have conducted interviews in the Nueva Esparta State in order to establish the local use and commerce on sea turtle products (Gomez et al., 1994) and they have produced information that make conspicious the high levels of sea turtle caughts to satisfy the local and regional markets in the mainland.
- A conservacionist foundation (OIKOS Fundacion Conservacionista del Estado Nueva Esparta) was constituted in Isla de Margarita and it will be mainly focused to promote the sea turtle conservation.
- The local concern on sea turtles had produced several interesting facts: in January of 1994, one person bought a male leatherback turtle ready to be killed , in order to give it to the Universidad de Oriente (UDO). The sea turtle was successfully released to the sea. Periodically, the fishermen are bringing sea turtles to the marine biologists of the UDO, for their tagging and releasing.

Moreover, Isla de Margarita and the Nueva Esparta State (including Coche and Cubagua islands) have an strategic value to the sea turtle conservation. They are located in the middle of two important areas for sea turtle feeding and nesting in the eastern Caribbean from Venezuela: La Blanquilla and Los Testigos Archipelago and all the conservation efforts realized in Isla de Margarita will radiate to the other islands. The conservation efforts must be focused to the involvement of the local population in the protection of the sea turtles and their nests and in the reduction of the mortality through the fisheries.

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THE SEA TURTLES AT FALCON STATE, VENEZUELA

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Since the end of the 1980's some detailed work to establish the sea status of the populations in the Falcon State have been done. Moreover, several institutions have been realized some conservation efforts focused to the Peninsula de Paraguana and the eastern coast of the state, specifically in the Morrocoy National Park.

Through the field work of the Project "Inventory of sea turtles in the Caribbean coast of Venezuela" from FUDENA, realized during 1987 and 1988 (Guada and Vernet, 1988; Vernet, 1988) it was showed the high pressure the suffer the sea turtles around the entire coast of the state. The high demand of the sea turtle products is to satisfy the regional and national market and to export illegally sea turtle meat and carapaces to Aruba, Curacao and Bonaire, where the foreign exchange benefits to the Venezuelan fishermen. By these reasons, since 1988 it had been solicited the declaration of a protected area in the northern Peninsula de Paraguana. Moreover, the turtles died incidentally in the nets of the shrimp trawlers.

After of the inventory of sea turtles comprising the main part of the Venezuelan mainland and some islands, several initiatives from OGs and NGOs were initiated. For 1988, PROVITA prepared a project of sea turtle conservation to be executed in the Paraguana Peninsula (Nassar and Yurman, 1988), but it was not implemented. In 1989, H. Guada and P. Vernet prepared for FUDENA a poster tittled "The sea turtles of Venezuela". The poster was printed by FUDENA through support of PEQUIVEN.

Between 1989 and 1990, it was created a Group for the Conservation of the Sea Turtles in the Paraguana Peninsula, through auspices of the Gustavo Rivera Zoological Park, FUDENA, INPARQUES, PROVITA and several GOs and NGOs of the Peninsula. Unfortunately, the activities of the Group ceased in 1990.

A new field work in the Golfete de Coro realized in 1990 confirmed some sea turtle nesting beaches in this area (Guada and Vernet, 1990). During 1991 and 1992 FUDENA had a sea turtle monitoring program in the Morrocoy National Park accomplished with the evaluation of feeding areas. By the same time, the National Parks personnel in Morrocoy N.P. began to patrol several sea turtle nesting areas in the mainland and keys of the protected area. In 1993, it was taught a short course on sea turtle monitoring for the personnel of the National Park Morrocoy and other interested institutions (Guada et al., 1994). In the Zoning Plan of the National Park (to be published in the Gaceta Oficial) there were established several specific areas for protection of the feeding and nesting places of the sea turtles within the Park. At ends of 1994 it was prepared by H. Guada and V. Vera a pamphlet for the National Parks users tittled "The sea turtles in the National Parks of Venezuela". Actually the pamphlet it is being printed.

It may be appreciated that since 1990 the research and conservation activities have been focused to the Morrocoy National Park and Cuare Wildlife Refuge, to the east of Falcon State. However, the efforts have not been enough to diminish the illegal caught of sea turtles and all the weeks and mainly in the nesting season, the fishermen take the turtles and their eggs. The Fisheries Service (SARPA - MAC) have established the use of TEDs for the shrimp trawlers in the Falcon State for all the shrimp trawlers.

By other hand, fibropapillomas in *Chelonia mydas* caught by fishermen had been detected in the Peninsula de Paraguana (Guada et al., 1991) and in the eastern coast (G. Sole, pers. comm.), areas for elevate caught and consumption.

It is needed to enforce the protection of the sea turtles in the protected and not protected areas. More detailed work must be realized toward the population of the Falcon State and the numerous tourists who arrive to the beaches and that constitute aditional pressure for the consumption of sea turtles.

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SEA TURTLE NEST DEPREDATION BY A FERAL HOG; A LEARNED BEHAVIOR

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Conservation management necessitates balancing many variables in the real world, among these are the rights of different species to utilize the same habitat. Loggerhead sea turtles (*Caretta caretta* Linnaeus) deposit nests on Georgia barrier islands that are liable to depredation by a number of predators including humans, ants, ghost crabs, raccoons and feral hogs. Predator control and nest protection have proven effective in decreasing, but not eliminating, depredation on St. Catherines Island, Georgia. Data from the 1994 nesting season strongly suggests nest rooting by feral hogs is a learned behavior and can be controlled by rapid identification, targeting, and elimination of the specific offending hog.

BACKGROUND

Depredation of sea turtle nests on the Georgia coast is dependent upon the suite of predators present and the control measures taken to manage the potential predators and protect sea turtle nests. Ossabaw Island, formerly with a largely uncontrolled feral hog population, exhibited devastating hog depredation; St. Catherines island has significant raccoon depredation and occasional feral hog depredation; Sapelo Island, with a small population of descendants of former African-American slaves, experiences some human depredation; and Little St. Simons reports little depredation.

Although St. Catherines' sea turtle nest depredation history is sketchy, indications of the magnitude of past predation on loggerhead sea turtle nests was first investigated by Sydney Anderson (1 981). The severity of the problem in the past was indicated by Harris and Maley (NMFS/USF&WS: 1 991: 9): "In Georgia, on Ossabaw and St. Catherines Island, an estimated 90 percent of all nests were lost to feral hogs prior to the implementation of predator control programs. (GDNR, unpub. data)." Both Islands have since taken measures which largely control their depredation problem.

The St. Catherines sea turtle predator control program has included the trapping and hunting of feral hogs and trapping of raccoons to decrease their population densities along the beaches supplemented by covering nests with screen held down by rebar. Sydney Anderson called attention to sea turtle nest depredation in 1 979 and calculated that 46 of 68 nests were depredated, half of them by feral hogs. In 1984 Marshall documented 107 nests of 184 depredated; 102 of those by feral hogs. Corliss recorded 83 nests for part of the nesting season in 1986; 49 of 51 unscreened nests were depredated while 0 of 32 screened nests were not. Small recorded 96 nests in 1989 and reported 2 depredated by hogs and 17 by raccoons. The following year, 1990, Reagan recorded 145 nests and had no feral hog depredation and 18 nests depredated by raccoons. In 1991 Waller reported two inactive nests out of 105 were depredated by hogs. In 1992 Brannen and Bishop reported 3 of 148 nests depredated, in 1993 none were depredated, and in 1994 they reported 26 of 184 nests predated by raccoons; with 14 nests which had previously hatched depredated by a single hog on South Beach described in this paper.

The major change in sea turtle nest depredation which occurred between 1986 and 1989 was due to the initiation of a predator control program initiated by one of us (RHH) to decrease the total feral hog population on St. Catherines Island, particularly on the beaches in 1986. It is known that 1300 hogs were initially removed by trapping from St. Catherines Island during the Winters of 1975 and 1976; it is estimated that 1,000 were shot between 1976 and 1986, and 600 since 1986. The feral hog population since 1976 has been stabilized at 125-200 hogs.

METHODOLOGY

Track and trail data were taken during daily beach monitoring on St. Catherines Island in the Summer of 1994. Each nest was examined daily and tracks found lying on the nests' screens were identified and recorded on a daily monitoring form. Trailways of feral hogs were marked as lines on a monitoring form as monitoring progressed along each beach. Trails of raccoons were marked occasionally if they were especially persistent or represented significant events.

RESULTS

Distribution of feral hog trails were found to be remarkably consistent from day to day (Fig. I Trails were found to begin, exit the beach, return to the beach, and terminate at about the same points each day. After several days of recording such data, specific pigs, or groups of pigs, could be identified. Three daytime hog sightings on the beaches were made during the summer. The paucity of daytime sightings and consistent tracking observed early each day indicated hogs were foraging the beaches primarily at night.

On August 26, three nests (94-88, 94-85, and 94-92) on South Beach were dug to assess their success after having hatched and their protective screens were removed (Table 2). On August 27 we found two of them (94-85, and 94-92) had been rooted out by a hog. They were back-filled with sand. On August 28, the two previously rooted nests and a third inactive nest were again rooted out by a hog (94-88, 94-85, and 94-92); on August 29 two were again rooted (94-88 and 94-92); and on August 30 one nest was rooted out again (94-85). On August 31, not only were all three initial nests rooted out again, but nest 94-45 [located 2.023 km further north [and also previously dug for assessment and rescreened] was rooted out with the pig pushing under the screen to access the inactive nest. On September 1, another eight nests were rooted out, and on September 2, we found eleven nests had been rooted the night of September 1, all, of which also had already hatched and been assessed for success.

The consistent reopening of old nests followed by the progressive inclusion of more nests indicates that a feral hog had learned a nest-rooting behavior (Harris and Maley, 1990:6). The hog's trackways also strongly suggested it was beginning to key on wooden stakes marking each nest; as the hog would forage parallel to the beach scarp until it neared a stake, make a distinct turn toward the stake, and then continue wandering parallel to the beach. Until this time no unhatched nests had been depredated, the increasing intensity of the depredation and its proximity to active nests, it was decided to terminate the experiment and the hog. On the night of August 1, one of us (GAB) occupied a position along a consistent segment of the hog's trailway near nest 94-11 6 at grid point 5.598 km which provided a high dune as a backstop. A hog was smelled at about 1:00 P.M. on a southerly wind of about 10 mph and then spotted against the dune at about 1:11 P.M., illuminated with a 500,000 candlepower lamp and eliminated with a Ruger 223. Subsequent to the depreciations made by this hog on the night of September 1, recorded as data on the monitoring rounds of September 2; no nests were subsequently depredated by hogs on South Beach, although the beach was still being tracked daily by at least one other mature pig.

CONCLUSIONS

The observations and events of Summer 1994 clearly indicate:

- Feral hogs forage St. Catherines' beaches for food on a nightly basis.
- Feral hogs exhibit a consistent foraging pattern reflected in their daily trackways.
- Feral hogs do not instinctively depreciate loggerhead sea turtle nests.
- The presence of feral hogs foraging on the beach represents a clear potential hazard to nests.
- Feral hogs foraging on the beach may rapidly learn predatory bp-havior.
- Once learned, predatory behavior by feral hogs is consistently and progressively applied.
- Eliminating the hog responsible for the depredation eliminates the problem.

MANAGEMENT CRITERIA

- Feral hogs foraging on the beaches present a potential hazard to loggerhead sea turtle nests and must be closely monitored on a daily basis.
- If depredation of sea turtle nests by feral hogs is learned, removal of the offending hog should remediate the problem.
- We have demonstrated that predatory behavior on sea turtle nests is learned by hogs; we think this behavior may be transferred by observation from one hog to another.

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Table 1. Time Line of Explosive Pig Depredation, South Beach, St. Catherines Island, Georgia, August 26- September 3, 1994. Daily track observations and depredation by feral hogs (noted as P R) showing reinforcement of original learning then application to other nests along the beach.

[Pt=Pig track, P R=Pig Rooting, Rt=Raccoon track, Rd=Raccoon Dig, GC=Ghost Crab; nd=no data; -=nest not tracked; E(xx)=Emergence of xx hatchlings; SW=swashed by surf]; and Continuous Pig Trackway(s) from 7.1 to 3.5 km. *=Pig Shot

Nest	Location	8/26	8/27	8/28	8/29	8/30	8/31	9/1	9/2	9/3	9/4
045	6.609	-	Pt	-	Rt	Rt	P R	P R	-	Rt	-
-											
18 nests											
-											
116	5.598	-	GC	-	-	E(19)	-	-	*	E(1)	-
-											
070	5.485	-	nd	nd	-	-	-	P R	P R	-	-
125	5.372										
071	5.364	Pt,Rt	Rd	-	Pt,Rt	-	-	P R	P R	-	-
066	5.344	Rd3,GC	RD,GC	nd	-	-	Rd3	-	P R	-	-
096	5.275	-	GC	GC	GC	-	-	-	-	-	-
159	5.255	-	-	-	-	-	-	-	P R	-	GC
126	5.219	-	-	-	-	-	-	P R	P R	-	-
130	5.214	-	GC	GC	-	-	-	P R	-	-	-
142	5.094	-	-	-	-	-	-	-	-	-	E(m)
131	5.070	-	-	-	Rt	-	E(28)	-	P R	-	-
110	5.056	-	GC	-	-	-	nd	-	P R	-	Rt
135	5.034										
	5.000		South Beach Entrance								
-											
5 nests											
-											
121	4.915	SW	GC	GC	-	-	-	-	P R	-	SW
091	4.893										
003	4.824	nd	Pt	Pt	-	-	-	-	Pt	-	nd
017	4.791										
120	4.778	Pt	Pt,Rt	Pt	-	-	Rt	Rt	P R	-	Pt
102	4.702										
010	4.601										
088	4.586	dug	Rd,Pt	P R,Rd	P R	Rd3	P R	P R	Pt	-	-
085	4.515	dug	P R	P R	Rd	PR,Rd3	P R	P R	P R	-	-
092	4.478	dug	P R	P R	PR,Rd	Rd3	P R	P R	Pt	-	-
164	4.337				-	-	Rt	-	Rt	-	SW
113	4.310										
078	3.813										
Flag Inlet											

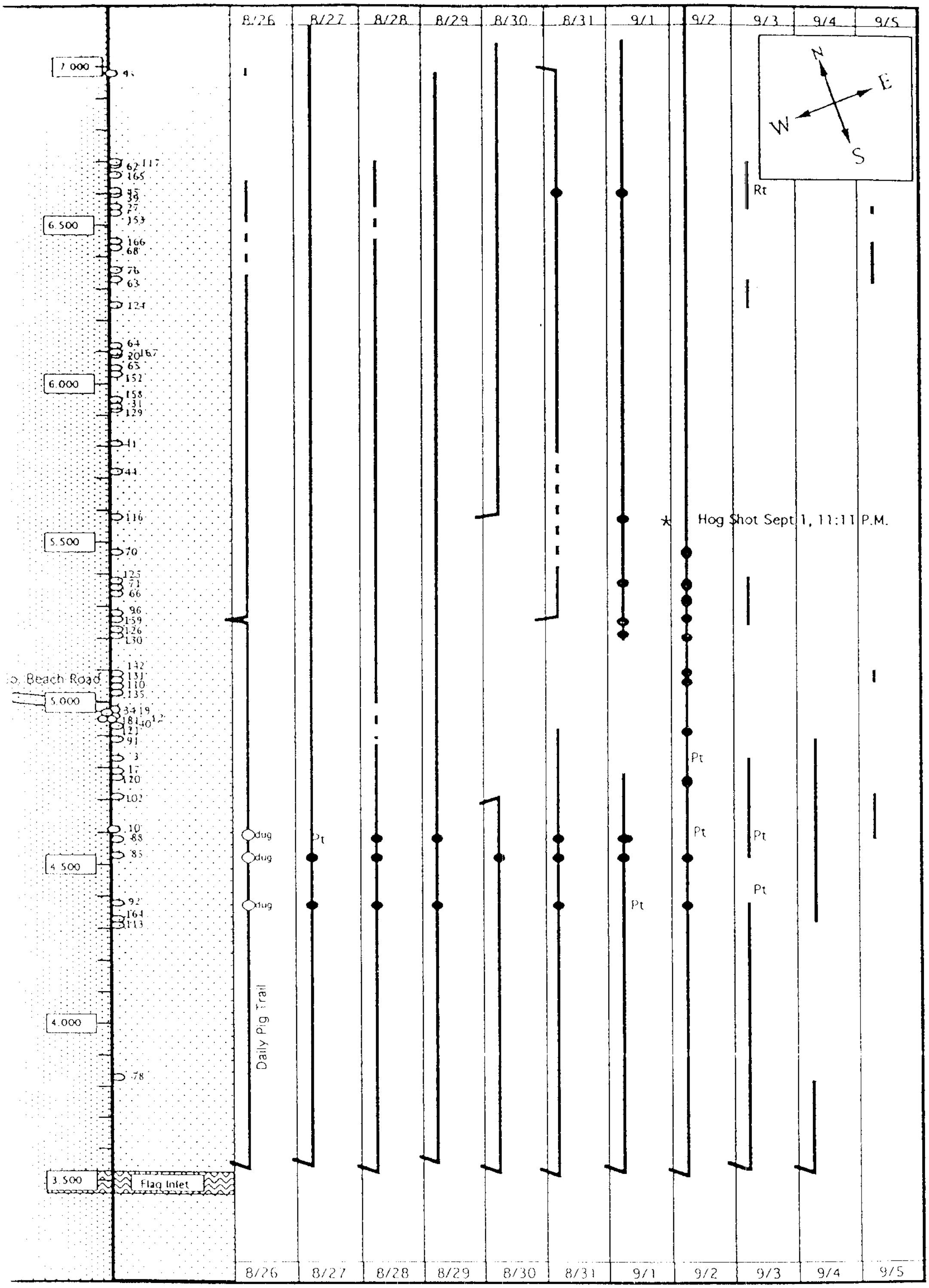

Figure 1. Daily trailways of feral hogs along a stretch of South Beach, St. Catherines Island. Nest locations plotted along shoreline. Depredated nests indicated with closed ovals along daily trailways. Drawing scale in kilometers.

IDENTIFICATION AND CHARACTERIZATION OF THE GREEN TURTLE FIBROPAPILLOMATOSIS AGENT

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Our transmission experiments have demonstrated that the etiology of Green Turtle Fiobropapillomatosis (GTFP) is a filterable infectious agent, most probably a virus and have ruled out the direct involvement of spirorchid trematode ova in pathogenesis. A serologic survey of Florida green turtles for antibodies to blood flukes using an ELISA developed with monoclonal antibodies specific for turtle IgY also fails to support any association between fluke exposure and GTFP. Histologic examination of early experimentally induced fibropapillomas revealed focal areas of epidermal degeneration consisting of cytoplasmic vacuolation and ballooning degeneration in 72% of 24 biopsies from 10 turtles. In these areas some cells contained intranuclear inclusions that were shown by electron microscopy to contain Herpesvirus type particles. In addition immunohistochemistry using anti-sera from a GTFP positive turtle revealed the presence of herpesvirus in 11% of 72 spontaneous tumors from 20 free-ranging turtles. A serodiagnostic test using monoclonal antibodies to detect turtle IgY and IgM antibodies against this GTFP-associated herpesvirus was used to test pre- and 1-year post-experiment plasma samples from all transmission experiment turtles. All 12 transmission positive (GTFP positive) turtles demonstrated herpesvirus sero-conversion. Control and transmission negative turtles did not sero-convert. A serologic survey of free-ranging turtles with and without spontaneous GTFP also revealed a strong statistically significant association between herpesvirus sero-reactivity and fibropapillomatosis (100% of 20 GTFP affected, 10% of 20 GTFP-free turtles). This evidence supports the hypothesis that this herpesvirus is the GTFP agent (etiology) and ongoing experiments have been designed to test this hypothesis and rule out papillomavirus as a possible etiology. Transmission experiments are underway to characterize the the GTFP agent using GTFP homogenates that have been treated to destroy the infectivity of enveloped viruses (e.g. herpes) but leave the infectivity of naked viruses (e.g. papillomavirus) intact. Definitive proof that one or another virus is the etiology of GTFP will depend upon being able to reproduce GTFP with purified virus (Koch's postulates). Development of practical molecular and immunological diagnostic tests for subclinical GTFP also requires purified virus or viral genes. While our ongoing attempts to culture the GTFP-associated herpesvirus *in vitro* have not yet been successful, extraction of virus directly from infectious GTFP material by fractionation on Cesium Chloride gradients have yielded some promising results. Electron microscopic examination of isopycnic gradient fractions of tumor extracts has revealed the presence of particles consistent in morphology and density to herpesvirus and no evidence of papillomavirus. Transmission experiments are underway with this material. DNA extracted from these positive fractions is being analyzed. Similarly, nucleic acids (DNA and RNA) have been extracted from GTFP-derived and normal skin-derived cell lines and is being probed for virus genomic material. Preliminary comparisons of mRNA expression between normal and tumor cells reveals several differences one or more of which may be viral gene products. Thus substantial and rapid progress that has been made toward understanding GTFP and several lines of active experimentation are focusing on the identification of the GTFP agent that will eventually lead to the means to monitor, prevent, and/or control epizootics in free-ranging green turtles.

AUTOGENOUS VACCINATION AS AN ADJUNCT TO SURGERY IN THE REHABILITATION OF GREEN TURTLES WITH FIBROPAPILLOMATOSIS

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The recommended treatment for green turtles with fibropapillomatosis (GTFP) is surgical excision followed by monitoring for up to one year before release. Multiple surgeries are often required because of tumor recurrence. Recent findings that GTFP is caused by an infectious agent raises prospects for immunotherapy. This paper describes an ongoing study using autogenous killed vaccine to help prevent GTFP recurrence in surgically treated green turtles. Autogenous vaccines are prepared from a filtered GTFP homogenate of pooled tumors removed at surgery. This filtrate, which has been shown to be infectious in transmission studies is killed with 0.1% formalin. Turtles are injected with 0.5ml total volume intradermally and subcutaneously at several sites. Booster injections are given in 2 weeks and then monthly. Inoculation sites and surgical sites are monitored for tumor growth. At present, 10 turtles are receiving autogenous vaccines. All had severe GTFP including ocular involvement and have a history of tumor recurrence following surgery. Nine of the turtles have received vaccine for less than 3 months during the winter and cannot be evaluated adequately. One turtle has received vaccine for over 9 months. This turtle was presented in October 1993 and was treated surgically. Regrowth of eye lesions and flipper lesions began 6 months later (in spring with onset of warmer weather) and autogenous vaccination was begun. Since vaccination, the eye mass has not progressed and other skin tumors have regressed. During this same time period other turtles showed tumor progression following surgery. Thus there is some evidence that vaccine may help turtles recover from GTFP. On the other hand spontaneous recovery has been documented in some free-ranging turtles, so the efficacy of this vaccine strategy remains open to question. Efficacy is difficult to evaluate because these vaccines have unknown antigen dose and other undefined properties. It becomes an ethical dilemma to withhold either surgery or vaccine from turtles with severe disease for the sake of improving the study and having control data. While the evidence for efficacy is limited, autogenous vaccination apparently does no harm. Future vaccine development work should involve challenge infection studies in unvaccinated versus vaccinated turtles but it is probably best to delay these studies until an experimental vaccine with defined properties can be produced.

1994 -- THE YEAR OF EXPANDING, STANDARDIZING, AND PLANNING FOR THE FUTURE OF HAWKSBILL TURTLE RESEARCH AT BUCK ISLAND REEF NM.

Zandy -Marie Hillis, Brendalee Phillips

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DOCUMENT, DEFINE, and STANDARDIZE

1994 was the conclusion of our seventh season of research on the hawksbill turtles nesting at Buck Island Reef National Monument (BUIS), St. Croix, Virgin Islands. After training with the Queensland Turtle Research Program in Australia last January and February and being exposed to new methods, their applications, and their long term database we began preparing BUIS data for the database. A history of each nesting season was compiled describing the problems and peculiarities --

hurricanes, measurement techniques, who worked where and when, and why not. Research terminology was defined as it applies to BUIS and data was standardized. Prior to the start of the 1994 nesting season the draft project dictionary and seasonal summary data sheets (to be used to record each females nesting activities), and a training manual were completed. To date several years data have been entered into the database which has greatly simplified data compilation and analysis. Documenting the program in this manner will ensure faithful compliance with the established nesting beach research methods over the long term.

NESTING SEASON RESULTS

In 1994, a cooperative research effort among the St. Croix hawksbill research projects was initiated. Funding was provided through an Interagency Agreement from the U.S.Fish and Wildlife Service's Caribbean Field Office to the National Park Service to support three volunteer's with room and board. These volunteers assisted with hawksbill research at BUIS, Sandy Point National Wildlife Refuge, and on St. Croix's East End beaches, Jack's and Issac's Bay. Volunteer training and scheduling was a cooperative effort between the agency's project managers. These volunteers combined with our staff volunteering on their off duty nights, plus three Buccaneer Hotel-supported interns, and many individuals from the NPS Volunteers-in-the-Park Program provided coverage for all the beaches seven nights per week for three months. This additional volunteer help allowed for improvements and expansion of the BUIS research program.

With more nightly field support than any prior season 94 nights of beach patrol were completed. Twenty-seven hawksbill turtles (Eretmochelys imbricata) were encountered. Twenty- four were remigrants from other years. To date almost 50 percent of the hawksbill females tagged while nesting at BUIS have been seen nesting again. This year only two nesting hawksbill turtles were untagged making "new" recruits only 8 percent of the 1994 cohort. One remigrant, QQD -113, was found stranded dead on St. Croix's north shore just days prior to the start of the research season. During the necropsy shelled eggs were found in her body cavity indicating she had returned to nest after three years of absence.

This year data collection was expanded to include clutch counts at egg deposition. A sample of 15 eggs from each clutch were weighed and measured, and abnormalities or yolkless eggs were recorded (yolkless, calcium strings, and translucent shells). Post-egg deposition each female was measured, and weighed once for the season (Table 1). Five females were selected to be "priority" turtles. These females were weighed after each nesting. All the eggs in their clutches were caught in sequential order and weighed and measured.

Blood samples were collected for genetic analysis from 24 individual nesting hawksbills. To date 41 of 81 BUIS hawksbill turtles have contributed to the population study, with either blood or salvage hatchlings. The initial analysis of BUIS hawksbill turtle nesting population and its comparison to other known hawksbill populations in the Caribbean has been completed and the manuscript by Anna Bass, et al, 1995, is in press.

A nesting beach temperature/hatchling sex ratio study was initiated. Ten Omega brand temperature dataloggers were buried at 30 cm depth in each habitat type and on each beach section. The mean temperatures ranged from 32 to 25.2 Celsius between September to January. Overall nesting beach hatch success for 104 nests was 65 percent, the lowest since hurricane Hugo, September 1989. Salvage hatchlings' kidney/gonad complex were collected for the sex ratio study. To date, 450 specimens from salvage hatchlings have been sent to University of Alabama for histological preparation. Five clutches from the southshore area have been analysized resulting in all female hatchlings. As part of the "priority" female experiment several of those clutches, which had been completely weighed and measured, were caged prior to emergence. Over 500 hatchlings were collected and weighed, measured, and scute abnormalities recorded. Mean straight line carapace length was 4.1 cm and weight was 14.7 grams.

An unprecedented amount of rat predation on hawksbill turtle nests was observed this season. Two complete clutches were predated and 12 more impacted by rats. Rats were observed sitting on turtle's carapace during egg deposition, eggs were stolen directly out of the egg chamber, or while eggs were being measured. Frequently technicians chased rats away from a nesting turtle or nest. Presently, BUIS is requesting approval for an island-wide rat control program to begin during the 1995 season.

In May, a pilot study to determine if subadult hawksbill turtles were present in the nearshore habitat at BUIS, and if they could be captured for study was initiated with volunteer assistance. To date 14 hawksbill turtles have been captured, tagged, weighed, measured, and a blood sample collected for genetic analysis. The results are reported in the paper by Brendalee Phillips.

THE FUTURE

During the recent U.S. Fish Wildlife Service's U.S. Caribbean Sea Turtle Workshop held in Boqueron, Puerto Rico several sea turtle project coordinators, including Mona Island, Culebra, mainland Puerto Rico, and the Virgin Islands discussed nesting beach method's standardization, communication, and research database management and applicability. We all agreed that cooperation and communication among the regions nesting beach/foraging studies was essential for data comparison, setting research priorities, and reaching sea turtle recovery goals. A draft questionnaire and dictionary, nesting beach project turtle tag lists, and description of project protocols and procedures are being circulated for review. A working group has been established and will provide for better communication between the projects.

In conjunction with Virgin Island National Park, National Biological Service's Inventory and Monitoring program BUIS may have the opportunity to put the sea turtle research program into a Geographic Information System in 1996. Our push to document and standardize the project data is in preparation for GIS data entry.

The 1995 hawksbill turtle nesting study will begin in July and will continue to collect information on hawksbill nesting behavior, habitat requirements, hatch success, etc. Genetic analysis of hawksbill turtles nesting and foraging at BUIS will continue to further establish the genetic relationship of BUIS hawksbill turtles to other known hawksbill populations in the Caribbean.

The Virgin Islands have a newly elected government. We intend to be proactive with the new territorial government and remind them that one of the greatest treasures in the Virgin Islands are the sea turtles who nest and forage year round among our tropical islands.

Table 1. Summary of the 1994 Nesting Season Results for Eretmochelys imbricata, at Buck Island Reef NM, St. Croix, U.S. Virgin Islands.

Adult Female	**N**	**Mean**	**SD**	**Range**
CCL (N-Tip)	26	89.5 cm	3.9	80.5 - 95.5 cm
CCW	26	79.2 cm	4.9	68.8 - 90.5 cm
PL. LENGTH	26	66.1cm	5.1	57.1- 90.0 cm
WEIGHT	26	70.5 kg	11.2	51.0 - 90.0+cm
Remig. Interval	24	2.7 yrs	0.8	1 - 4
Internest. Intrval	42 (X to E)	16.6 days	1.7	14 to 22 days
Internest. Intrval	38 (X to X)	16.3 days	1.4	14 to 20 days
Clutch/Turtle	24	2.62 clutches	1.2	1 to 5 nests
Clutch Size	62	151 eggs	28	98 - 205
Nest Top	43	15.1 cm	6.5	0.5 to 27 cm
Nest Depth	57	39.9 cm	6	25.0 to 54 cm
Egg Diameter	60 clutches	3.7 cm	0.08	3.5 - 4.1 cm
Egg Weight	57 clutches	30.3 grams	2.1	22.2 - 34.8 gm
Yolkless Eggs	10 clutches	3.3 yl eggs	3.3	1 to 11 eggs
Hatch Succ.	97 clutches	65%	31	0 - 100 %
Emerg. Succ.	97 clutches	60.2%	32.3	0 - 100 %
Hatchlings Emerged from known nests	7984			
Hatchl. Length	24 clutches	4.05 cm	0.11	3.8 to 4.2 cm
Hatchl. Weight	24 clutches	14.7 gm	1.55	10.1 to 16.7gm
Nesting Activ.	July = 49	August = 43	Sept = 45	Oct = 22
Activity/Beach	NS = 36%	WB = 18 %	SS = 37%	TB = 9%
Adverse Impacts on Nests	by rats = 14	by erosion = 3	clutch destruction by turtle = 4	Unkn = 20

COLLECTION AND HANDLING OF BLOOD IN SEA TURTLES

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Several sites can be used to obtain blood from chelonians, each having advantages and disadvantages. Sites include the heart, jugular vein, brachial vein, ventral coccygeal vein, orbital sinus, and trimmed toe-nails. In sea turtles, for the most part, peripheral vessels cannot be visualized. Cardiac blood sampling can be obtained from small sea turtles. In large sea turtles, sampling from cervical vessels is preferred. Complete blood counts (CBCs) are routinely performed in health assessment. Microtainer tubes containing lithium heparin (Fisher Scientific, Orlando, Florida, USA) are routinely used when collecting blood for CBCs and plasma biochemical profiles. Since potassium ethylenediaminetetracetic acid (EDTA) results in hemolysis of chelonian red blood cells, this anticoagulant is not recommended. When calculating CBCs, analyses should include: 1) red blood cell counts; 2) white blood cell counts; 3) differential white blood cell counts; 4) packed cell volumes; 5) hemoglobin concentrations. Up to 0.06% of the total body weight in blood can be collected from a healthy turtle safely. Red blood cell counts are determined using an automated Coulter counter. White blood cell counts can be determined manually using a hemocytometer. PCVs are determined following centrifugation of a sample in a microhematocrit tube. Hemoglobin values are calculated using a hemoglobinometer. Biochemical evaluations of blood generally involve analysis of plasma or serum samples for a variety of inorganic and organic constituents. Plasma is preferred rather than serum since a greater volume of plasma can be collected per unit volume of blood compared with serum. Also, it is more common for serum to clot than plasma. Blood should be centrifuged immediately following collection and plasma separated and frozen in liquid nitrogen or in an ultrafreezer at 70°C. To date, limited information is available on the accuracy of different methodologies used in determining various plasma biochemicals in reptiles. A variety of automated machines have been developed for use in determination of plasma/serum biochemical profiles of humans and have been used by the veterinary profession in domestic and wildlife medicine. Quality assurance programs are mandatory in order to insure that meaningful and biologically correct information is being obtained.

ENHANCING FLORIDA'S ORGANIZED TURTLE WATCH PROGRAM

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Loggerheads (Caretta caretta) are an important ecotourism resource in Florida. Various organizations conduct organized turtle watches each summer to provide the public with the opportunity to view a nesting loggerhead. Organizations follow guidelines established by the Florida Department of Environmental Protection which regulate participant activities during turtle watches. In 1994, we asked six organizations conducting organized turtle watches at locations along the east coast of Florida to distribute questionnaires to participants. Based on responses to the questionnaires, results of a study on effects of organized turtle watches on loggerhead nesting behavior and hatchling production (Johnson et al., 1994), and observations made during organized turtle watches, we have developed recommendations for guidelines to enhance the experience of the participants without compromising success of loggerhead nests. Although designed for turtle watches on Florida beaches, these recommendations may be applicable to sea turtle watch programs worldwide.

ACKNOWLEDGMENTS

We are grateful to the staff of the following groups for distributing questionnaires: Sea Turtle Preservation Society; Florida Power and Light Company; Merritt Island National Wildlife Refuge; Sebastian Inlet State Recreation Area; John D. MacArthur Beach State Park; and John U. Lloyd Beach State Recreation Area. The efforts of D. Brager, our 1994 field assistant, are most appreciated. We also thank all the members of our Technical Advisory Team (C. Coombs, L. Ehrhart, R. Hight, H. Hill, J.B. Miller, B. Schroeder, J. Stiner, K. Whaley, J.R. Wilcox, and B. Witherington) for constructive comments and suggestions on the questionnaire and B. Bolt and T. O'Toole for providing valuable assistance. This project was funded by the Florida Sea Grant College Program and the Archie Carr Center for Sea Turtle Research, University of Florida.

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CONSERVATION CONCERNS FOR THE NANCITE OLIVE RIDLEYS.

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Directly offshore of Playa Nancite, Costa Rica a large aggregation of thousands of olive ridley sea turtles, *Lepidochelys olivacea* can be found (Richard and Hughes, 1972; Kalb & Owens, 1992). During aerial surveys, Richard and Hughes (1972) estimated that over 100,000 individuals were gathered off Playa Nancite in August of 1970. Behavior, blood chemistry, and ultrasonography suggest that these turtles are all in a reproductively active state, i.e. looking for mates or awaiting the next arribada.

Playa Nancite is located in the Gulf of Papagayo on the Pacific coast of Costa Rica just south of Nicaragua in Santa Rosa National Park. The beaches isolation within the park and the presence of researchers protect the nesting turtles. Our primary concerns for this nesting population revolve around the offshore aggregation of reproductive individuals. This aggregation is vulnerable to trawlers, long liners, "turtle" fisherman, collisions with boats, and the rapidly developing tourist industry.

FISHING INDUSTRY

We all know that when turtles and TEDless trawlers meet, turtles lose. Imagine an aggregation of perhaps 10,000 gravid female turtles in an area less than four kms in diameter and then introduce a trawler. This past October within two days we had over 30 dead, bloated, otherwise "healthy" appearing females floating ashore at Nancite. Nancite is only 1 km long.

The Costa Rican shrimping fleets are currently interested in learning about TEDs. Costa Rica and AID will be working together to introduce TED technology on the Pacific coast. If you are interested in more information on TED's and trawling in Costa Rica, please contact

Randall Arauz.

Smaller fishing boats and long-liners are also seen in the aggregation on occasion. Turtles are found during each arribada with fishing hooks caught in their mouth and fishing line trailing behind. These boats are also responsible for a lot of the garbage, i.e. fishing line, burlap bags, nets, that entangle the turtles.

TOURIST DEVELOPMENT

All of the beaches between Santa Rosa National Park and Playas del Coco, the closest city to the south (app. 25 km.), have been purchased for hotel development. The plan is to build 18,000 rooms in this region (A. Chaves, pers. com.). One area is advertised to be the ACAPULCO of central America (Roldan Valverde, pers. com.). Construction of main paved roads to these beaches has been completed and an international airport in this region is already operating.

Tourists will be attracted to the area by promises of hotels with first class service, beautiful beaches, fishing, SCUBA diving, and lots of wildlife. (In addition to olive ridleys, leatherbacks and black sea turtles also nest along the shores and dolphins, flying fish, sea birds and manta rays can usually be seen in the Gulf.) Sounds good, doesn't it! BUT, this will mean more large speeding boats in the area (the high density of turtles found in the aggregation and their sluggish response to the presence of large speeding boats make it impossible to avoid hitting them), more garbage (the local currents and winds deposit large quantities of garbage and driftwood upon Nancite), more fisherman, and more lights along the coastline (currently, the only lights visible from Nancite are from Playas del Coco, 25 kms away). Hotel development of the scale planned here will destroy the ecology of the Gulf of Papagayo unless stopped or WELL CONTROLLED.

WHAT CAN AND IS BEING DONE TO HELP.

EDUCATION

In 1993, Santa Rosa National Park, the U.S. Fish and Wildlife Service, and Texas A&M University offered a week long sea turtle class to Costa Rican park rangers. This class consisted of both lecture and field work at Nancite. This class was so successful that in 1994, it was expanded to include sea turtle researchers and park rangers from other latin american countries. Having the educated support of the park rangers and administration is critical. In this area, we have been fortunate at Nancite.

We believe that education of the local communities will help. Interviews with locals in Playas del Coco, show that few individuals know that sea turtles are endangered or that large arribadas only occur on five or six beaches in the entire world. We are currently hoping, with the proper support and funding, to address this issue by returning to Playas del Coco during the fall of 1995. We hope to give talks and slide shows to the locals, schools, dive shops, and hotels in an effort to pass along information and conservation concerns about this population. Any suggestions or ideas that you might have in these areas would be truly appreciated (please contact first author).

During the fall of 1994, we treated all visitors to Nancite with one on one talks about sea turtle life histories and conservation problems with an emphasis on Nancite. Beautiful posters with Spanish dialog were used. This project was conducted by Jennifer Kureen and funded by the Baltimore Zoo. We believe that programs of this sort need to be continued with long term goals defined.

ACTUAL PROTECTION OFFERED TO THE AGGREGATION

The Marine Turtle Action Group of the I.U.C.N. has proposed that the Gulf of Papagayo be declared a protected area.

Santa Rosa will be purchasing a boat for a research station in Murcielagos (Bat Islands). The park needs to be encouraged to use this boat to monitor all unwanted boat activity in the aggregation.

PLEASE CONTACT

For more information or to express your concerns on the various topics discussed, please contact the following people.

1) Trawling: Randall Arauz at Rarauz@cariari.ucr.ac.cr

2) Negative impact of hotel development on the marine environment in the Gulf of Papagayo:

Carlos Roesch
Ministro de Tourismo
I.C.T.
San Jose, Costa Rica, Central America

Ing. Rene Castro
Ministro Recursos Naturales Energia y Minas
San Jose, Costa Rica, Central America

Please, send a copy of your letters to Juan Carlos Cruz (journalist):
011 (506) 234-9478

3) Santa Rosa Sea Turtle Class: Roger Blanco (see below)

4) Minimizing unwanted boat activity in the aggregation:

Roger Blanco
Santa Rosa National Park
Apdo 169
Liberia, Costa Rica, Central America
Fax/phone: 011 (506) 695-5598

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ALLOMORPHOSIS OF THE LOGGERHEAD TURTLE, CARETTA CARETTA

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Allomorphosis (non-ontogenetic allometry) of the loggerhead turtle, Caretta caretta was studied on the basis of measurements of 175 turtles, whose straight carapace lengths ranged from 38.4 mm to 835 mm. These turtles were classified into four size classes: hatchlings (38.4 mm to 58.4 mm in SCL); juveniles (60.3 mm to 149 mm); subadults (152 mm to 265 mm); adults (475 mm to 960 mm). Nineteen meristic characters representing overall body shape were measured. The straight carapace length and the head length were taken as the reference dimensions, to which 11 and eight characters, respectively, were regressed. Of the total 75 significant regressions, 39 were found isomorphic ($a=1$ in $Y=bX^a$), 30 bradymorphic ($a<1$), six tachymorphic ($a>1$). Patterns of allomorphosis among four size classes were significantly different in most of the characters examined. On the other hand, as is well-known, habitats of sea turtles are shifted in accordance with their growth. Thus, changes in growth pattern are expected to be related to ecological, ethological, and physiological (e.g., habitat, food, and reproduction) shifts of turtles.

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USE PROTECTION!, OR A CASE OF VIBRIO INFECTION FROM A SEA TURTLE

John A. Keinath

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Approximately 200 sea turtles strand annually in Virginia. The majority of the fresh carcasses are necropsied by members of the VIMS Sea Turtle Research Project to determine sex, sample gut contents, and to try to determine cause of death. On the morning of 24 May a fresh dead loggerhead was brought to VIMS. I, as usual, necropsied the animal without gloves, which I find cumbersome. Early the following morning (3 am) I awoke with a large (3 cm diameter) pustule on the right front index finger, accompanied by intense pain and swelling. In addition, a secondary infection of the lymph system was progressing toward the elbow. A physician initially prescribed Lincocin injection and Augmentin tablets, and amputation of the finger was discussed as a possibility. By 3 pm the pustule had become larger, and the lymph infection had progressed passed the elbow. The physician became very concerned, since this was now a life threatening situation. Because time was a major factor, there was no culture to determine the exact infective agent, it was determined that the primary infection was Vibrio, most likely Vibrio vulnificus, a virus ubiquitous in the marine environment. Seftin and Rocephin was administered for the next several days, along with Darvon for pain. The infection abated and the wound healed, however a fair (sic) amount of anxiety was involved! Although I have necropsied several hundred sea turtles without gloves, I will not do so in the future. Although infection from Vibrio vulnificus is rare, it infected individuals had a death rate in Virginia of 7 - 22%! (Schmidt and Hoyt, 1985).
PLEASE USE PROTECTION!

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PRELIMINARY ASSESSMENT OF COMPETITION FOR PREY BETWEEN LEATHERBACK TURTLES AND OCEAN SUNFISH IN NORTHEAST SHELF WATERS

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Leatherback sea turtles are regular, albeit relatively rare, inhabitants of continental shelf waters off the northeast U.S., with a regional population estimated at several hundred individuals (Shoop and Kenney, 1992). Their peak occurrence in the Northeast region, in late summer when water temperatures are at their peak, coincides with the seasonal occurrence of their principal prey, jellyfish and other gelatinous organisms. Recovery of critically endangered leatherback populations can obviously be retarded or prevented by direct impacts such as incidental take in commercial fisheries, egg poaching, or loss of nesting habitat. However, recovery can also be slowed by more indirect impacts, including competition for prey resources. Other predators which similarly specialize on gelatinous organisms are not particularly common, however one species which may be a significant competitor for this resource is the ocean sunfish. I conducted a preliminary assessment of the potential for an effect of prey competition on leatherbacks by looking at the distribution and abundance of ocean sunfish in northeast shelf waters, based on data from aerial surveys for marine mammals and turtles.

METHODS

Estimates of abundance of ocean sunfish in shelf waters in the region from Cape Hatteras to the Gulf of Maine were computed using line-transect methods from dedicated aerial surveys conducted during the Cetacean and Turtle Assessment Program from 1979 to 1981 (CETAP, 1982). Since sunfish were not a target species of the CETAP study, the right-angle distance data necessary to derive sighting probability functions were not collected. The probability functions derived for loggerhead turtles were used as a substitute, since loggerheads and sunfish are about the same size, provide similar sighting cues, and occur in similar areas and seasons. Seasonal estimates for each of four regions of the northeast shelf - Gulf of Maine, Georges Bank, Southern New England, and Mid-Atlantic Bight - were computed by combining all aerial survey lines conducted over the three-year study in that region/season as replicate samples. Seasonal maps of distributions of ocean sunfish were also plotted including all available sighting data.

RESULTS

Between 1974 and 1992, there were 1,834 sightings of ocean sunfish off the northeast U.S., with almost 94% of the sightings coming from the CETAP surveys in 1979-1981. The sighting records include some data from shipboard surveys, however the large majority of sunfish sightings were made from aerial surveys. Sightings were most common during the warmest months of the year, with 90% of all sightings between May and September. The peak monthly sighting frequency was in August, with 27.3% of all sightings.

Ocean sunfish are very abundant in the region (Table 1). Peak abundance was in the spring on Georges Bank and in the summer in the Gulf of Maine. The Southern New England and Mid-Atlantic Bight regions each had roughly equivalent sunfish abundances in spring and summer. The total ocean sunfish population off the northeast United States was estimated to be as high as 12,000 individuals during the spring season, and 18,000 during the summer.

Table 1. Seasonal estimates of abundance (95% confidence intervals) of ocean sunfish in four regions off the northeast United States, 1979-1981. GOM=Gulf of Maine; GBK=Georges Bank; SNE=Southern New England; MAB=Mid-Atlantic Bight.

Region	Winter	Spring	Summer	Fall
GOM	0	0-274	3,067-11,313	518-2,835
GBK	0	1,928-6,771	422-1,851	284-1,436
SNE	0	1,140-2,906	1,369-3,530	0-501
MAB	0-128	721-2,219	712-1,742	140-421
All	0-128	3,739-12,170	5,570-18,436	869-5,193

The geographic distributions of sightings show spatial and temporal patterns similar to that seen in the abundance data (Fig. 1). Sightings were rare in the winter, and largely confined to the southernmost portions of the study area. In the spring, the number of sightings increased dramatically, with sightings over much of the study area from North Carolina to Georges Bank, and scattered sightings in the Gulf of Maine. The number of sightings increased still further during the summer, with sunfish occurring everywhere in the study area except near North Carolina. Fall sightings were much reduced in number, and occurred throughout the area.

DISCUSSION

Ocean sunfish are extremely common off the northeast U.S. The abundance estimates presented here indicate a population perhaps 20 times that of leatherback sea turtles. In addition, the temporal occurrence patterns of sunfish and leatherbacks are nearly identical, with a peak in late summer (Shoop and Kenney, 1992). The potential for a competitive effect on leatherback recovery is certainly there, although there are many gaps in our knowledge of both species which need to be filled before any more definitive conclusions can be reached. Data requirements include information (for both species) on metabolic rates, feeding rates, and prey preferences, as well as good data on availability of various gelatinous prey.

Existing information on growth and fecundity, though sparse, suggests that ocean sunfish have the potential to increase at extremely rapid rates given the proper conditions. Studies of captive animals indicate that sunfish can attain body weights of over 100 kg by the age of two years (Sommer et al., 1989). One moderate-sized female sunfish was found to contain 300,000,000 eggs (Hart, 1973). This would suggest that sunfish are much more capable than sea turtles of expanding into a vacated niche and quickly increasing in abundance in the absence of competition.

As with the sea turtles, estimates of abundance of ocean sunfish account only for individuals at or very near the surface at the moment the survey aircraft passes overhead, and so are acknowledged to be underestimates. Sunfish have no requirement to surface to breathe, unlike turtles or cetaceans, so this problem becomes even more difficult to assess. It is very likely that the vertical movement of sunfish in the water column is a complex function of season, location, temperature, sunlight, prey distribution, and other factors. Very limited data from the Pacific suggested a correction factor of approximately 10X for basking sharks (Owen, 1984), but we apparently have no data at all available to make such an estimate for sunfish.

I have purposely avoided using a scientific name for the sunfish species in question. During our surveys, we generally presumed that we were sighting the common ocean sunfish (*Mola mola*). However, two other sunfish species also occur in the North Atlantic - the sharp-tailed sunfish (*Masturus lanceolatus*) and the elongate sunfish (*Ranzania laevis*) (Nelson, 1994). *Ranzania* has a very different shape and is much smaller (< 80 cm), and likely would have been recognized as something different. However, *Mola* and *Masturus* are of similar size and shape, and both are known from stranding records on the northeast coast (J.G. Mead, Smithsonian Inst., pers. comm.). The few individuals where we have managed to get clear photographs or video have been *Mola mola*, however without firm evidence, I can not conclude that the information presented here represents only that single species.

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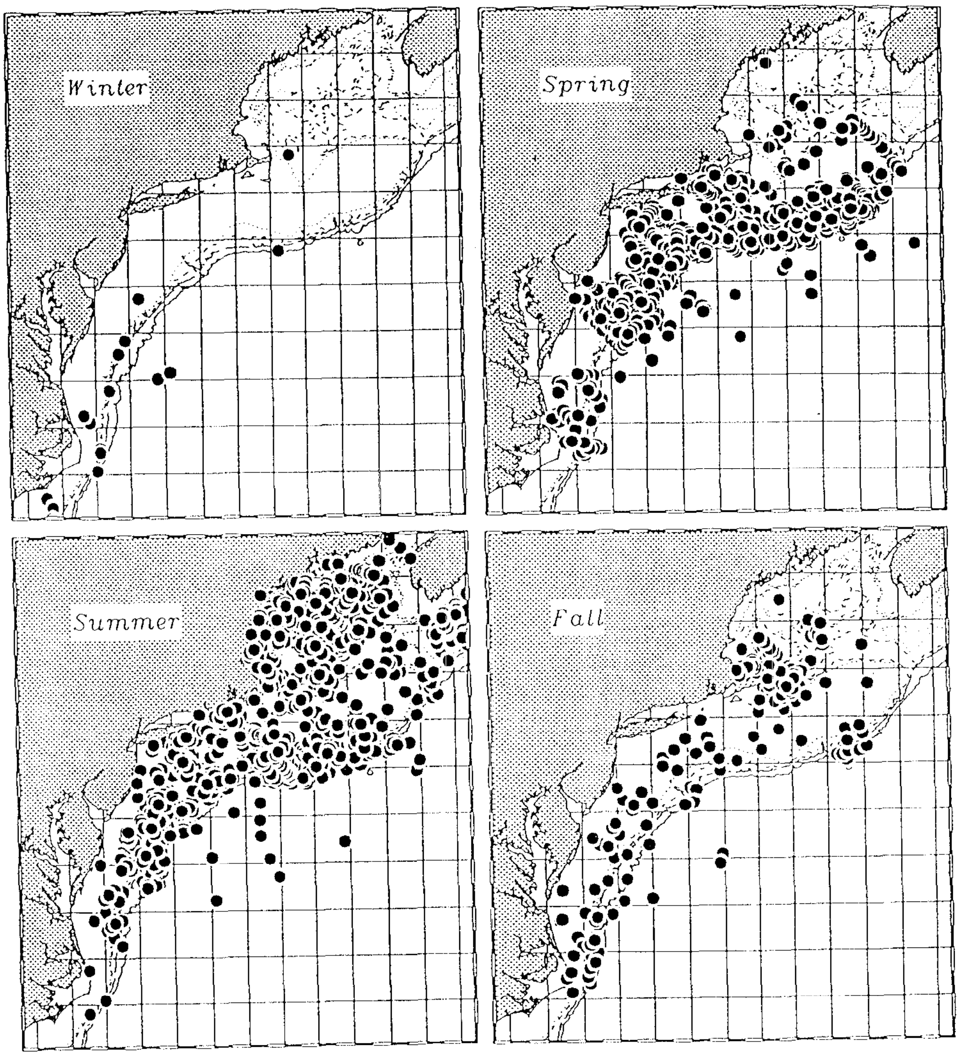

Figure 1. Seasonal distributions of sightings of ocean sunfish (Molidae) off the northeastern United States, 1974 - 1992. The latitude/longitude grid lines are at one degree intervals. The isobaths shown are at 100, 200, 1000, and 2000 meters.

SEX RATIOS OF GREEN TURTLES STRANDED IN THE HAWAIIAN ISLANDS

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BACKGROUND

All sea turtles exhibit temperature-dependent sex determination during egg incubation. Knowledge of natural sex ratios is therefore essential for formulating conservation strategies and understanding evolutionary processes (Magnuson et al. 1990, Mrosovsky 1994). Determining the sex of dead sea turtles salvaged after stranding provides a valuable means to estimate sex ratios in the wild. This method is particularly useful as it gives insight into a broad range of size classes representing many years of reproductive output for a given population. The sex ratio of immature Hawaiian green turtles, Chelonia mydas, has previously been estimated using a serum androgen sexing technique (Wibbels et al. 1993). Sixty-three healthy animals were sampled alive from coastal foraging pastures in this study and no significant variation from a 1:1 sex ratio was found.

Nearly all nesting by green turtles in the Hawaiian Islands occurs at the remote islets of French Frigate Shoals located at 24°N, 166°W (Balazs 1976, 1980, 1983). Incubation temperatures have thus far not been studied at this somewhat northerly site for green turtle reproduction. However, based on known air and seawater temperatures, and the near absence of vegetative shading on the nesting beaches, there is no reason to suspect excessively cool or warm nest conditions that could consistently bias hatchling sex ratios.

The present study is based on 421 stranded turtles that were salvaged and necropsied during 1984-94. The incidence of strandings in the Hawaiian Islands increased considerably over this 11-year period. For example, during 1984-86 an average of 54 cases occurred each year, while in 1992-94 the annual average was 200 (see also Balazs 1991). Factors thought to be responsible for this increase include the affliction of many turtles with an enigmatic tumorous disease known as fibropapillomatosis (Herbst 1994), and an overall increase in the number of turtles residing in coastal benthic habitats, especially juveniles and subadults. The latter phenomenon is believed to reflect the population's positive response to 16 years of protection under the U.S. Endangered Species Act (Balazs et al. 1994a, 1994b; Wetherall and Balazs, submitted). Necropsies to determine the sex of both non-tumored and tumored turtles in this study provide the first known opportunity to see if a sex bias exists relative to fibropapillomatosis.

METHODS

Turtles found dead throughout the Hawaiian Islands were salvaged and transported to the Southwest Fisheries Science Center's Honolulu Laboratory where they were stored in freezers until necropsy. During 1984-94, 1,387 cases of stranded green turtles were documented, 421 of which were necropsied and the sex determined by visual inspection of the gonads, as described by Rainey (1981). Only turtles that showed clear differentiation of ovaries or testes were included in this sample.

The 421 turtles originated from the islands of Oahu (80.8%), Maui (8.6%), Kauai (5.2%), Hawaii (3.5%), and Lanai/Molokai (1.9%). These percentages are generally proportional to the human population of each island. Consequently, there is a far greater probability of a stranded turtle on Oahu being found and reported. In addition, there is a concomitant level of adverse human impacts to turtles in the nearshore waters of each island (e.g., gill netting, vessel traffic) that can cause stranding.

RESULTS AND DISCUSSION

Of the 421 turtles, 226 were females and 195 males. The resulting sex ratio of 1.16F:1.00M was not significantly different from 1:1 (replicated goodness of fit test, $P > 0.05$). Assigning the 421 turtles into seven 10 cm size classes (30-90 cm) on the basis of straight carapace length also resulted in unbiased sex ratios ($P > 0.05$), except for turtles 90.0-99.9 cm (Fig. 1). This size class of mature adults had a significantly female-biased sex ratio of 6.00F:1.00M ($P < 0.01$).

Unbiased sex ratios have also been found in studies of green turtles in the Masirah Channel, Indian Ocean (Ross 1984) and in the Southern Bahamas (Bolten et al. 1992). However, female-biased sex ratios in green turtle populations have been reported in east central Florida (Schroeder and Owens 1994) and at Moreton Bay in Queensland, Australia (Limpus et al. 1994).

For statistical purposes, the 421 turtles were partitioned into non-tumored (49.2%) and tumored (50.8%), and each group was divided into seven 10 cm size classes (Fig. 2 & 3). The non-tumored group had an unbiased sex ratio of 1.01F:1.00M (replicated goodness of fit test, $P > 0.05$). None of the size classes in the non-tumored group were significantly different from a 1:1 sex ratio ($P > 0.05$). In contrast, the group of tumored turtles exhibited a sex ratio of 1.32F:1.00M that was significantly female biased (replicated goodness of fit test, $P < 0.05$). However, when size classes were analyzed, only turtles 90.0-99.9 cm showed a significant ($P < 0.05$) female bias (7.00F:1.00M). A significant female biased sex ratio among tumored turtles (1.26F:1.00M), and an unbiased ratio in non-tumored turtles (0.97F:1.00M), also existed when the statistical analysis was conducted deleting all turtles in the 90.0-99.9 cm size class. No explanation can be offered for the apparent female bias of turtles with fibropapillomatosis. However, this new finding needs to be further investigated in view of the importance of the disease to affected populations, such as in the Hawaiian Islands.

The reason for the significant female bias in the largest (and presumably oldest) turtles is unknown. The total numbers involved are small, i.e., 12F and 2M or 3.3% of 421 turtles sampled. One possible explanation for the bias could involve the documented taking of adult males and females for commercial and other purposes while the migrant turtles were basking ashore at French Frigate Shoals (Balazs 1980). This exploitation at the breeding grounds was stopped during the early 1960's, when stricter enforcement of the area's wildlife refuge status came into effect. Some (and possibly many) males are known to migrate to breed at French Frigate Shoals on an annual basis, while the females only breed every two or more years (Balazs 1983). Consequently, greater impact may have resulted to the male population from the killing of basking adults at this location during consecutive years. Intensive commercial hunting of all size classes of green turtles in Hawaiian waters (excluding French Frigate Shoals >1960) continued until being legally banned just 21 years ago in 1974. It is therefore possible that a depletion of large slow-to-mature males happening decades ago may still be evident today, as the population continues to recover.

It is interesting to note that there were only two turtles (both males) in the 30.0-39.9 cm size class of tumored turtles. In contrast, in the non-tumored group there were 56 turtles (28F & 28M) in this same size class (Fig. 2 & 3). These data support the hypothesis that the smallest green turtles (30-39.9 cm) recruiting to Hawaiian coastal foraging areas from pelagic habitats apparently arrive free of fibropapillomatosis (Aguirre et al. 1994, Balazs 1991). The agent, or triggering mechanism, responsible for the disease is therefore most likely found in coastal waters where the turtles establish residency and grow to maturity over several decades.

CONCLUSIONS

Two bodies of data, one based on serum androgen sexing (N=63) and the other from necropsies of stranded turtles (N=421), have demonstrated an unbiased sex ratio of 1:1 for Hawaiian green turtles in coastal waters. Among the various size classes examined, only turtles 90.0-99.9 cm differed significantly in favor of females. Non-tumored turtles had an unbiased sex ratio, while tumored turtles were significantly female biased. The unbiased sex ratio of turtles without tumors, and the female biased sex ratio of turtles with tumors, existed even when turtles in the 90.0-99.9 cm size class were excluded from the statistical analysis. The exact nature of this apparent female sex bias needs to be determined in relation to the etiology, mode of transmission, and susceptibility of Hawaiian green turtles to fibropapillomatosis.

ACKNOWLEDGMENTS

The following individuals and organizations are acknowledged for their valuable contributions to this work: A. Aguirre, B. Choy, M. Coelho, J. Coney, W. Dudley, D. Ellis, R. Forsythe, W. Gilmartin, L. Greenhouse, L. Hallacher, S. Hau, D. Heacock, P. Hendricks, S. Kaiser, L. Katahira, R. Miya, A. Morita, R. Morris, R. Nishimoto, W. Puleloa, M. Rice, B. Tamaye, G. Watson, T. Wibbels, Hawaii Institute of Marine Biology, Hawaii Preparatory Academy, Makai Animal Clinic, Marine Option Program of the University of Hawaii, Sea Life Park Hawaii, State of Hawaii Department of Land and Natural Resources, U.S. Fish and Wildlife Service, and the Waikiki Aquarium. We also thank J. Kendig, J. Guyant, D. Yamaguchi, and F. Fiust for editorial assistance in the preparation of this paper.

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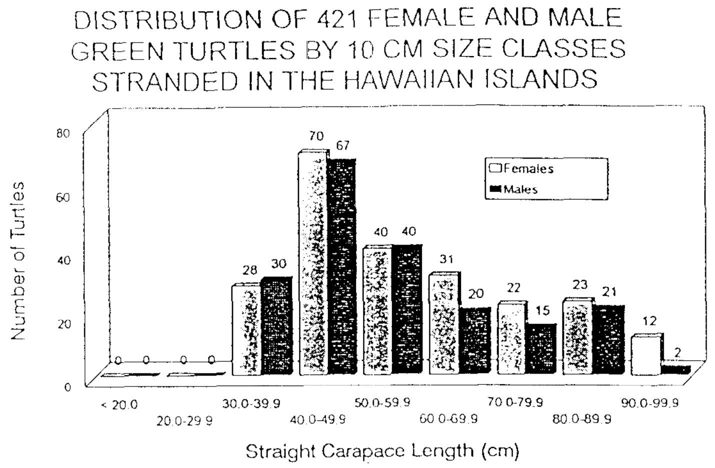
DISTRIBUTION OF 421 FEMALE AND MALE
GREEN TURTLES BY 10 CM SIZE CLASSES
STRANDED IN THE HAWAIIAN ISLANDS

Figure 1. The 226 female and 195 male green turtles had an unbiased sex ratio of 1.16F:1.00M (P > 0.05).

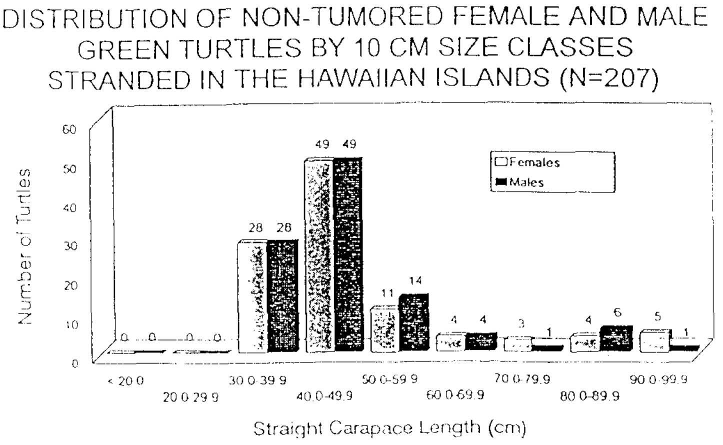
DISTRIBUTION OF NON-TUMORED FEMALE AND MALE
GREEN TURTLES BY 10 CM SIZE CLASSES
STRANDED IN THE HAWAIIAN ISLANDS (N=207)

Figure 2. The 104 female and 103 male non-tumored green turtles had an unbiased sex ratio of 1.01F:1.00M (P > 0.05).

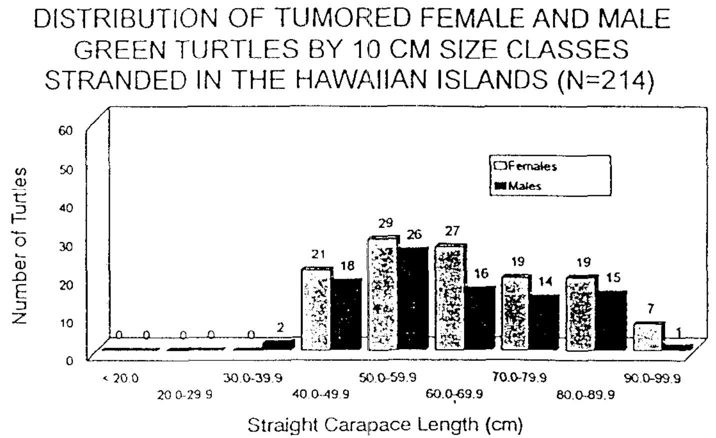

Figure 3. The 122 female and 92 male tumored green turtles had a female biased sex ratio of 1.32F:1.00M ($P < 0.05$).

NEWS FROM THE BAYOUS—LOUISIANA SEA TURTLE STRANDING AND SALVAGE NETWORK

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In 1992 the Aquarium of the Americas, a non-profit public aquarium which opened in the fall of 1990, took over the administration and coordination of the Louisiana Sea Turtle Stranding and Salvage Network (LA-STSSN) from the Louisiana Universities Marine Consortium (LUMCON), Cocodrie, LA. Currently, the Aquarium of the Americas serves to clarify stranding information and acts as a conduit for stranding information.

METHODS

Reports of sea turtle strandings were received in accordance with National Marine Fisheries Service (NMFS)/National STSSN guidelines. The NMFS-Galveston and Creole, LA. office, and the Louisiana Department of Wildlife and Fisheries-Grand Terre and Lafayette laboratories were major contributors to the network. Reports were also obtained from universities and the general public. STSSN reports from 1990 through 1994 were examined for trends in the data.

RESULTS

For the five years examined, 373 sea turtles were registered with the LA-STSSN. Of these, 268 (71.8 %) were Kemp's ridley sea turtles, 45 (12.1%) Loggerhead, 10 (2.7%) Greens, 8 (2.1%) Leatherbacks, 1 (.3%) Hawksbills and 41 (11%) unidentified (figure 1).

Of the nine parishes that have direct access to the Gulf of Mexico, all but two reported strandings (St. Mary's and Vermillion parishes). Three parishes reported 93.3 % of all strandings for the years examined. Cameron Parish, located at the west end of the state reported 222 strandings (59.5 %), Jefferson and Lafourche parishes, located towards the eastern half of the state tallied 95 strandings (25.5%) and 31 strandings (8.3%) respectively (figure 2).

The greatest number of sea turtle strandings reported to the LA-STSSN was in 1994 when 178 reports were recorded. The previous high for turtle strandings was 94 animals in 1993. During the previous three years, strandings ranged from 31 to 39 turtles. Sea turtle strandings occurred in each month during the period examined with 83.9 % of the strandings reported between May and September (figure 3).

The greatest number of strandings during several consecutive days occurred from May 28 to June 4, 1993. During this Memorial Day Weekend, 52 Kemp's ridleys washed ashore on Grand Isle in Jefferson Parish. In addition to these registered turtles, another 20-30 turtles may have been bulldozed and buried by the city of Grand Isle on May 26, 1993 in order to re-establish a clean beach.

Straight carapace length (SCL) of the Kemp's ridleys (n=163) ranged from 11.0 to 66.5 cm. Approximately 53.3 % were within the 20-30 cm SCL interval. No carapace measurements were made on 105 strandings (39.2%).

DISCUSSION

The state of Louisiana has over 7,000 miles of shoreline that is affected by tidal fluctuations. The majority of the irregular tidal shore is generally located on the southeastern edge of the state, while the western coastline consists of mudflats, marsh and several sandy stretches. Less than 2 % of this coastline consists of accesssible beach. This geograhic feature (foot accessible beaches) likely contributes to the frequency of stranding reports in Cameron, Jefferson and Lafourche parishes as well as the infrequency of stranding reports from other parishes. The number of reports may represent a lesser proportion of animals actually stranded.

When each year was examined independently, there were considerable periods when no strandings were reported. It is unclear whether surveys were undertaken during these times or if no turtles were encountered during a survey. In any case, procedures should be modified to clarify which situation actually occurred. The seasonal trend is not fully explained based on the information available in the data. The lack of information concerning fishery activity, beach survey effort, necropsy findings and environmental conditions considerably weaken any conclusions as to the reason for these strandings.

In light of the bulldozing that occurred at Grand Isle in 1993, a public awareness campaign concerning the STSSN should be directed towards the coastal communities. Local agencies must also be made aware of the need to respond appropriately to a sea turtle stranding. We will be recruiting Volunteer Naturalists to assist in scheduled beach surveys this year.

ACKNOWLEDGEMENTS

The author wishes to thank the NMFS-Galveston for assistance in responding to strandings in Louisiana, the Louisiana Department of Wildlife and Fisheries Field Biologists who survey the coastline and the Audubon Institute for encouraging involvement in the STSSN.

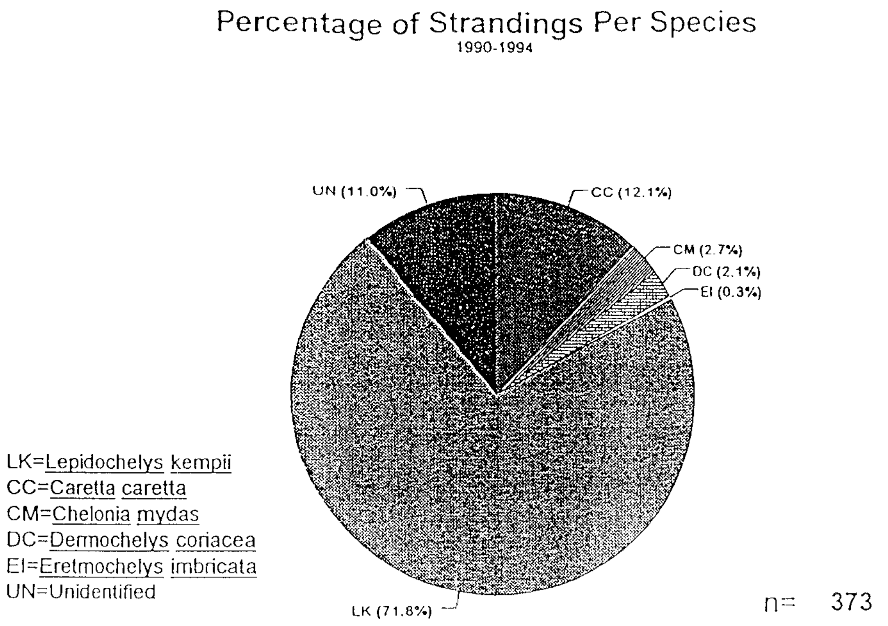


Figure 1. Percentage of Sea Turtle Strandings by Species for 1990-1994.

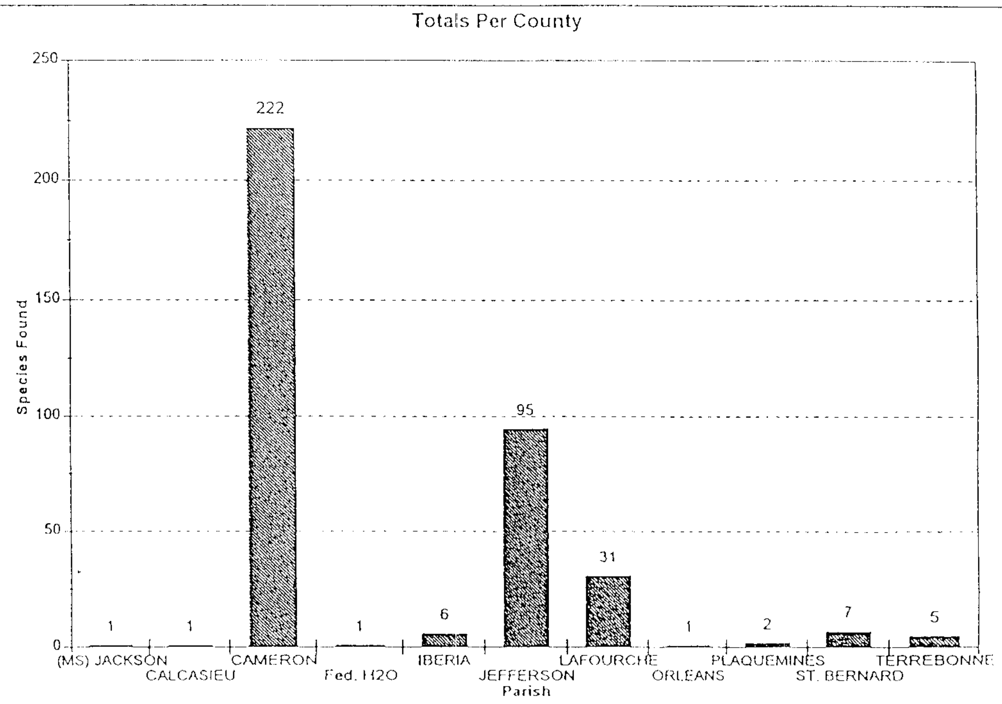


Figure 2. Number of Sea Turtle Strandings by Parishes for 1990-1994.

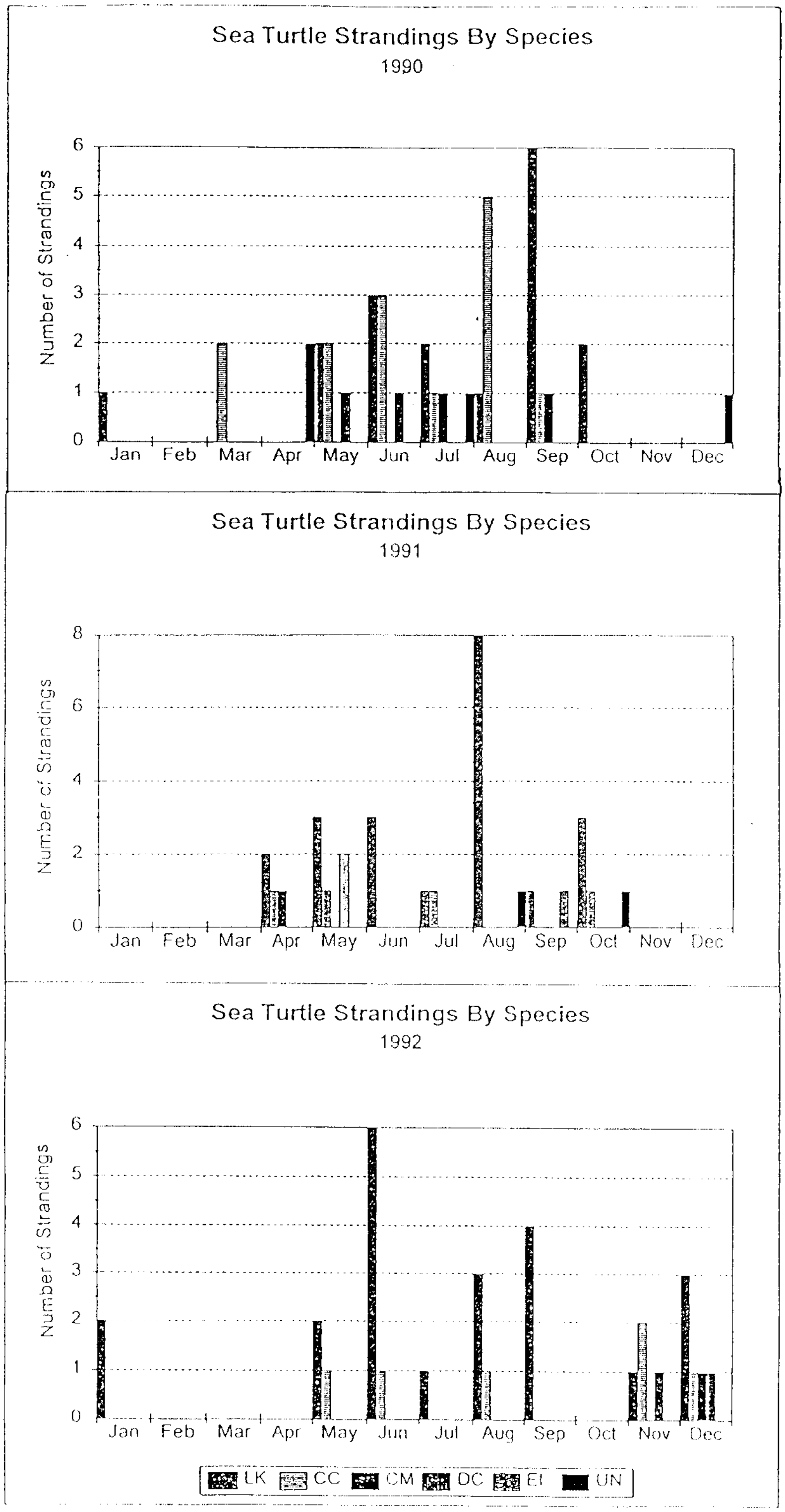
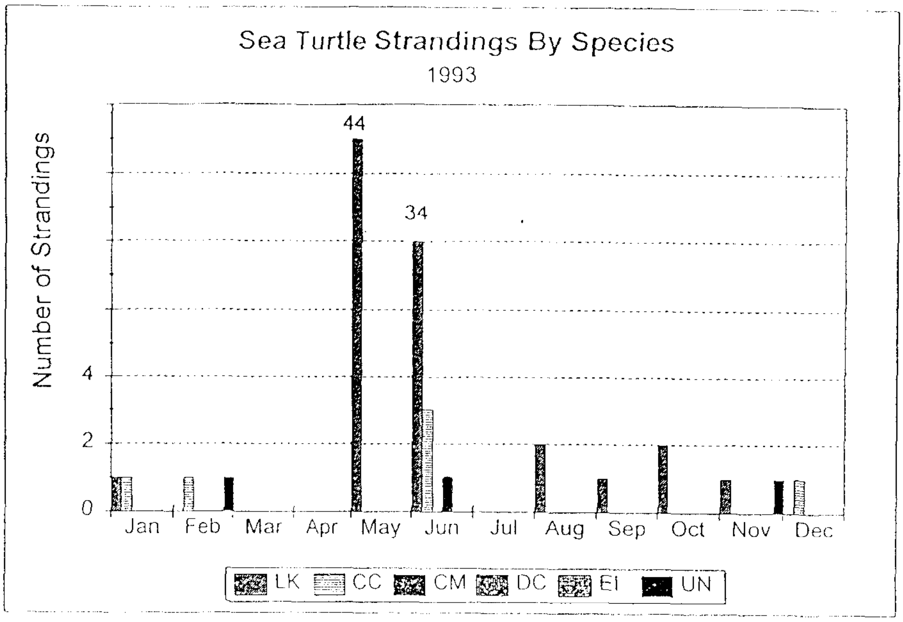


Figure 3 Monthly Number of Sea Turtle Strandings for the years 1990-1994



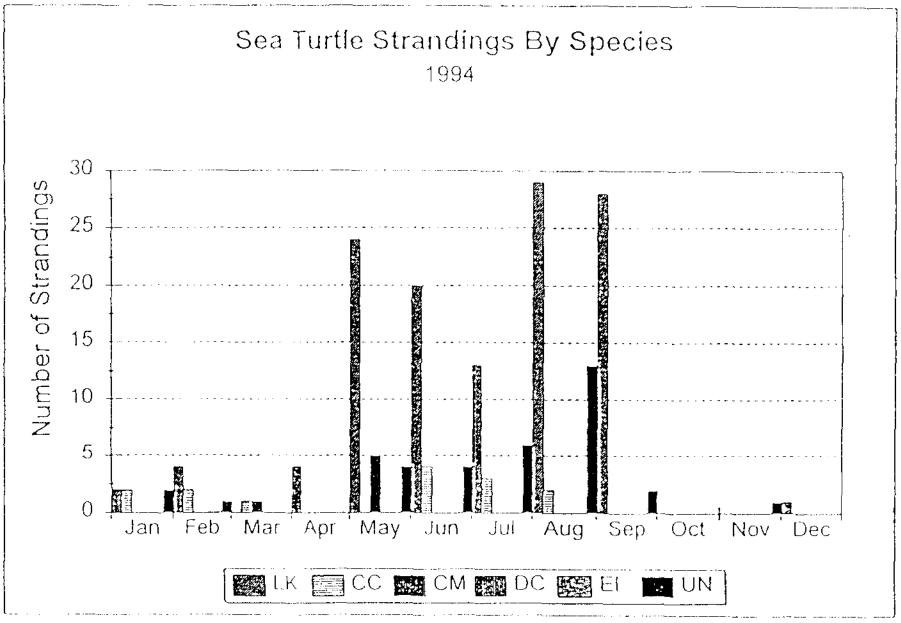


Figure 3 (continued) Monthly Number of Sea Turtle Strandings for the Years 1990-1994.

FROM THE BEACH TO THE CLASSROOM: AN ENVIRONMENTAL EDUCATIONAL PROGRAM IN GREECE

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INTRODUCTION

Compared to other European countries, Greece has an incredible variety of flora, fauna and geomorphology. This diversity is contained within a small area, which also houses some of Europe's last wilderness. Our civilization is strictly connected with this nature. The ideas of "human duty" and "justice", as described in the ancient greek drama, have their source in the natural laws and should dominate again the relationship between Man and Nature.

The Sea Turtle Protection Society of Greece (STPS) has been carrying out research work on sea turtles for more than 12 years. All this knowledge would have been sterile had we not tried to convey it to other people and especially to children. We believe that, conservationists' most important tool in promoting nature protection is public awareness, and its most promising investment is environmental education.

We started the environmental education program in 1985, after consulting specia-lists in pedagogy and child psychology (Kremezi-Margaritouli, 1992). The participants are all volunteers that have worked on sea turtle field projects. The environmental education program has evolved greatly since then and each year improvements and expansions are made. The aim is to try and help young people to live in harmony with nature, using it as a source of experience, pleasure and happiness.

STIMULATION

Stimulation is the summary of material, knowledge and persons to perform an environmental education activity.

Stimulation consists of the following:

- Our detailed knowledge about sea turtles. The fact that our efforts focus only on sea turtles makes our force stronger because it is concentrated on a single target.
- Charismatic researchers are selected to conduct environmental education activities.
- High-quality audiovisual material, combined well with few simple and specific comments for each picture.

After some years of work and having faced a big demand from schools, which we couldn't handle, we created in 1990 the "Turtle Briefcase". This is a portable educational display aimed at 4 different age groups with instructions for the teacher. The "Turtle Briefcase" contains 8 different items and was the first portable environmental education program in Greece. School administrations can borrow it, perform the presentation and return it to the Society free of any charges.

APPROACH

Approach is the way we use the stimulation in order to raise awareness among pupils. The approach we follow consists of:

- Formal co-operation with the Ministry of Education, which is the competent authority to inform schools about our program.

- Friendly behavior from us to pupils and educators, based on the idea of equality.

- Presentations at schools, both "live" and through the "Turtle Briefcase". Presentations follow standard rules which have been set after research, consultation and experience. For example, for 11 to 15 year old pupils, a presentation is divided into:

a) Organized kinetic games to get to know each other and create a friendly atmosphere for better communication (approx. 10 min).

b) A slide show on the functions of nâture, and another one or video on sea turtle biology and conservation efforts (about 30 min).

c) Questions, opinions, discussion (15-20 min).

d) Offering STPS publications to the school communities and calling for further communication and contact in order to establish various follow-up activities.

e) Optional painting of a poster or other art work (approx. 45 min).

- Exhibitions of children's art work. Two exhibitions have been organized by us, entitled "A Picture is 1,000 Words".

- A 4-day environmental and cultural excursion in Attica is offered every year to pupils and teachers from the island of Zakynthos. Zakynthos hosts the most condensed sea turtle nesting area in the Mediterranean, but also faces a strong negative reaction against turtle conservation from a portion of its inhabitants.

- A permanent exhibition is under construction at the Sea Turtle Rescue Center

at Glyfada, near Athens. The exhibition is housed in a train wagon and is being prepared by STPS volunteers. A small wooden amphitheater facing the sea for open air activities will be also constructed.

RESULTS

The results so far have been as follows:

- Nearly 1,500 presentations, either "live" or through the "Turtle Briefcase", have been conducted at schools throughout Greece. The total number of pupils that have attended the presentations is estimated at 100,000.

- Caretta caretta is the most widely known endangered animal in Greece and is used as a symbol for wild nature conservation. It is mentioned quite often in media, reviews and even cartoons.

- The attitude of the teachers has changed enormously since 1985. While the first presentations were met with some suspicion, now they are widely accepted and there is even a degree of admiration. There is a long waiting list for schools wishing to visit the exhibition of the Sea Turtle Rescue Centre, which has not yet opened to the public.

- The "Turtle Briefcase" has been used as a model for similar briefcases on other subjets such as: recycling rubbish, protecting brown bears, etc.

- In order to expand the educational program beyond the sea turtle issue, the STPS has created another briefcase: "Life on the Coast". The creation of this briefcase was stimulated by the results of a 3 year project aimed at identifying new sea turtles rookeries in Greece. This project provided the opportunity to collect a great deal of material on the Greek coasts. The experience acquired from the "Turtle Briefcase" has also been taken into account.

EPILOGUE

- The majority of people do not destroy nature in purpose, but because they are not properly informed. They think that their interests lie far from nature.
- We try to make children understand that sheer exploitation is the lowest level of relationship between Man and Nature.

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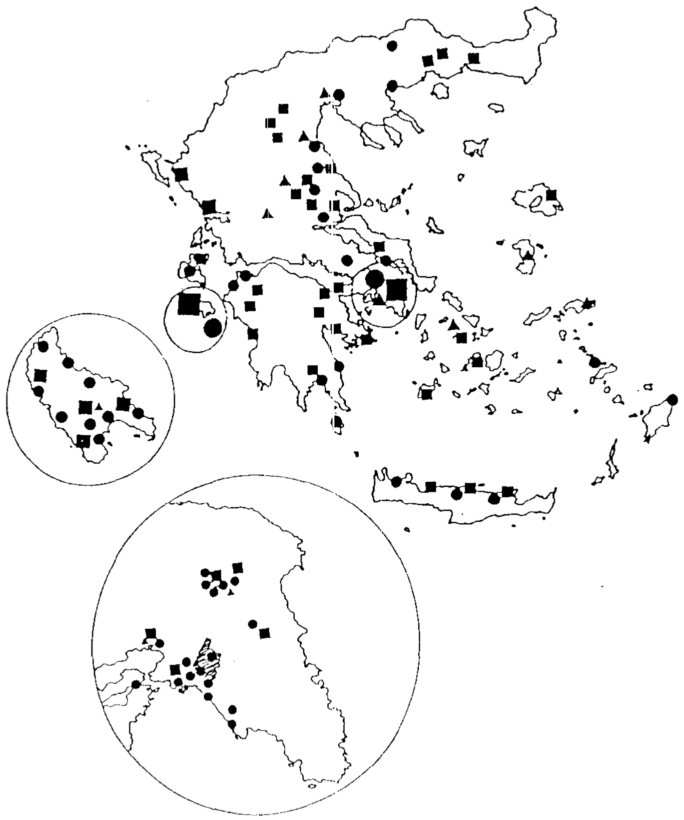

● Live presentations

■ Presentations with the "Turtle Briefcase"

▲ Presentations with the briefcase "Life on the Coast"

A METHOD FOR DETERMINING HEARING THRESHOLDS IN MARINE TURTLES.

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A behavioral audiogram for only one species of reptile, the red-ear turtle Chrysemys scripts elegans (Patterson, 1966). Previous attempts to obtained auditory behavioral responses involved observing motor responses as head or leg movements after sound presentation (Poliakov, 1930; Chernomordikov, 1958; Karimova, 1958) but the results were essentially negative or unreliable until Patterson (1966) succeeded in establishing head withdrawal to sound. The essential element in Patterson's conditioning was the pairing of the simultaneous presentation of sound pressure in air and vibration with electric shock. We have never observed head or flipper movement in loggerheads exposed to airborne sound pressure alone, but vibration delivered to the shell did induce rapid swimming underwater (Lenhardt, et al., 1983). Encouraged by our (M.L.; S.M.; J.M.) preliminary observations that loggerheads will startle to near field sound (effectively waterborne vibration), one of us (M.L.) carried out an exploratory psychophysical study to determine the threshold of bulk water displacement induced by sound in two species of marine turtle.

METHODS

One juvenile Atlantic Loggerhead (Caretta caretta) and one juvenile Kemps Ridley (Lepidochelys kempii) were placed in individual 50 gallon tanks. Turtles were stimulated with a 430 Hz tone that was delivered by a specially constructed speaker system. Sound pressure generated by the speaker acted on a water filed bladder, which in turn oscillated at the driving frequency. The water coupled speaker system was placed against the tank such that waterborne vibration within the speaker bladder passed with little transmission loss into the turtle tank. Bulk displacement of the water was measured by an accelerometer at the speaker tank interface. Turtles were tested early in the morning at which time they were always resting on the tank bottom. The sound was increased in intensity until arousal was noted. Two additional trials were carried out each day (six days of testing) only if the turtle returned and continued to rest on the bottom motionless for at least ten minutes. The acoustic startle threshold was determined by noting the lowest intensity (dB re: 1 micron) in a trial and averaging across total trials. Additional frequency thresholds have been determined by this method but not reported in this communication.

RESULTS AND DISCUSSION

The acoustic startle response consisted of two components. The first was a ballistic head contraction and rapid flipper activation. The second was a graded head displacement with or without any flipper movement. The first was always observed in initial presentation of sound energy and the latter was typically observed after initial exposure. The startle reflex was a repeatable and stable response in each animal. The behavioral threshold for each turtle is depicted in the Figure. These data are in good agreement with the cochlear microphonics recorded in three Green marine turtles (Chelonia mydas) by Ridgway et al., (1969) and auditory brainstem evoked potential recorded in our laboratory. The similarity in physiological threshold between species is striking even in light of the recording differences (intracochlea vs. skin over the ear) and mode of stimulation (air pressure in the case of microphonics and click vibration in the case of the evoked responses). It is expected that the behavioral thresholds are higher than the physiological ones, and the level of separation between the two provide external validation for the use of the acoustic startle in assessing hearing thresholds. Recall the testing is performed in small tanks so the stimulus to the turtle is bulk movement of water not sound pressure. The physical parameter we report is vibratory displacement. From our observations it appears that the two species studied maintain some air in the middle ear in the shallow (about 1 meter) tanks. Generalizing to nature we might expect turtles to maintain some air behind the eardrum when in shallow water. If so the middle ear air bubble could serve as a sound pressure to displacement transformer allowing turtles to detect sound beyond the near field.

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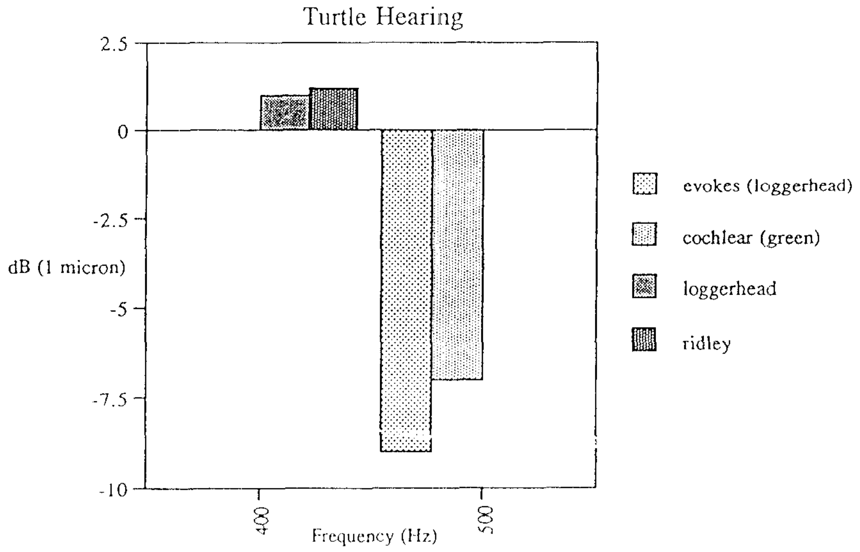

Behavioral thresholds for loggerhead and ridley turtles (430 Hz) is depicted as well as cochlear microphonic threshold (500 Hz) for pacific Green and auditory evoked potential threshold threshold for loggerhead. Note the behavioral thresholds are about 9 dB higher than the physiological thresholds.

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SEA TURTLE NESTING AND MANAGEMENT IN NORTHWEST FLORIDA

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INTRODUCTION AND STUDY AREA

The beaches of Northwest Florida (NWFL) support nesting populations of loggerhead (Caretta caretta), green (Chelonia mydas), and occasionally, leatherback (Dermochelys coriacea) sea turtles. These beaches are important in maintaining the historical nesting distribution of sea turtles. The higher latitude beaches of NWFL may contribute a significant number of male hatchlings to Gulf of Mexico (GOM) sea turtle populations.

Sea turtle nesting activity is monitored on 280 km of beach in Franklin, Gulf, Bay, Walton, Okaloosa, Santa Rosa, and Escambia Counties in NWFL (Figure 1). Increasing interest in sea turtles is resulting in expansion of the coverage area. New areas in Walton County will be monitored in 1995.

NESTING

Historical data on sea turtle nesting prior to the advent of the Gulf shrimp industry is lacking. The first aerial nesting surveys of NWFL were conducted in 1976-77 (Carr and Carr 1977). Three surveys in 1976 and five in 1977 reported maximum activity to be 45 tracks on 19 June 1976. Peak activity occurred in Franklin and Gulf Counties.

Nesting has been surveyed daily by Tyndall AFB (TAFB) on Crooked Island since 1984 (Figure 2). Data indicate an increasing trend in activity. St. Vincent Island (SVI) has monitored nesting since 1968, with an average of 20.9 nests/year from 1969-76. Nesting decreased from 1977-91, with an average of 5.2 nests/year and only two years with 10 or more nests. In 1992-94, nesting has increased to an average of 29.3 nests/year.

The loggerhead is the most common species nesting in the area. In 1994, 727 loggerhead nests were reported in the study area, with 78% (565) of the nests occurring in Franklin and Gulf Counties (Figure 1). Peak nesting density (11 nests/km) occurred in Gulf County.

Green turtles appear to be establishing a trend of consistent, periodic, nesting in NWFL, with 21 nests in 1994. Most nesting is concentrated in Okaloosa County, on Eglin AFB (EAFB) (Figure 3). This is one of the northernmost green turtle nesting beaches in the United States.

Leatherbacks occasionally nest in NWFL. LeBuff (1990) reports a leatherback nest in 1974, on SVI, in Franklin County. In 1993, one nest and one false crawl were recorded in Gulf County, at St. Joseph Peninsula State Park.

The 1994 nesting season was adversely affected by tropical storms in both July and August and a tropical depression in early October. Mean hatching success was 47% (223 nests evaluated) for loggerhead and 58% (17 nests evaluated) for green turtles. On SVI, 20 of 36 nests were totally destroyed by storms before hatching. As described in LeBuff (1990), the age of embryo death was estimated in seven nests from SVI. Six of the nests revealed mortality coincidental with a major storm event. In 14 nests evaluated on SVI, only 20% of the eggs hatched.

THREATS

Sea turtles in NWFL face many of the same threats that occur elsewhere. In June, most of the area beaches were fouled by tar balls which persisted throughout the nesting season. National Marine Fisheries Service (NMFS) and USFWS (1991) report spills in the vicinity of nesting beaches are of special concern and could place nesting adults, incubating egg clutches, and hatchlings at significant risk. No direct negative effects were observed, but nesting females did become involved in the tar. Although tar was transferred to body pits by females, no tar was observed on eggs.

Beachfront lighting is a growing threat because of increasing coastal development. To date, no communities in NWFL have adopted lighting ordinances to protect sea turtles. Beach driving, permitted in Walton and Gulf Counties, poses significant threats to nesting and hatching sea turtles. As population levels continue to rise, these threats will increase.

Coyotes have expanded their range into NWFL and have become a major nest predator in undeveloped areas of Gulf County. Other significant nest predators include raccoons and feral hogs.

GOM sea turtle populations have experienced serious declines due to incidental capture in shrimp trawls. Turtle Excluder Devices (TEDs) have reduced this threat. In November 1994, Florida voters passed a net ban, which should take effect in July 1995. This should help minimize threats from net fisheries in coastal waters within three miles of shore in the GOM.

RESEARCH, MANAGEMENT, AND FUTURE NEEDS

In 1992-93, effects of predator control on sea turtle nest success were examined on the islands in Apalachicola Bay (Lewis et al 1994). Nest success was higher in areas where predator control was implemented and area managers plan to increase control efforts.

In 1993, sand temperatures at 30 and 60 cm below the surface were measured at two sites on Panama City Beach (PCB) and two sites on TAFB in Bay County (Watson 1994). The depths correspond to typical upper and lower portions of loggerhead nests on these beaches. Daily mean sand temperature was estimated from maximum and minimum temperatures over a 24-hour period. Estimated means ranged from 25 to 30° C (Figure 4 and 5), suggesting a male-biased sex ratio. Significant numbers of male hatchlings may be contributed to the GOM from NWFL beaches.

The USFWS has funded a lighting demonstration project to monitor the effect of shielding lights at a multi-family, beachfront development in Bay County. TAFB has also proposed a lighting study. At EAFB, beachfront exterior lighting conversion is underway.

The future of sea turtle nesting in NWFL looks promising, but several issues must be addressed to further protect sea turtles. Ordinances regarding beach driving and exterior lighting must be created and enforced. More effective predator control measures are needed in many areas. Studies of hatchling sex ratios should be conducted to assess the degree of male-bias on NWFL beaches.

The authors wish to thank everyone who participated in nesting beach surveys or assisted with review and completion of the manuscript. The names are too numerous to list.

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Figure 1 - Map of Northwest Florida Showing Loggerhead (CC) and Green (CM) Nesting in 1994.

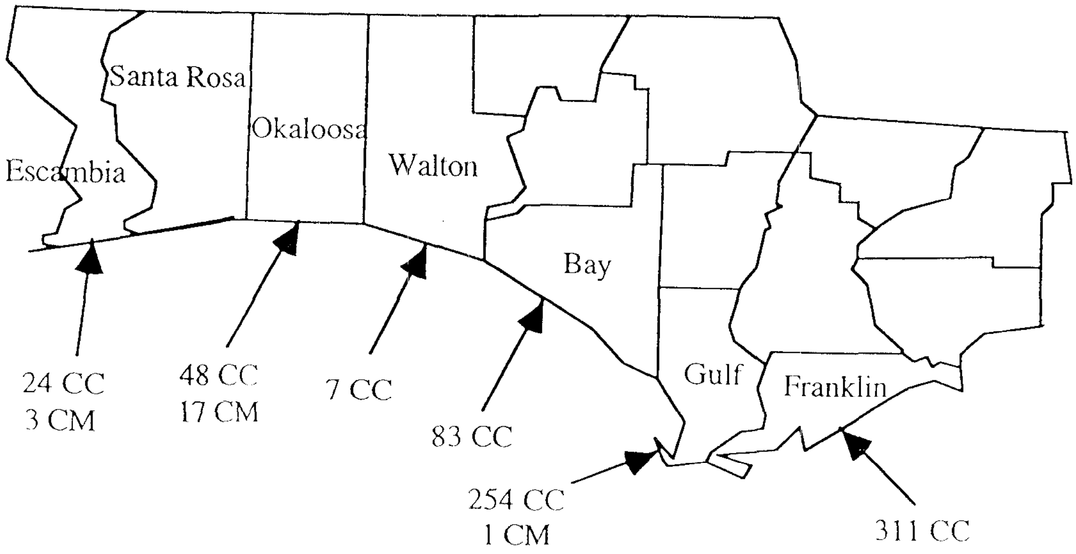


Table 1 - Summary of 1994 Loggerhead (CC) and Green (CM) Nesting in Northwest Florida (SRA - State Recreation Area, AFB - Air Force Base, NWR - National Wildlife Refuge).

County	Beach Name	Management	Length (km)	CC Nests	CM Nests
Escambia & Santa Rosa	Gulf Islands National Seashore	National Park Service	37 (1)	21	3
	Perdido Key	Florida Park Service	10 (2)	3	0
Okaloosa & Santa Rosa	Eglin AFB	US Air Force	27 (1)	32	16
Okaloosa	County Beach	Local government	12 (2)	14	0
	Henderson Beach SRA	Florida Park Service	2 (2)	2	1
Walton	County Beach	Local government	2 (2)	0	0
	Grayton Beach SRA	Florida Park Service	4 (2)	7	0
Bay	Panama City Beach	Local government	29 (1)	21	0
	St. Andrews SRA	Florida Park Service	9 (2)	15	0
	Tyndall AFB	US Air Force	24 (1)	40	0
	Mexico Beach	Private	8 (2)	7	0
Gulf	St. Joe State Park	Florida Park Service	14 (2)	86	0
	Cape San Blas	US Air Force	5 (1)	53	0
	County Beach	Private	27 (2)	115	1
Franklin	St. George Island State Park	Florida Park Service	14 (2)	104	0
	St. George, Cape St. George, Dog Islands	State government	42 (2)	171	0
	St. Vincent NWR	US Fish & Wildlife	14 (1)	36	0
	TOTAL		280	727	21

Notes: (1) Measured beach length, (2) Estimated beach length.

Figure 2 - Loggerhead Nesting at Tyndall AFB, Florida, 1984-94.

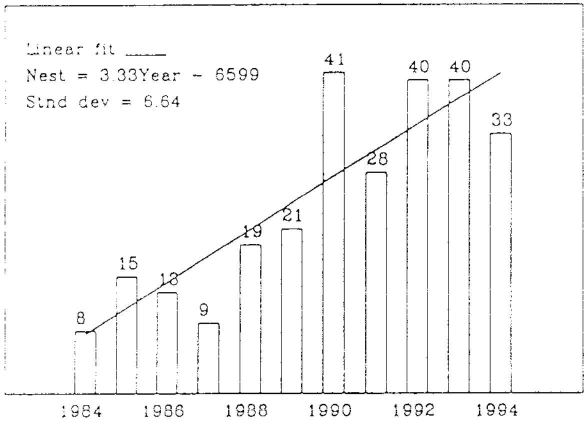


Figure 3 - Green Nesting at Eglin AFB, Florida, 1987-94.

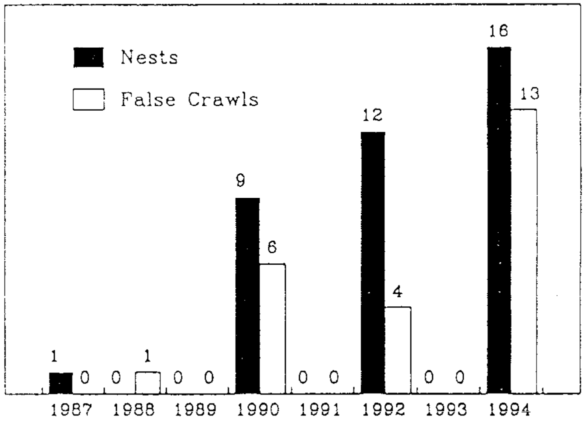


Figure 4 - Measured Sand Temperatures at 30-cm Depth at Panama City Beach and Tyndall AFB.

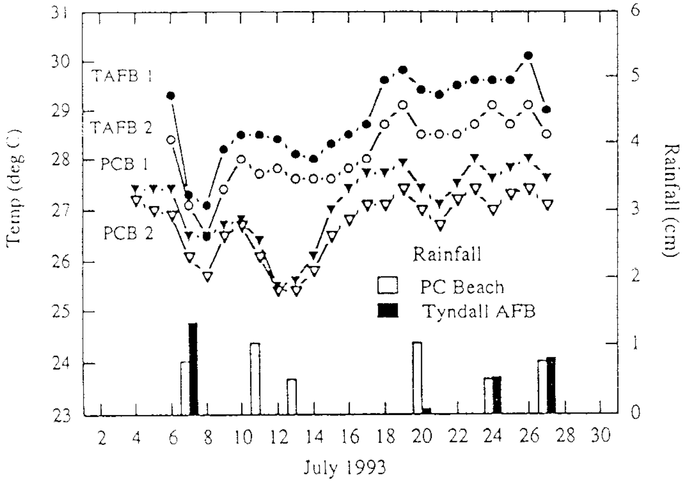
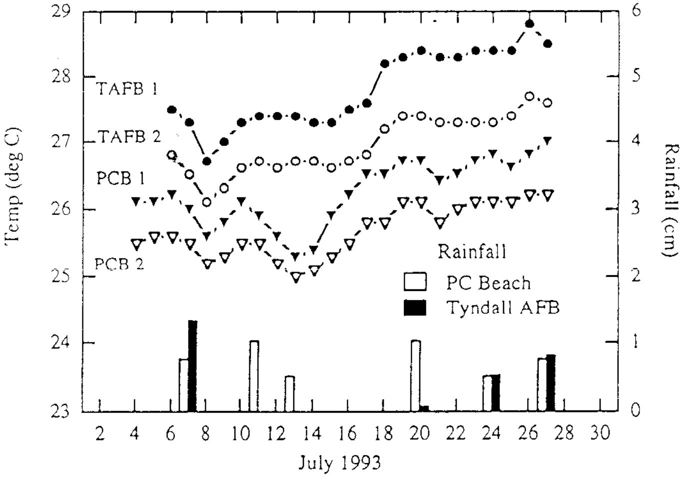


Figure 5 - Measured Sand Temperatures at 60-cm Depth at Panama City Beach and Tyndall AFB.



CHANGING FECUNDITY WITH AGE IN QUEENSLAND *Caretta caretta*.

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The long term tagging study of *Caretta caretta* at Mon Repos and adjacent beaches on the Bundaberg coast in southeastern Queensland continues to shed new insights into the demography of these long lived animals. This presentation examines some of the impacts that changes in the number of eggs per clutch, number of clutches per season and remigration interval with respect to age have on annual fecundity of individuals and ultimately the population.

METHODS

A total tagging census of nesting marine turtles, principally *C. caretta*, at Mon Repos and the five other small beaches on the 22km of rocky coast between the Burnett and Elliott Rivers in south eastern Queensland commenced in December 1968 (Limpus, 1985) and continues to the present time. Tagging : initially these turtles were single tagged but, because of high rates of tag loss, from 1978 onwards all turtles have departed the rookery wearing a minimum of two tags; prior to 1982 all tags were standard monel turtle tags and in 1982 the tag design was changed to titanium turtle tags (Limpus, 1992). Also commencing in 1982, a sample of the annual nesting population has had their gonads visually examined using laparoscopy to determine if the female had ovulated in a previous breeding season (the presence of healed corpora lutea indicates that breeding has occurred in a previous season).

Since 1982, using the combined results of tag recoveries, identification of tag scars and gonadal examination, it has been possible to classify an untagged nesting female arriving at the rookery as breeding for her first ever season with greater than 98% probability. These females with a known commencement of their breeding life have been assigned to breeding "age" classes as follows:

breeding "age" class 1 = female in her 1st breeding season, breeding "age" class 2 = female in her 2nd breeding season, breeding "age" class 3 = female in her 3rd breeding season.

Size (midline curved carapace length, cm), remigration interval (years) and total number of clutches laid in the breeding season also have been recorded for these turtles. For most of these females, the eggs of one or more clutches in each season were counted within two hours of oviposition.

RESULTS

Table 1 summarizes the results obtained during the 1993-1994 breeding season. This particular season occurs at a time equal to the sum of the first three remigration intervals (~11yr) for the known breeding "age" females, i.e. equivalent to the first three breeding cycles for these females.

These data indicate that as the females progress through their first three breeding seasons, there was a significant increase in their size between the first and second seasons but not between the second and third seasons. There were significant increases in the number of clutches laid per season as the females progress from first to second to third breeding seasons. The number of eggs per clutch increases slightly from the first to second breeding seasons but there is no further significant change with the third season.

Females in their second and third breeding seasons increased their seasonal egg production 1.50 and 1.63 times, respectively, relative to the egg production of females in their first breeding season.

Remigration interval progressively shortened across the first three breeding cycles. When egg production is averaged across the years between successive breeding seasons, annual egg production during the second and third remigration cycles is increased by 2.04 and 3.23 times, respectively, relative to annual egg production during the first remigration cycle.

Comparable results have been obtained during the other breeding seasons that this study has been in progress.

CONCLUSION

There are major increases in egg production with age as the eastern Australian *C. caretta* mature from being new recruits to the breeding population to being remigrants in their second and third breeding seasons. Most of these increases in egg production are the result of shortening the interval between breeding seasons and increasing the number of clutches laid per season. Increases in the number of eggs per clutch make little contribution to these changes in annual egg production.

Seasonal egg production for a rookery will be a function of the proportions of new recruits and remigrants of various year classes in the population. These proportions may in turn be a function of incidental mortality within the population at distant feeding sites.

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Table 1. Summary of the size of the adult female *Caretta caretta* and their egg production by breeding "age" class for the 1993-1994 breeding season at Mon Repos and adjacent rookeries in south eastern Queensland, Australia.

A. BREEDING "AGE" CLASS : 1st

	Mean	SD	Min	Max	n
CCL (cm)	94.6	4.06	85.3	106.5	68
clutches per season	2.64	1.10	1	5	64
eggs per clutch	123.36	21.40	73	170	61

Mean egg production per season = 325.7

	Mean	SD	Min	Max	n
1st remigration interval (yr)	4.96	2.16	2	10	23

Mean annual egg production = 65.66

B. BREEDING "AGE" CLASS : 2nd

	Mean	SD	Min	Max	n
CCL (cm)	96.8	2.86	92.0	105.0	24
clutches per season	3.82	0.91	2	6	22
eggs per clutch	130.14	17.78	89	154	22

Mean egg production per season = 492.78

2nd remigration interval (yr)	3.67	1.65	2	7	21

Mean annual egg production = 134.27

C. BREEDING "AGE" CLASS : 3rd

	Mean	SD	Min	Max	n
CCL (cm)	96.5	3.89	90.5	105.0	21
clutches per season	4.11	1.10	2	6	19
eggs per clutch	129.0	17.31	88	156	26

Mean egg production per season = 530.19

3rd remigration interval (yr)	2.5	0.5	2	3	6

Mean annual egg production = 212.08

MYTHS, REALITY AND LIMITATIONS OF GREEN TURTLE CENSUS DATA

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MYTH

Those of us who have been conducting long term census studies of green turtle, Chelonia mydas, populations no longer accept that the status of the population can be judged with any precision from the results of even a decade or so of census data at the nesting beaches.

For example, there has been an annual tagging census of the green turtle nesting population at Heron Island, southern Great Barrier Reef, Queensland, Australia, for 20 years (Figure 1). While these data suggest that there has been a doubling of the size of the average nesting population over these two decades, such an increase in population is not supported by observations in the associated feeding areas. At best, the population is not increasing; at worst, it could be decreasing.

REALITY

Green turtle nesting populations are characterised by:

-highly variable census counts in successive breeding seasons (Figure 1. See also Carr et al., 1978; Nacu et al., 1994).

-very synchronous fluctuations in annual breeding numbers in adjacent colonies within one genetic stock (Figure 2. See also Chin, 1975).

-some synchrony in annual fluctuations in breeding numbers among adjacent stocks (Figure 3).

The size of the annual nesting population is a function of:

-climatic variability. El Nino Southern Oscillation (ENSO) accounts for 76% of annual variability in eastern Australian green turtle nesting numbers (Limpus and Nicholls, 1994).

-reproductive physiology. Less than 1% of adult female green turtles breed in successive breeding seasons (Limpus et al., 1994) because, at most feeding sites, an adult female takes in excess of one year to develop the necessary fat reserves and prepare the large yolky ovarian follicles for a breeding season.

The size of the annual nesting population of green turtles is not a measure of the number of adult females in the total feeding area population but is a measure of the proportion of the adult females in the population that prepares for breeding in that season (Limpus and Nicholls, 1994; Limpus and Reed, 1985a,b. Figure 4). It appears that under some climatic conditions, large numbers of the females may have very long remigration intervals, up to 10 years or more. It should be noted that reliable quantification of long interval remigration intervals is only possible with a tagging system that has very low probability of tag loss.

LIMITATIONS

Many decades of annual census data are required before the stability of a green turtle population can be reliably defined with census data from nesting beaches.

A better indication of population stability will be derived from a combination of:

-annual nesting census and

-measurement of the proportion of adult females preparing to breed at representative feeding areas.

This is not intended to discourage the gathering of long term census data for green turtle nesting populations. Rather, conservation managers are urged to maintain ongoing rigorous monitoring of their nesting populations while expanding studies of their turtles in their distant feeding areas to quantify breeding rates from these feeding areas (Limpus and Reed, 1985a,b. See also Limpus, Couper and Read, 1994 for a comparable study on Caretta caretta).

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Figure 1. Annual number of female green turtles nesting at Heron Island determined by a tagging census.

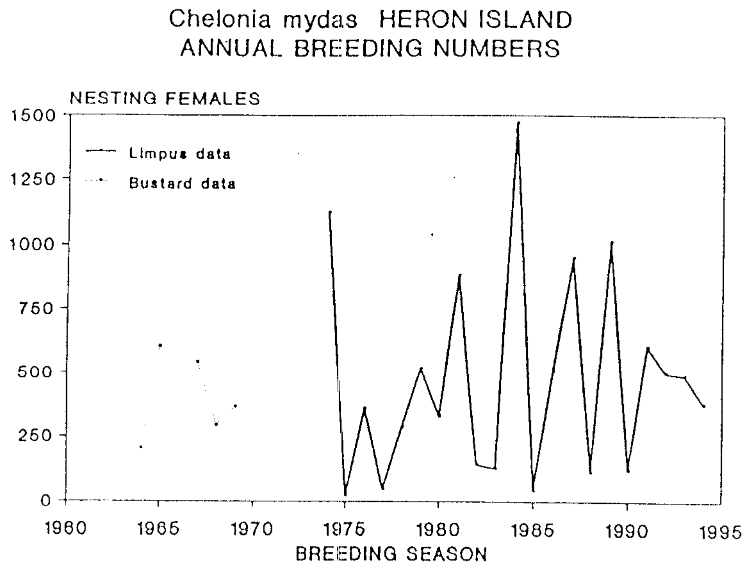

Figure 1

Figure 2. Synchronous fluctuations in the size of the annual green turtle nesting population on each of five adjacent islands within the Capricorn Group, southern Great Barrier Reef genetic stock.

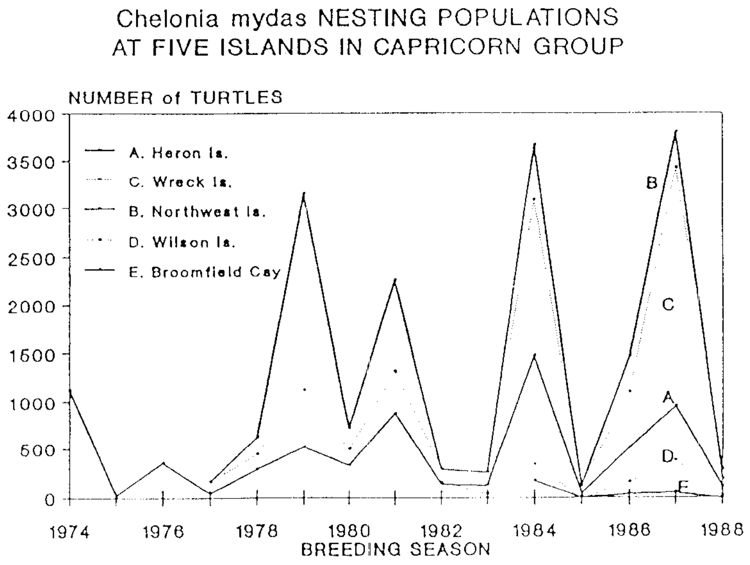

Figure 2

Figure 3. Approximately synchronous fluctuations in size of the annual green turtle nesting populations at widely separated rookeries in southeast Asia (Nacu et al., 1994). With these data, egg production is used as an index of the size of the nesting population. These Malaysian and Philippines rookeries are now known to be of different genetic stocks (C. Moritz, personal communication).

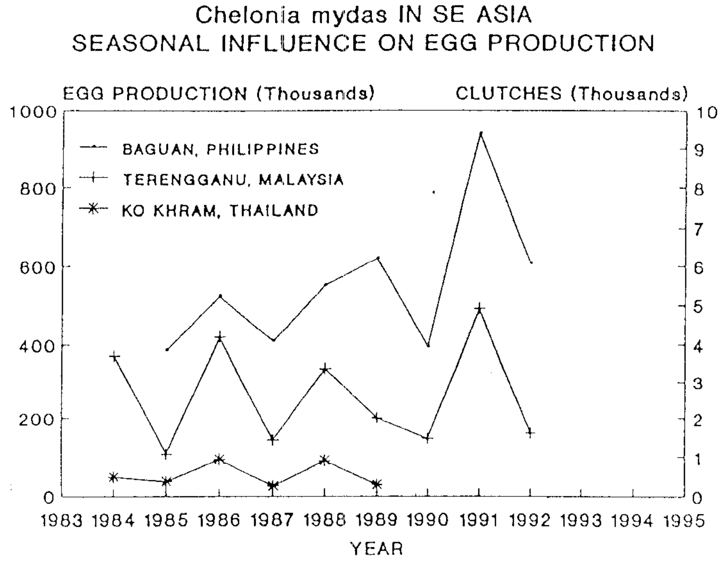

Figure 3

Figure 4. Correlation of the proportion of adult female green turtles recorded as preparing to breed from widely scattered feeding areas in northern and eastern Australia with the number of females recorded nesting at Heron Island in the southern Great Barrier Reef.

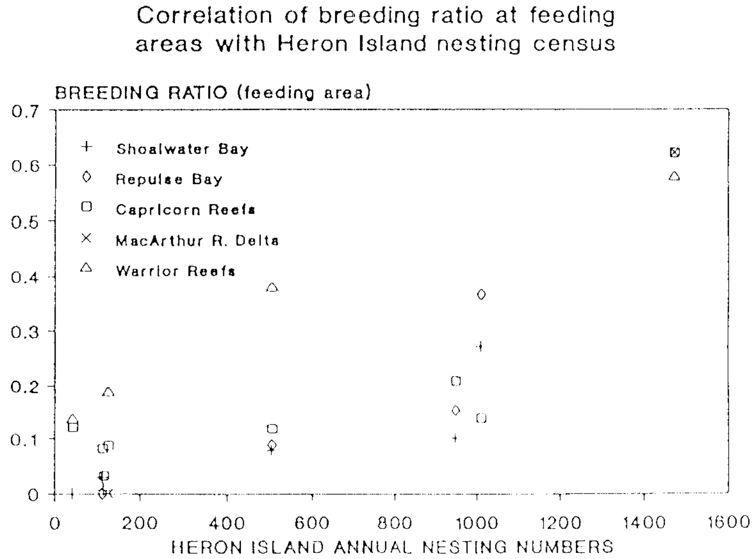

Figure 4

SEA TURTLE COMMERCIALIZATION ROUTES IN NUEVA ESPARTA STATE, VENEZUELA

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Although sea turtles are legally protected in Venezuela, they are under commercial and subsistence fishery pressure. Nueva Esparta State as been reported as one of the most important black markets of this species (Buitrago, 1980; Guada & Vernet, 1992). However there is not a real diagnosis of the problem magnitude. In consequence it was decided to determine the sea turtle commercialization routes in Nueva Esparta State. For that, four survey levels were established (fishermen, middlemen, restaurants and artisans).

The survey was sent to 102 fishermen from 20 fishing communities and showed these results: 1) all the 5 sea turtle species reported from Venezuela (Márquez, 1990) are captured by Margaritan fishermen, 2) 91.87% of the fishermen said that they captured sea turtles at least once, 3) 27.45% captured sea turtles less than a year before this study 4) 79.41% of the fishermen said that Chelonia mydas is the principal species captured and they are captured alive. Nevertheless few turtles are released to the sea. Most of them are eaten or sold 6) Most of the fishermen (90.16%) know that sea turtles are protected.

Also we asked which parts of the turtles are used, what are these parts used for and what are the costs in the market.

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PLANNING YOUR NEXT MEAL: LEATHERBACK TRAVEL ROUTES AND OCEAN FRONTS.

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INTRODUCTION

Perhaps because so little is known about the travel routes that leatherbacks take, we are often surprised by their regular appearance in high latitudes. Equally intriguing is that the cosmopolitan, far-ranging leatherback seems to prefer a rather monotonous diet, subsisting mainly on gelatinous medusae, siphonophores, and salps (Pritchard, 1971). The purpose of this paper is to examine energetic relationships of the leatherback's "jellyfish" diet and how leatherbacks might select pelagic travel routes along ocean frontal systems that enhance their chances of finding food.

In choosing gelatinous prey, leatherbacks appear to be dietary specialists. Optimal foraging theory holds that the widespread availability of a resource may lead an animal to specialize on it (Dobzhansky, 1950). Use of this resource alone should then minimize search time. Leatherbacks as deep diving (Eckert et al., 1989), highly mobile animals (Pritchard, 1971) lack much in the way of latitudinal or water column limits. Yet in ranging far from their low-latitude nesting areas they seem to journey widely in search of hydrozoan prey.

Hydromedusae are about 95% sea water and energy poor. Small leatherbacks would have to consume gelatinous prey equal to their biomass per day in order to support a routine metabolic rate (Lutcavage and Lutz, 1986). Adults may need on the order of tens of kilograms. For example, a 1 kg jellyfish has an energy content of about 52 kcal. Assuming that a 342 kg adult has a routine metabolic rate of 1.09 ml O_2 $min^{-1}kg$-1 (Lutcavage et al., 1992), it would consume 537 Liters O_2/day (2,609 kcal/day) or the equivalent of 63 kg jellyfish. Reliance on a highly specialized, low-energy diet suggests that leatherbacks must habitually find large and dependable supplies of their planktonic gelatinous prey. These concentrations are found in coastal areas, along oceanic frontal systems, and along vertical gradients located at fronts (Olson et al., 1994).

There is building evidence that the leatherback's offshore travel routes intersect with pelagic longline and gillnet fishery locations. Anecdotal records, aerial surveys, and incidental take data from NMFS observer and logbook programs suggest a notable abundance of leatherback sightings offshore (Witzell, 1984; Gerrior, 1994). Many of these sightings occur at shelf break or at the edges of oceanic gyre systems such as the Gulf Stream's western boundary (Shoop and Kenney, 1992), and the Gulf of Mexico Loop Current (Fritts et al., 1983; Collard, 1990), areas of strong thermal, water color, or salinity differences. Distribution of leatherbacks along thermal fronts were noted in aerial overflights conducted from Cape Hatteras, NC to Key West, FL (Thompson, 1991; Shroeder and Thompson, 1987). The distribution and migration routes of whales and active pelagic fishes such as skipjack, bluefin, and swordfish are linked with frontal filament and ring systems spinning off the Gulf Stream and Kuroshio. Concentrations of prey and perhaps hydrodynamic advantage increase chances of successful forage and travel (Olson et al., 1994; Podesta et al., 1993).

OCEANOGRAPHIC FEATURES AND LEATHERBACK DISTRIBUTIONS

The southern sector of the Gulf Stream, reaching from the Florida Straits to Cape Hatteras, hugs the edge of the continental shelf and has a great deal of influence on the outer (40-60m) and mid (20-49 m) shelf region. At about 32°N, the Gulf Stream is deflected eastward by the topographic feature known as the "Charleston Bump", and returns to the shelf break near 33.5°N. The Gulf Stream's western edge undergoes disturbances that are sheared from the front and moved along the shelf break and slope region. These long stable waves grow and break backward, forming 20-200 km filaments surrounding cold pools of water (Pietrafesa et al., 1985).

Downstream of the Charleston Bump, the Gulf Stream is deflected eastward and has two preferred modes. In the onshore mode, the front follows the shelf break, and frontal eddies interact with inner shelf waters. The offshore mode shifts the Gulf Stream frontal boundary as much as 100 km seaward of shelf break. In this position increased biological productivity takes place across the outer and midshelf. Periodic upwelling of cold, nutrient-rich water impinge shoreward, entraining phytoplankton. These intrusions then stimulate growth and reproduction of zooplankton, attracting predaceous fishes and other consumers. Upwelling events take place with frequencies of 2-14 days. Leatherbacks travelling across the South Atlantic Bight would encounter bands of high productivity on a regular basis. Leatherbacks could also locate prey-rich intrusions through vertical migration - diving to layers where gelatinous forms have concentrated.

Leatherback turtles, well equipped for long distance oceanic travel, may utilize tactics of large pelagic vertebrates and follow migration routes along highly productive water masses. This would explain why leatherbacks, pelagic fishes and mammals converge on the same feeding grounds.

In a preliminary analysis to determine whether leatherback abundance coincided with Gulf Stream boundary conditions, monthly summaries of Gulf Stream position and sea surface temperatures for the years 1982-1993 were examined (Oceanographic Monthly Summary). When leatherbacks did not appear to be abundant on the coastal shrimp grounds (1982,1983,1984,1986) the Gulf Stream in April through June was in its eastern-shifted position. Multiple warm filament/cold core systems were present on or seaward of the shelf edge. In those years highly productive boundary fronts were probably located east of the inner shelf off Georgia and S. Carolina, keeping leatherbacks offshore.

In all but one of the years where peaks in abundance were noted (1987, 1989-1992), the western boundary was on or shoreward of the shelf edge. Persistent filament systems were absent or near shore. It is plausible that when these conditions occur, narrow thermal fronts are located closer and parallel to the coast, causing leatherbacks to move onto the shelf as they travel north from the Florida Straits.

An example of an apparent clumped distribution of leatherbacks that might be linked with Gulf Stream boundary events occurred in late February, 1988. On 22 Feb. Knowlton and Weigle (1989) counted 68 leatherbacks in an aerial survey between St. Augustine and Sebastion Inlet, FL. At that time a prominent warm filament system was present near 80°W, flanked by narrowly spaced isotherms running parallel to the coast.

CONCLUSIONS

Reliance on a highly specialized, low-energy diet suggests that leatherbacks must habitually find large and dependable supplies of their planktonic gelatinous prey. These concentrations are found not only in coastal areas, but along oceanic frontal systems, and within the watercolumn along vertical gradients located at fronts. Leatherbacks may seek associations with oceanic fronts, filaments, and meanders found along the western wall of the Gulf Stream, or Gulf of Mexico Loop currents. Retrospective analysis of Gulf Stream western boundary locations against incidental take and strandings data supports an association between leatherbacks and oceanic frontal systems. This suggests that remote sensing techniques may be used to forecast leatherback occurrence on pelagic or coastal fishing grounds. Satellite tracking offers the best hope of identifying leatherback migration routes offshore within the context of real time oceanographic conditions and pelagic fishery activities.

ACKNOWLEDGEMENTS

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SEA TURTLE ACTIVITY SURVEY ON ST. CROIX, U.S. VIRGIN ISLANDS (1992-1994)

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Three species of marine turtles nest on the beaches of the United States Virgin Islands (USVI): the green (Chelonia mydas), hawksbill (Eretmochelys imbricata), and leatherback (Dermochelys coriacea). Historically, these species have been important components in the culture and economy of the USVI. The slaughter of adults for their shell and/or meat and the consumption of eggs have been implicated in the sharp decline of sea turtle populations in the USVI (Eckert, 1989).

Until recently, existing information on sea turtle nesting in the USVI has been fragmented and, at times, inaccurate. Previously, all information concerning numbers of turtle nests per year was collected on an opportunistic basis. The scarcity of information on hawksbill and green turtle nesting was particularly pronounced. This lack of basic information is especially regrettable in light of the increase in large-scale coastal development which threatens critical nesting habitat. In 1992, preliminary survey work was initiated on St. Croix to begin to redress the lack of data on hawksbill and green turtle nesting. During the subsequent nesting seasons (1993-1994), funding from the Division of Fish and Wildlife, USVI Department of Natural Resources (DPNR) allowed for the development of a more comprehensive survey.

The preliminary survey work was conducted from 1 July to 31 December 1992. During this time, it was established which beaches supported sea turtle nesting. Coastal areas, which were later incorporated into the comprehensive survey, were judged as "possible nesting areas" during island-wide, on-site inspections. Interviews with officers from the USVI Bureau of Environmental Enforcement (BEE), long-time island residents, local fishermen, and hotel owners also helped to identify potentially important and active breeding sites for further study. The initial survey period was also used to develop survey and reporting methodology used during the subsequent nesting seasons.

METHODS

In 1993, thirty-one beaches were monitored for sea turtle activity. Regular foot patrol commenced 1 July and ended 31 December. Beaches were patrolled as often as possible, but the interval between patrols varied (range 3 - 14 days) depending on how active the area was with respect to both turtle activity and daily beach traffic which might obscure turtle crawls. Whenever possible, patrols took place during the early morning hours in order to document fresh crawls and avoid beach traffic. This was especially important during the weekend when traffic was heaviest. During patrol, all turtle activities were identified to (1) species and (2) outcome (nest, dry run, poached, depredated). Special note was taken of potential threats to nest success such as artificial lighting, nest compaction (from horses, foot traffic, and vehicles) and erosion.

During this past season (1994), additional funding from the U.S. Fish and Wildlife Service (USFWS) and National Park Service (NPS) and continued support from DPNR, allowed us to continue the daytime survey work and begin night monitoring on Sandy Point National Wildlife Refuge (SPNWR) and an area on St. Croix that we refer to as the East End. During the 1993 season, both of these areas showed levels of sea turtle nesting which were categorized as heavy nesting (greater than 30 nests) with respect to activity levels in the other survey areas. These beaches were monitored nightly whenever personnel were available. During this time, all nesting hawksbill and green sea turtles observed were tagged with both inconel and PIT tags.

RESULTS AND DISCUSSION

In order to simplify this poster presentation, we have characterized each of the survey beaches according to the number of recorded sea turtle nests (of any species) : 1) little or no nesting (0-10 nests) and 2) moderate nesting (10 - 30 nests) and 3) heavy nesting (greater than 30 nests). In 1993, thirty-one beaches were surveyed and the majority of these, 65% were characterized by little or no nesting. Only two beaches (6%), Sandy Point National Wildlife Refuge (Henry, 1993) and Jack's Bay, supported heavy nesting while the other nine beaches in the survey (29%) supported moderate nesting (Mackay, 1994). With only two beaches having concentrated levels of activity, hawksbill and green sea turtle nesting on St. Croix is diffuse in nature. As previously mentioned, these data prompted the initiation of a night monitoring program under the auspices of an interagency agreement between USFWS and NPS.

Results from the 1994 season are comparable to those from past seasons. Once again, most of the beaches (68%) were characterized by little or no nesting. Only six (19%) of the survey beaches showed moderate nesting, and the final four beaches (13%) were characterized by heavy nesting. The latter once again included SPNWR and Jack's Bay but appreciable levels of nesting activity were also recorded on the beaches closest to Jack's, Isaac's Bay and East End Bay. These three beaches are commonly referred to as the East End.

Night monitoring was initiated on SPNWR and Jack's Bay in an effort to quantify the nesting populations using these areas. However, early on in the season, logistical problems were encountered which hindered effective coverage via regular foot patrol on SPNWR. Nesting is much too diffuse within the Refuge to allow for the implementation of a monitoring project without a large number of research personnel and funds. Consequently, all monitoring activities were concentrated on Jack's Bay. Fortunately, the two adjacent beaches, Isaac's and East End Bay, could also be easily monitored. Nightly monitoring showed greater nesting concentrations on these three beaches than previously found from daytime surveys alone (See Data Table).

During the night monitoring program, we tagged fourteen hawksbill and eight green sea turtles on the East End of St. Croix. We observed a total of 22 hawksbill activities of which 10 resulted in the deposition of eggs. Twenty green sea turtle activities were also observed, ten of these being successful nesting attempts. Unfortunately, due to limited funding for research personnel, we were unable to carry out nightly monitoring in a consistent manner throughout the season. Thus, these numbers only represent a portion of the total population of turtles that used the East End during the 1994 season. Yet, increased daytime survey work in this area yielded an additional 70 hawksbill activities (26 dry runs and 44 nests [suspected and confirmed]) and another 84 green sea turtle activities (29 dry runs and 55 nests [suspected and confirmed]). However, daytime work is restrictive because only a raw number of sea turtle activities is recorded and individual turtles are not observed. Furthermore, the night monitoring program clearly showed that in past seasons, daytime survey work was not carried out often enough on the East End. We soon discovered that activities disappear much faster in this area than previously thought. Thus, we feel that during the initial survey period, our methods underestimated the number of activities on these beaches.

During past seasons, predation by mongoose (Herpestes auropunctatus) was recorded on both SPNWR and Jack's Bay. More than 50% of the hawksbill nests laid on Jack's Bay suffered from some form of mongoose predation (Mackay, 1994). In 1994, we began trapping and subsequently destroying this exotic species on Jack's Bay. For the duration of the season, predation was not observed. Poaching has also been a traditional threat to the sea turtle nests on the East End, and early in the season four hawksbill and two green sea turtle nests were poached. During the rest of the season, we camouflaged all activities and relocated five hawksbill and one green sea turtle nest. Poaching activity was observed in the area throughout the season but no more losses were recorded. Poaching was recorded on three other St. Croix beaches but mongoose predation appears to be limited to the East End and SPNWR.

Our data support that the East End of St. Croix is critical habitat for hawksbill and green sea turtles and, in response to this, we propose to continue monitoring this population. A saturation tagging project is essential if we are to do so in an effective manner.

Daytime survey work on the beaches of St. Croix needs to continue. Due to the increased nesting concentrations found on the East End after night monitoring began, efforts should also be made to monitor other beaches that have exhibited moderate nesting. This work will expand our knowledge of these beaches so that informed decisions about their future can be made by regulatory agencies.

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DATA TABLE

Records of green (*Chelonia mydas*) and hawksbill (*Eretmochelys imbricata*) sea turtles nesting on the East End of St. Croix, U.S. Virgin Islands (1992-1993 and 1994). Species abbreviations are C.m. and E. i., respectively. Activity categories are abbreviated in the following way: SN = suspected nest , CN = confirmed nest, DR = dry run (nesting did not occur).

		1992-1993			1994		
Beach	Species	SN	CN	DR	SN	CN	DR
Jack's Bay	E. i.	19	12	07	26	19	25
	C.m.	09	00	06	07	03	08
Isaac's Bay	E.i.	11	00	03	04	02	07
	C.m.	12	00	09	14	08	15
East End Bay	E.i.	< 5 activities			02	01	06
	C.m.	> 20 activities			23	06	20

CAPTURE AND TAG-AND-RELEASE OF JUVENILE TURTLES CAUGHT IN GILL NETS IN NEARSHORE HABITAT OF THE EASTERN GULF OF MEXICO DURING FISHERY-INDEPENDENT SHARK STUDIES

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INTRODUCTION

Immature Kemp's ridley (Lepidochelys kempii) and green turtles (Chelonia mydas) frequent the coastal waters near Cedar Key, Florida (Carr and Caldwell, 1956; NMFS & USFW, 1991; Schmid and Ogren, 1992; USFW & NMFS, 1992) and Florida Bay (Meylan, 1986; B. Witherington, FL DEP, St. Petersburg, pers. comm.), but little is known of the marine turtle populations utilizing the remainder of the west central coast of Florida. Information is lacking concerning the species composition, feeding grounds, size distribution or abundance of turtles in the nearshore and estuarine waters of this area.

In 1992, Mote Marine Laboratory's (MML) Center for Shark Research began fishery-independent surveys of shark nursery areas along the Gulf of Mexico in Florida state waters. Occasionally sea turtles were captured in the nets and released. Scientists with the Center for Shark Research and the MML Sea Turtle Conservation & Research Program recognized that by collecting data on the bycatch turtles, information concerning the populations utilizing central Florida's Gulf waters could be gathered. Thus, MML biologists began to document information and tag captured turtles prior to release.

METHODS

Sea turtles were captured incidentally in gill nets set to collect juvenile and small adult sharks in and near estuaries of the Gulf coast of south-central Florida (Figure 1) from 1993 to present. The primary net was a commercial pompano-type gill net, 9 ft deep, 400 yd long, 4⅝ in stretch mesh of #208 monofilament. A second net, an experimental sampling gill net, 9 ft deep, made up of 3 panels 200 yd long each, of 3, 4⅝, and 6 in stretch mesh of #208 monofilament was occasionally used. These nets were selective for small turtles, as larger turtles were seen in the area of the nets but never captured.

Nets were set for no more than one hour at all times of the day and night but the preponderance of effort was between daybreak and late afternoon. Nets were set in water with depths ranging from less than one foot to about 28 feet and weighted so that they would rest on the bottom. As the net was pulled in, each animal was removed, vertebrates were identified and measured, and all live sharks, game fish, and sea turtles were tagged and released. Therefore, the time required to remove the net from the water was dependent on the number of animals captured. The end time of the set was recorded as the time the last of the net was removed from the water.

Sea turtles were measured (straight line length and width), weighed if possible, double tagged (except for the first turtle tagged) with inconel non-corrosive metal tags supplied by NMFS, photographed, evaluated for condition and released. The one turtle which died was preserved on ice, transported to Mote Marine Laboratory, then turned over to the Florida DEP laboratory in St. Petersburg for necropsy. Additional data recorded included location (latitude and longitude), weather condition, wind, tide, sea condition, depth, bottom type, mid-water salinity and temperature, and gear type utilized.

For statistical comparisons between species, all data was tested for normality and equal variance and then compared using a t-test. A significance level of $P<0.05$ was required to be considered significant.

RESULTS

A total of 16 sea turtles were captured between 4/93 and 7/94 (Figure 1), 5 of which were C. mydas and 11, L. kempi. Of these, 2 C. mydas and 9 L. kempi were tagged and released, 1 C. mydas died upon capture, and the remainder were released without tags prior to our initiation of tagging. All 16 were juveniles based on the classification utilized for the Florida Department of Environmental Protection's (FL DEP) Marine Turtle Holding Facility Monthly Reports (L. kempi Juvenile->5 and <45cm, Subadult->45 and <60cm; C. mydas Juvenile->5 and <60cm, Subadult->60 and <90cm).

Chelonia mydas were captured from March through November and L. kempi were caught from April through August (Figure 2). C. mydas were found in water of lower temperature (3.3°C less) and higher salinity (2.5 ppt greater), but the differences were not significant due to small sample size. L. kempi were generally found inside the bays nearer rivers than C. mydas were. Turtles were caught during all phases of the tidal cycle, with no differences between the two species. Depths at which the turtles were captured ranged from 1 to 11 feet, but there was no statistical difference in depth of capture between the two species.

Total fishing effort in the fishery-independent gill net surveys was 1,428.2 set-hr. Total catch per unit effort (CPUE) was 0.011 sea turtles/set-hr or one turtle per 89 hours of fishing effort. C. mydas CPUE was 0.0035 sea turtles/set-hr while L. kempi CPUE was 0.0077 sea turtles/set-hr. CPUE by region is shown in Figure 3.

Other findings related to foraging. Fifteen of the 16 turtles captured (93.8%) were caught on sets which began between 0600 and 1200 hrs while only 57% of all sets began in that same time period. This may indicate foraging in estuaries during the morning hours and movement away from the estuaries in the afternoon. Three of the five C. mydas (60%) were captured over seagrass but only three of eleven L. kempi (27%) were captured over grass. The remainder were captured over sand or mud bottom. This is probably due to different feeding habits.

All of the L. kempi appeared robust and healthy. A C. mydas tagged QQZ715/QQZ716 north of Beacon Rock, Bayport (Weeki Wachee) was observed to have numerous small to medium size fibropapillomas around the flippers, neck and head. C. mydas tagged QQZ721/QQZ722 near Long Point in Pine Island Sound had monofilament line wrapped tightly around its neck, and the line was removed prior to tagging and release. The three C. mydas collected in the Tampa Bay area appeared robust and healthy.

DISCUSSION

Stranding data for immature turtles from the Sarasota Bay area in this region are consistent with the year-round capture of immature turtles in this study with only one exception, loggerhead turtles (Caretta caretta), post-hatchling through subadult stages, were also documented by stranding events (J. Foote, unpubl. data). Strandings occurred in all months except October and December which is also consistent with the live capture dates.

Extensive tagging efforts are ongoing in Florida Bay, south Florida (B. Witherington, FL DEP, pers. comm.), and near Cedar Key, north central Florida (Schmid and Ogren, 1992). Immature turtles have also been collected and tagged in Apalachee Bay in the Florida Panhandle (Rudloe et al., 1989). None of the turtles collected during our study exhibited any evidence of previous tagging such as external flipper tags or tag scarring from tag loss. One externally-tagged turtle was observed in the area of the net but was not captured. None of the turtles were checked for internal PIT tags.

The observed mortality of 6.3% is closely linked to fishing methodology. Gill nets were set for the maximum time allowed by Florida state laws. This would indicate that a one hour limit on net sets probably greatly reduces sea turtle mortality. Mortality would be expected to increase above this level for nets set for longer times.

The results of this study are strictly preliminary. It is not known if the turtles captured during this study are utilizing the area as developmental habitat or are merely transients. Further efforts will determine if the turtles are remaining in the vicinity of original capture or if they are just migrating through the area. The shark study will continue for at least three more years in the same area with a much greater portion of the effort centered just south of Cedar Key in the Yankeetown area. Additionally, the study will expand to the Ten Thousand Islands and Florida Bay of south and southwest Florida. We plan to begin using and monitoring for presence of PIT tags in the immature turtles in the near future.

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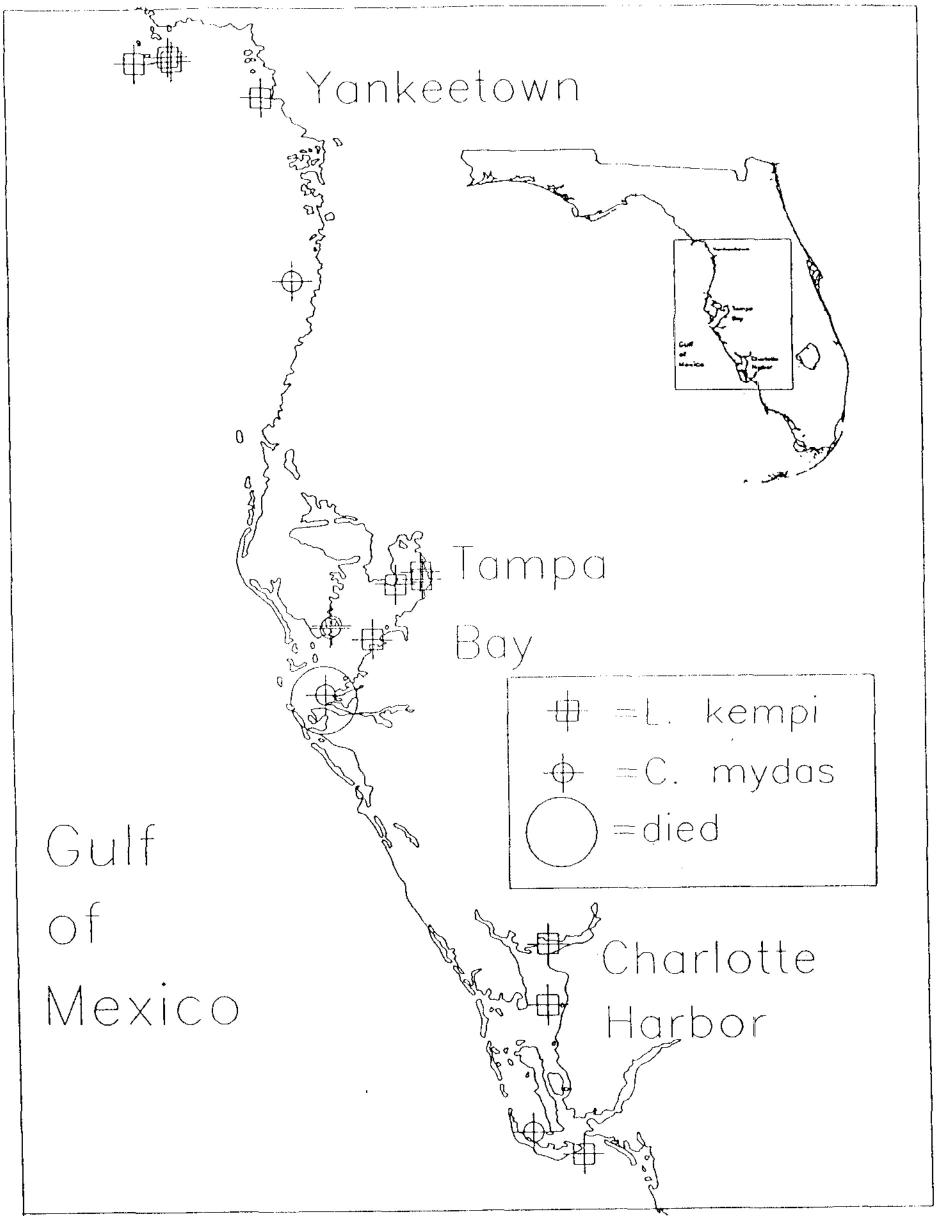


Figure 1. Map of study area showing location of capture of each turtle.

Figure 2. Comparison of turtles captured with fishing effort by month of the year.

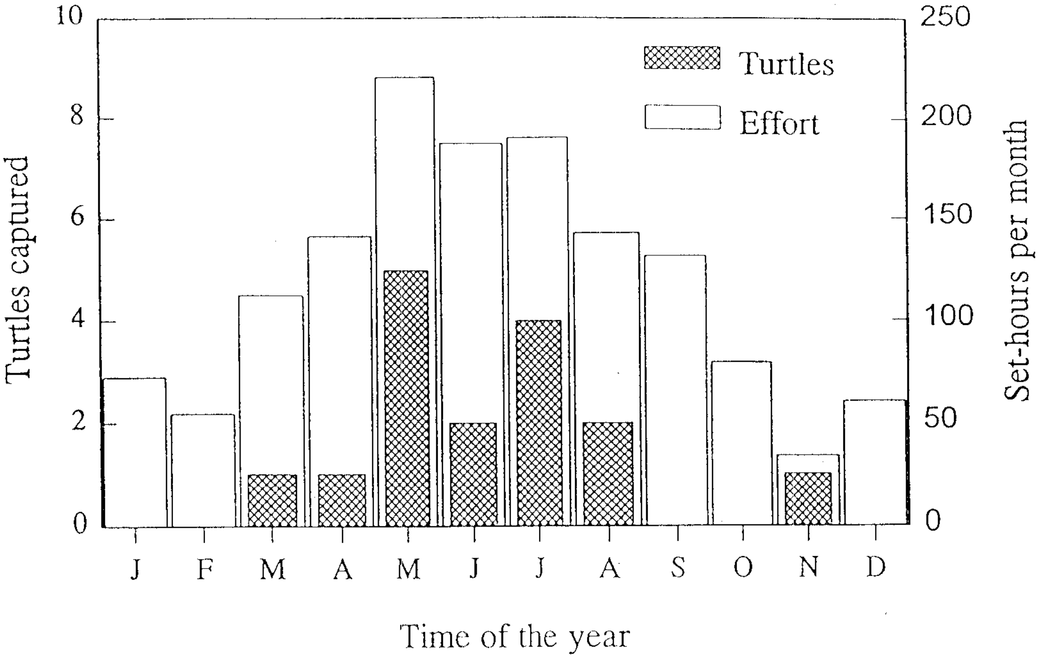
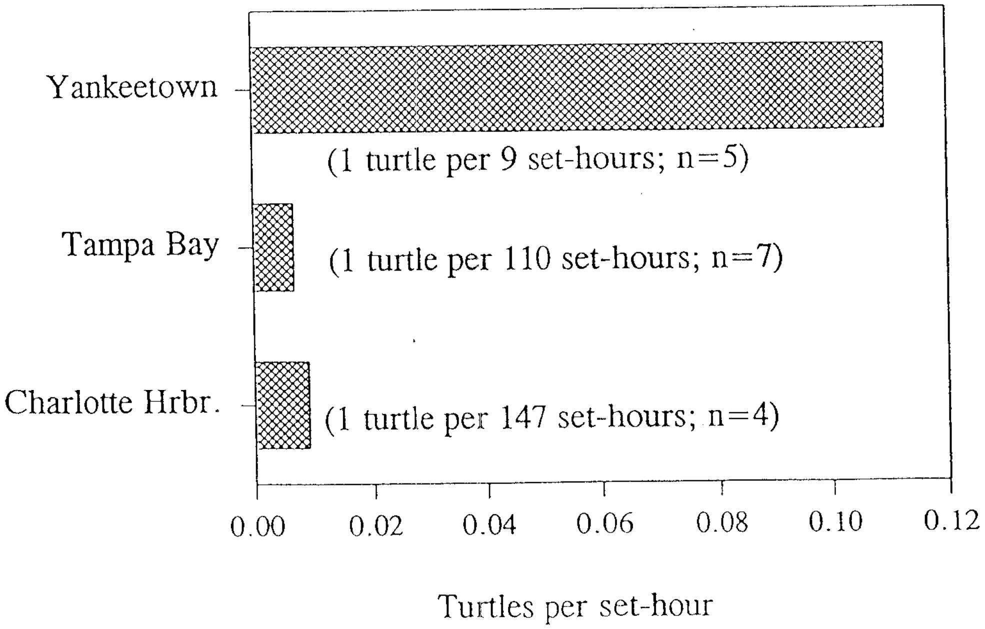


Figure 3. Comparison of catch per unit effort (CPUE) for three areas in study.



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BRAZILIAN SEA TURTLE PROGRAM - TAMAR/IBAMA: "ECOTOURISM AND EDUCATIONAL PROGRAM --PRAIA DO FORTE, BAHIA-BRAZIL"

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Over the past several years, Projeto Tamar has taken steps to create a small ecotourism program in order to further environmental education, help local residents and raise money for sea turtle conservation activities. Tamar takes the approach that ecotourism can be a productive conservation venture if the following conditions are met:

1) Ecotourism will provide income and other benefits for the local population;

2) Ecotourism is not promoted in a pristine and undeveloped region, but in an area where tourism development is already well underway;

3) Tamar is not creating a tourism scheme which will grow to unmanageable proportions;

4) The ecotourism program provides substantial income for Tamar's conservation activities,and;

5) The ecotourism program has a substantial component of true environmental education.

Tamar's pilot ecotourism program in Praia do Forte in the Northeast of Brazil is made up of two important components: A comprehensive Visitor Center and a turtle watch excursion program called "Turtle by Night."

Projeto Tamar's Visitor Center includes holding tanks with turtles of various ages and species, nest incubation sites, a sea turtle museum, and Tamar's own gift shops. The Visitor Center at Projeto Tamar's base in Praia do Forte allows hundreds (sometimes thousands) of visitors to learn about sea-turtles and Tamar's field work each day. The Visitor Center's holding tanks display sea turtles of various ages representing the four species which nest in Bahia: Caretta caretta, Chelonia mydas, Eretmochelys imbricata, and Lepidochelys olivacea.

In addition to these display tanks, there are two open-air hatcheries which hold numerous nests which have been transferred from sites on the beach where their security is uncertain or heavy development and beachside lighting does not allow for "in situ" hatching. Hatcheries are managed so that that they closely replicate in situ sites. Because the hatcheries are located within the visitor center, tourists can watch daily as interns transfer nests, collect hatchlings, and open unhatched eggs. Another part of the Projeto Tamar's environmental education process is the periodic release of hatchlings on beaches where a number of tourists can view the release.

The visitor center also includes a small sea turtle museum with instructive photos, charts, and explanations, and even a video about Tamar's work. In 1986, Tamar established its first gift shop. There are now gift shops at a number of Tamar's bases and each provides both income for conservation work and jobs for local residents.

"Turtle by Night" excursions are part of the "Adopt a Sea Turtle" fundraising program. In return for a $50 donation to Tamar (which will be used to pay for the salaries of over 200 fisherman who patrol 1,000 km of Brazil's nesting beaches), participants receive a certificate and can choose either a t-shirt or an educational field trip with a TAMAR biologist. During the field trip, participants get a guided visit to the Tamar museum and Visitor Center, then take a jeep ride to a nearby beach to release hatchlings from the hatchery and patrol the beach looking for nesting females. "Turtle by Night" participants come away from their experience with a good deal of knowledge about the sea turtle and a desire to spread the word about the protection of the species and its environment.

PROTECTING LOGGERHEAD NESTS FROM FOXES AT THE BAY OF KIPARISSIA, WESTERN GREECE

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THE STUDY AREA - OBJECTIVES

The loggerhead sea turtle is considered an endangered species in the boundaries of the European Union and its main nesting areas in the Mediterranean are found in Greece (Groombridge, 1982).

As it was assessed by the work of the STPS, in the context of various projects since 1983, loggerhead turtles in Greece nest mainly on Zakynthos island, Kiparissia Bay, Lakonikos Bay and Crete. The second most important nesting area, after Zakynthos, is Kiparissia Bay.

The Bay of Kiparissia is an open bay in western Peloponnesus, at about 90 km SE from Zakynthos. Nesting takes place over a continuous beach of 44 km, between the rivers Alfios and Arcadikos, interrupted only by the river Neda (Fig. 1). The area is strongly affected by the NW winds. This creates heavy surf which usually reaches, during the summer, the high beach.

The beach, in its greater part, is backed by extensive dune fields, probably the largest in Greece. Behind the dune system and along its greater length exists a coastal pine forest. Coastal development in the form of holiday houses has almost completely covered the dune field close to the river Alfios. The majority of these houses are built illegally and destroy sand dunes and coastal vegetation. Tourism development along the Bay is generally very low and restricted to certain areas.

Monitoring work at Kiparissia Bay has shown that more than 80% of the nesting concentrates at the southern part of the Bay and specifically at the 10 km stretch between the rivers Neda and Arcadikos (Fig. 1). Furthermore, loggerhead nests along this area are subject to heavy depredation and inundation by the sea (Margaritoulis, 1988). During 1984, about 57% of the nests were depredated, while during 1989 about 62%.

Since 1990, the southern part of the Bay is the main operating area for the Sea Turtle Project at the Bay of Kiparissia. During 1994 the main objectives of the project were:

1. Monitoring of nesting activity.
2. Tagging of female turtles.
3. Protection of nests from inundation (which is effected by relocation of nests made close to the sea, to the natural beach hatchery).
4. Protection of nests in situ from predation.
5. The onset of public awareness.

In order to facilitate the work, the study area was divided in four sectors: O, A, B and C. Two field stations were established during the 1994 summer project (at Vounaki and the village of Kalo Nero). The project was accomplished with the enthusiasm and devotion of 42 volunteers from Greece and several other countries.

The work was part of the Integrated Ionian Project, financed 75% by the European Union and 25% by WWF Greece.

PROTECTING THE NESTS FROM PREDATION

The main predator of loggerhead nests at Kiparissia Bay is the red fox (Vulpes vulpes). The red fox is a common carnivore in Peloponnesus. Its body length is about 58-85 cm and the tail length 35-55 cm. It is usually active during the night. Its opportunistic diet includes turtle eggs and hatchlings when it visits the beach. Foxes at Kiparissia Bay live in the woodland hills behind the beach. When a fox locates a turtle nest it digs it up and throws out the top eggs which either consumes on the spot or takes away. The fox usually leaves excrement by the predated nest as a territorial sign. The predation of the same nest goes on for 3-5 consecutive nights until all the eggs are taken. Exposed eggs attract other mammals (rats and martens) and birds (hooded crows).

In 1990 preliminary efforts started to control nest predation. To protect the nests from the fox, cages were first used. Nest cages were very expensive and labour consuming to construct. They were also very difficult to transport along the beach. Furthermore, they needed continuous attention to make sure that no hatchlings were trapped in the wire mesh. In many cases, foxes could dig under the cage and reach the eggs.

In 1992 and 1993, nest cages were abandoned in favour of a special screen made of thick iron wire (diameter 4 mm). The screen could be found at the local market in large sheets of about 3.5x1.5 m which could easily be cut down to the needed size (about 60x70 cm).

Nest screens were anchored in position with bamboo sticks that are found cut in the area. Bamboo sticks were inserted about 50 cm in the sand around the screen and did not allow the fox to dig under it. The screen's openings (about 10x10 cm) were big enough to allow emerging hatchlings to pass through them but hindered the fox from digging and reaching the eggs. During 1994, only this method of nest protection was followed.

The nests were located during daily morning surveys that were done on foot (sectors O and A) or on beach bikes (sectors B and C). As soon as a fresh track was spotted it was followed up the beach to check, by the nesting spoor, whether the turtle had nested or not. In case of a nest, the sand above the nest was removed by hands in order to locate the eggs. After the location of the egg chamber, the site was covered immediately with wet sand and compacted with dry sand until the original level. Then the screen was placed on top and secured with about a dozen bamboo sticks.

In case of a nest predation, the egg-chamber and the surrounding area were cleared from destroyed eggs and the nest was covered with moist and dry sand up to its original level. Care was taken not to move the intact eggs still in the egg-chamber. Predated unprotected nests were fenced as above and protected ones were reinforced with more bamboo sticks. Destroyed eggs, eggshells and predators' excrement were taken and buried away from the beach.

Furthermore, all nests were given a code number and were marked with a small STPS sign indicating that the fenced area is a turtle nest.

RESULTS AND DISCUSSION

During the 1994 season, 577 nests were located. Of these, 88 were transferred to the beach hatchery. The other 489 were protected in situ with the screens. In addition, 123 nests were discovered during the season either after predation or after hatching. Apparently these nests escaped location during the initial search.

From the total 489 nests that were fenced, 18 nests (3.7%) were predated, despite fencing (Table 1). Of these, only one was totally predated. Predation of fenced nests occurred either because of misplacement of the screen and the bamboo sticks or because of the top eggs being very close to the surface.

From the 123 nests that were left unfenced, 60 nests (48.8%) were depredated. Of these, 18 were predated totally. As it was mentioned before, foxes predate a nest in subsequent nights. The restriction of their ability to predate due to fencing caused the atypical behaviour of consuming all the eggs of a nest in one night.

Predation peaks of fenced nests (Fig. 2) are attributed mainly to favourable sand digging conditions due to rain or inundation by the sea (on 11 and 12 July: inundation by the sea, on 6 August: rain, e.t.c.). In both cases, sand becomes wet and this facilitates the foxes to dig up nests or tunnel under the screen.

Nest predation is closely correlated to egg development (Fig. 3). Predation was effected, on the average, 42.5 days after egg-laying (n=78; s=10.1; CV(%)=23.8). At this stage eggs have started being hatched in the nest and this probably provides the necessary olfactory cues which guide the fox to locate the nest.

In total, 78 nests were predated which amounts to 11.1% of the total number of clutches laid during 1994 at Kiparissia Bay. Considering that nest predation in previous years exceeded 60% of the total number of nests, the 1994 predation rate of 11.1% manifests a very successful result for the benefit of the sea turtle.

Taking into account that clutch size during 1994 was 115 eggs and the percentage of emerged hatchlings at the surface was 70.4%, our intervention saved at least 27,688 hatchlings.

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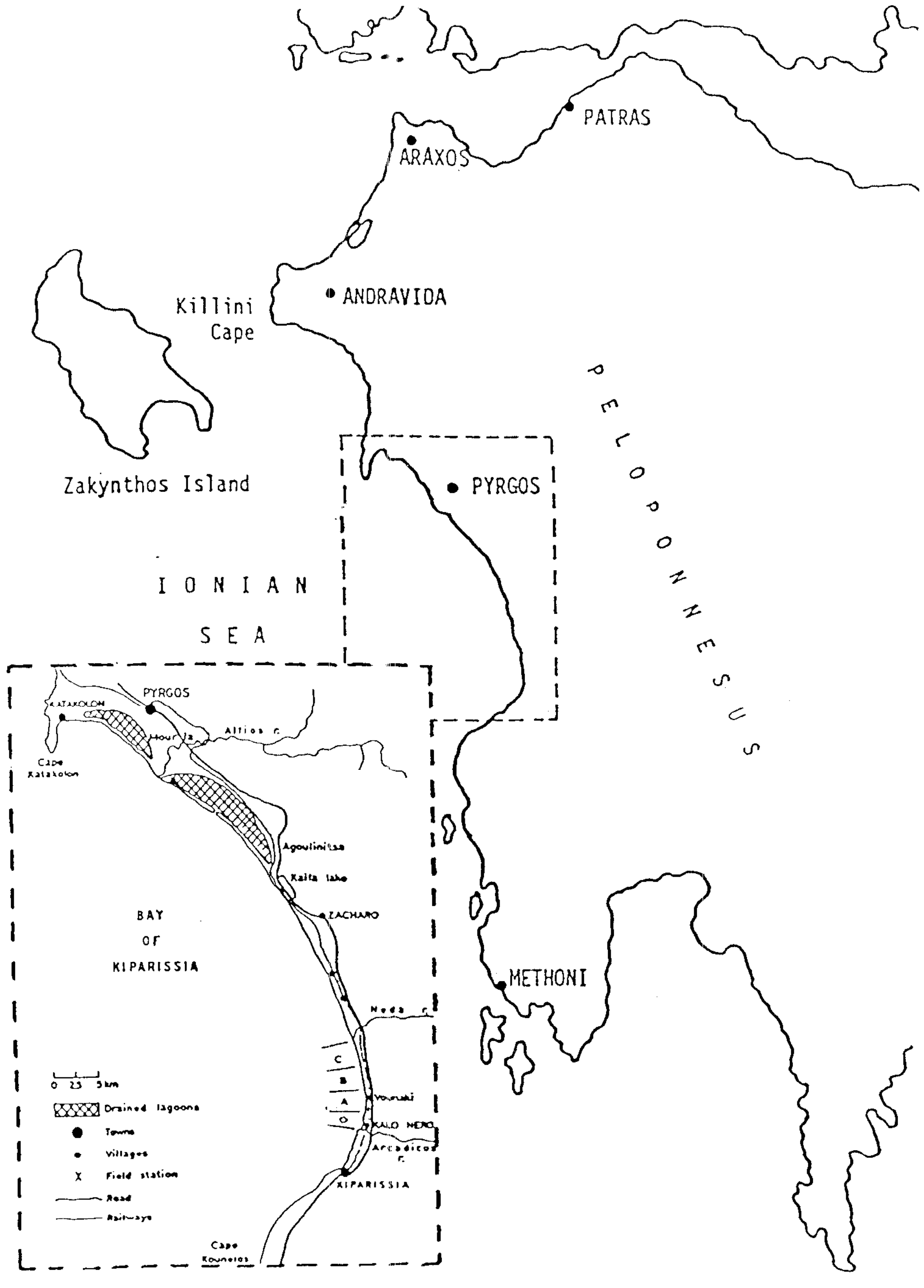

Fig. 1. Sketch maps of western Peloponnesus coast showing position of Kiparissia Bay and beach sectors (O through C) where the Sea Turtle Project was carried out during 1994 nesting season.

Table 1. Comparision of predation response on protected and unprotected nests at Kiparissia Bay during 1994.

Sector	Protected nests			Unprotected nests		
	Total No	Predated	%	Total No	Predated	%
O	137	4	2.9	39	11	28.2
A	215	6	2.8	46	20	43.5
B	87	4	4.6	26	20	76.9
C	50	4	8.0	12	9	75.0
Overall	489	18	3.7	123	60	48.8

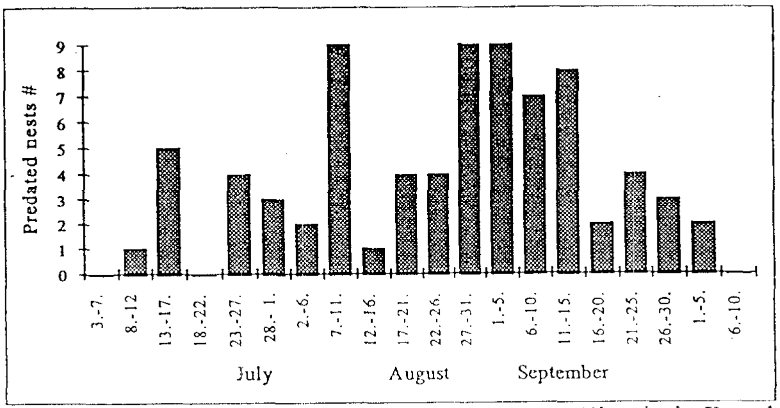

Fig. 2. Distribution of predation over the nesting season at Kiparissia Bay during 1994 (in segments of 5 days).

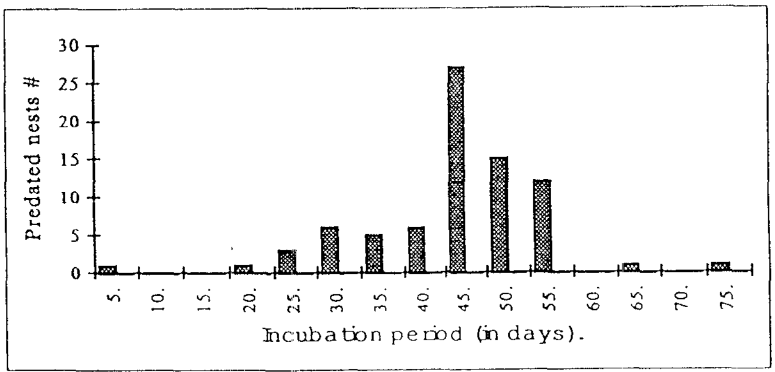

Fig. 3. Distribution of predation over the incubation period at Kiparissia Bay during 1994 (in segments of 5 days).

PREDATION OF ADULT LOGGERHEADS BY MEDITERRANEAN MONK SEALS

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The Mediterranean monk seal Monachus monachus is considered the most endangered mammal in Europe with a world population estimated from 400 to 600 individuals. Monk seals live mainly in the central and eastern Mediterranean and also along the Atlantic coast of Africa from Morocco to Mauritania.

Mediterranean monk seals have an average body length of 2.75 m and weigh about 250 kilos. They are very intelligent animals and well adaptive to changing conditions. Possibly in response to human persecution monk seals have changed their habits and instead of using open beaches, as they did in the past, they have retreated to remote caves, sometimes with underwater entrances, where they give birth and raise their young or use as hauling out (resting) sites. Monk seals feed mainly on fish and cephalopods. Monk seals are often killed by fishermen who blame them for taking fish from nets and damaging their equipment.

On the island of Zakynthos, western Greece, a large nesting aggregation of loggerhead turtles Caretta caretta has been documented since 1977 (Margaritoulis, 1982). Nesting occurs mainly on the beaches fringing Laganas Bay, a semicircular bay with a 12-km opening at the southern coast of the island (Fig.2). Turtle nesting in the Bay is systematically monitored, by the Sea Turtle Protection Society of Greece (STPS), since 1984; the total number of nests recorded per season fluctuates from 857 to 1,822 depending on the season (Margaritoulis and Dimopoulos, 1995).

Zakynthos island hosts also a colony of the Mediterranean monk seal. According to monitoring work carried out by WWF Greece, a minimum population of 8-10 individuals inhabits the many caves mainly along the western and northern coasts. Monitoring is conducted by visiting the caves at regular intervals and recording the occurrence of seals or traces of them in the form of tracks, scats or hair (Karavellas, 1995).

In the course of the turtle monitoring work at Zakynthos, all dead turtles that appear either on the beaches or are found floating in the Bay are inspected, measured and buried. During the turtle nesting season of 1994 (beginning of June - middle of August) five adult loggerheads were found dead in the Bay (mostly at its western part) with an apparently similar injury: their plastrons were snapped off towards the rear. In two cases, conspicuous marks of canine teeth were found at the plastron scutes in close proximity to the injury. From the size and shape of teeth marks (approx. bite distance: 7.5 cm, hole diameter: 8 mm) and the absence of any terrestrial mammal on Zakynthos larger than martens, it was originally suspected that the turtles had been preyed upon by monk seals.

However, direct evidence came later. On 31 August 1994, Italian tourists travelling in an inflatable boat along the southwestern coast of Zakynthos, witnessed and videotaped monk seals, probably two, attacking an adult loggerhead. The tourists scared away the seals and transported the injured turtle to the STPS base station in the Bay. The plastron was snapped off at its posterior edge and a large part of the entrails were protruding from the opening. Despite efforts for treatment, the turtle, a male with a SCL of 77 cm, died soon.

On 18 October 1994, two more turtle carcasses (SCL: 62 and 83 cm), in advanced decomposition, were found stranded in a small cove at the western boundary of the Bay. Both specimens bore the same telltale injury on their plastrons. The last finding raises the total observed number of predated turtles to eight. But the actual number is probably higher.

It is worth to note that the absence of any similar observation elsewhere in the Mediterranean and specifically on Zakynthos where the turtle monitoring project runs its 12th season, as well as in the Hawaiian archipelago where turtles and Hawaiian monk seals (Monachus schauinslandi) coexist peacefully (Balazs, pers. comm.), lead us to conclude that we might be facing a major local disruption of the natural balance.

During 1994, available evidence seems to indicate a dramatic decrease of fish stocks at Zakynthos. This was supported by fishermen reports on exceptionally small fish catches from May 1994 onward, which coincides with the onset of attacks. Another possible indication of fish depletion was the observed increase of damage caused to nets by monk seals. Damage of fishermen nets, recorded systematically by the monk seal monitoring team, seems to be negatively correlated to fish catches (Karavellas, 1995). A coastal fisheries survey is under way by WWF in order to quantitatively assess the state of fish resources.

Local depletion of fish stocks is, at least partly, attributed to the excessive use of dynamite for fishing during the spring of 1994 at Zakynthos. Dynamite fishing increased in spring 1994 due to the absence of Port Police patrols. Patrols were started later in the season after enormous pressure exerted by environmental organizations, hoteliers and divers.

It is interesting to note that, as derived by examination of the carcasses and also by the videotape, the seal approaches from underneath and presumably behind when the turtle is basking on the surface. The seal grasps the plastron in the region of the anal/femoral scutes, which is the only place to get a good hold. A part of the plastron is then snapped off and discarded. The broken edge can then be bitten again and snapped. The process is repeated until the entrails can be eaten (Fig. 1). Five of the turtles had been cleaned out completely. Monk seals do not seem to consume other turtle parts; all eight carcasses but the first one, which was in a decomposed state, had all their flippers and tails intact.

Of the eight predated turtles, five (62.5%) were recognized as males. This can possibly be attributed to the fact that male turtles generally avoid entering the shallow Bay waters which constitute the main internesting area of the breeding females and, thus, males are more likely to be attacked by the monk seals living outside the Bay and especially at its western boundary where most of the incidents occur. This recently documented change in the behaviour on the part of the monk seal bears substantial importance because Monachus monachus and Caretta caretta are listed as endangered in the boundaries of the European Union. In the case of Zakynthos, both species possess, at least during the turtle nesting season, adjacent and partly overlapping habitats and this might create additional implications to on-going conservation efforts (Fig. 2).

We thank Giorgos Pologiorgis, monitoring leader of the Sea Turtle Project on Zakynthos, for providing information on the dead turtles.

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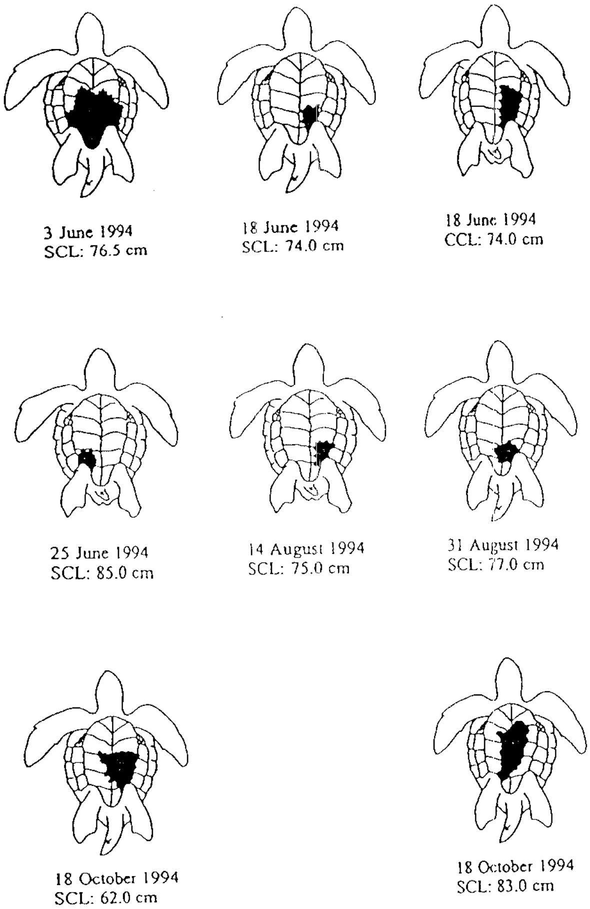

3 June 1994
SCL: 76.5 cm

18 June 1994
SCL: 74.0 cm

18 June 1994
CCL: 74.0 cm

25 June 1994
SCL: 85.0 cm

14 August 1994
SCL: 75.0 cm

31 August 1994
SCL: 77.0 cm

18 October 1994
SCL: 62.0 cm

18 October 1994
SCL: 83.0 cm

Fig.1. Injuries of turtles predated by monk seals

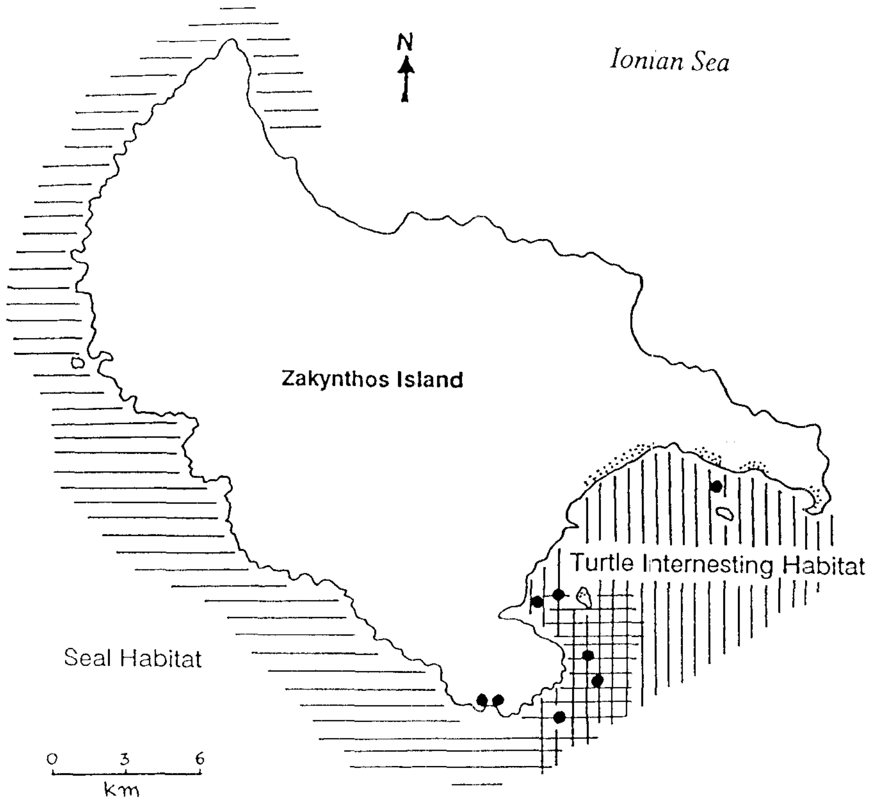

Fig. 2. Sketch map of Zakynthos island showing overlapping monk seal and turtle habitats as well as approximate positions of turtles found predated by monk seals.

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EFFECTS OF TEMPERATURE AND MOISTURE ON HATCHING RATES IN TRANSPLANTED NESTS OF OLIVE RIDLEY IN PLAYON DE MISMALOYA, JALISCO, MEXICO, 1994 SEASON.

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INTRODUCTION

The success of the programs for protecction of the nests and eggs of the sea turtles depends particularly of the microhabitat of incubation. It's known that the temperature and moisture of incubation can affect the viability of the embryos. In México, particularly in the Playón de Mismaloya, the high rate of erosion of the beach and depredation of the nests obligates the movement of the nests to hatcheries, where the incubation conditions imitate the natural conditions. However, in these beachs the weathers conditions changes year to year, making more difficult to know the better ambient for development of the eggs. In this study was analyzed the effect of the temperature and moisture variations in the embrionary mortality of the olive ridley Lepidochelys olivacea, in the camp "La Gloria" Playón de Mismaloya, Jalisco, México, during the season 1994.

METHODS

A total of 203 nests were collected of olive ridley in Playón de Mismaloya, Jalisco, México, during august, september and october of 1994. The nests were tansplanted in three hatchery (1, 2 and 3) with 77, 75 and 51 nests, respectively. All hacthery together cover an area near to 700 m². The hacthery were divided appropiately in three zones (A, B y C) respect at distance of the shore-line; where zone A it more near to shore-line. Intervening six sensor (in to the sand to 45 cm depth; two in each zone). In same zones of each hacthery the moisture was mesasured of the following way: were taked samples of sand to 45 cm depth; measured weight moisture and weight dried of the sand (the sand was dried for 45°C during 72 hr). The weight dried between weight wet multiplicated for 100 was the Gravimetric Moisture Index (GMI). Moreover, was recorded the pluvial precipitation (in mm) by means of conventional pluviometer. After hacth (43 to 55 days) were counted hatch and unhacthed eggs and multiplicated for 100 was the Embrionary Mortality Index (EMI). The moisture and embrionary mortality percent were transformated by function arcsine, subsequently One-way analysis of variance was used to test for differences among these values with 0.05 as significant level.

RESULTS

The temperature recorded on three zones A,B and C are different for the three hatcheries and was significantly more high in zone B ($F_{2,315}=6.88$ $P=0.0012$) but without differences among zones A and C -see figure 1 and 2-. Moisture contents (%GHI) between zones are differents by each zone on the hatcheries and was significantly more high into zone C ($F_{2,288}=13.46$ $p<0.0001$) but without diferences among zones B and A -see figure 2-.

With respect to Embrionic Mortality Index (EMI) for same zones on the hatcheries, the zone C was significantly more low ($F_{2,321}=11.63$ $p<0.0001$). Among hatcheries this index was significantly more high in hatcheries 1 and 2 with respect of 3 ($F_{2,326}=65.28$ $p<0.0001$) -see figures 4, 5 and 6-. For other hand, temporal mortality pattern showed was very high in first six weeks -see figure 3, in A2, A3, A4, SE1, SE2 and SE3- decreasing in a important form into latest posterior weeks -Figure 3 in O4-. This pattern is accord and/or in stretch relation with increasing and decreasing in temperature -Figures 1, 2 and 3.

DISCUSSION

The pattern of EMI within the zones and between hatcheries coincide with increasing temperature periods, overall into zone B of three hatcheries (T >34°C, see Figures 2 and 3), moreover, moisture contents is relatively more low in this same zone B (GHI <3.0%). In hatcheries 1 and 2 were buried august and first 15 days of september'94 nests, during this period which occurs two temperature increments over 34 °C, it occurs at the same time that embrionary development is interrupted due highest temperatures recorded. Besides, probably nests exposes at 34 °C for a long period may results a lethal temperature and it was a determinant factor in high mortality recorded in first two hatcheries.

On the other hand, relative scarcity and delay in rainy season recorded for this year, suggests rain scarcity has an effect on the increasing temperature, which produces dissecation and dead eggs. Moreover, only heavy rain over 200 mm could change moisture factor and temperature conditions at 45 cm nest depth.

McGehee (1979; 1990), Bustard and Greenham (1968), Bustard (1971) and Cabral-Medina et al. (1982) determined in experimental and field conditions, "fit" conditions for eggs of different species. These authors, have mentioned Chelonia mydas, is the species most tolerant at high temperatures; moreover, that 35 °C is a "critical" temperature. Our study, apparently supports this hypothesis that high temperatures prevalient during reproductive season 1994, decreased the "optimum" moisture condition of the sand and this was a descisive factor to induction of high mortality in nest of L. olivacea, in Playón de Mismaloya, Jalisco, México.

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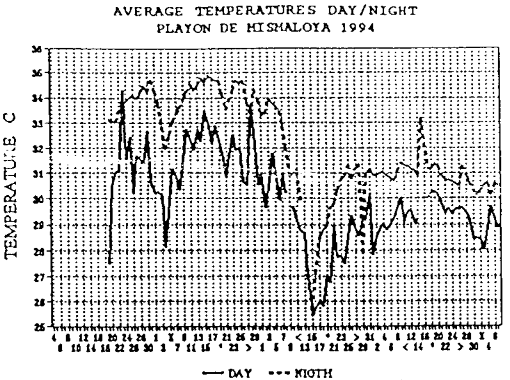

FIG. 1.- Temperature Averages Day/Nigth in the Hatcheries in all Season.

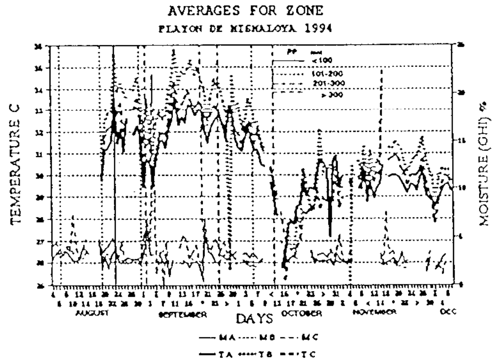

FIG. 2.- Averages Recorded of Temperature, Moisture and rain for zones in all Season.

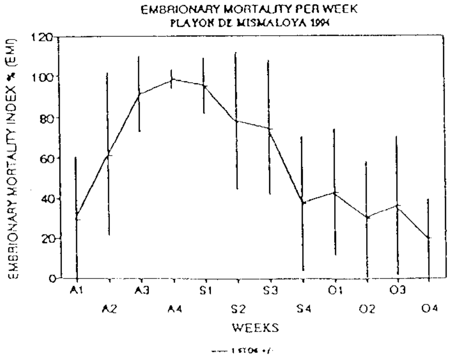

FIG. 3.- Embrionary Mortality per Week in all Hatcheries.

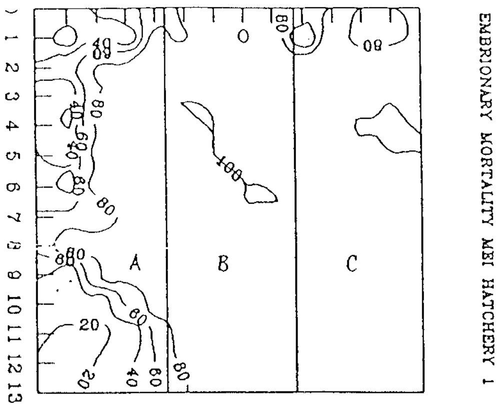

FIG. 4.- Patterns Embrionary Mortality (EMI) in the Hatchery 1.

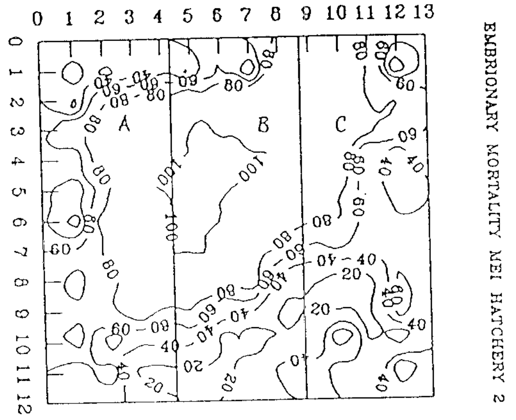

FIG. 5.- Patterns Embrionary Mortality (EMI) in the Hatchery 2.

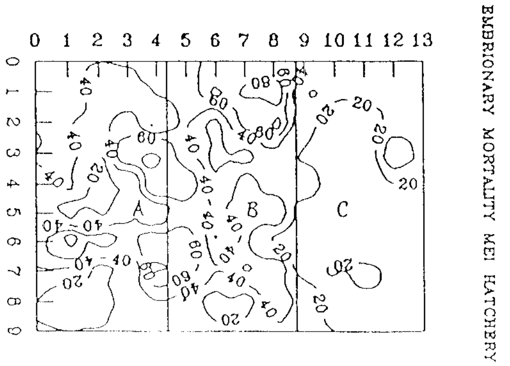

FIG. 6.- Patterns Embrionary Mortality (EMI) in the Hatchery 3.

SEA TURTLE CONSERVATION: IMPLICATIONS OF THE CONVENTION ON MIGRATORY SPECIES (THE BONN CONVENTION)

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The Convention on Migratory Species (CMS), also known as the Bonn Convention, is an intergovernmental treaty aimed at conserving migratory species on a global scale. Growing out of the United Nations 1972 Conference on the Human Environment, CMS was put into effect 3 November 1983. Providing strict protection measures on the national and regional level, CMS is fully compatible with CITES, which deals primarily with international trade in endangered species. CMS works to establish AGREEMENTS (capitalization intentional) and agreements (lower-case intentional) which differ in types of species included and in content. AGREEMENTS are strict conservation measures designed to restore populations of migratory species to favorable conservation status over their entire range. In contrast, agreements are established for species which periodically cross national boundaries and need not cover the entire range of the species. Neither type of agreement has been concluded for any species of sea turtle. However, CMS has appointed Dr. Colin Limpus to serve on its scientific council and intends to give high priority to marine turtles in 1995.

PHOTOIDENTIFICATION OF LEATHERBACK SEA TURTLES (DERMOCHELYS CORIACEA) AT THE SANDY POINT NATIONAL WILDLIFE REFUGE, ST. CROIX, USVI

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One of the physical characteristics unique to the leatherback sea turtle (Dermochelys coriacea) is a notable pink spot on the top of the head of each adult, located above the pineal gland in the brain. Its appearance has been found to be unique in each individual, and to persist from year to year (McDonald et al. In Prep). In 1986, researchers began photographing the pink spot of leatherbacks nesting at the Sandy Point National Wildlife Refuge (SPNWR) in St. Croix, U.S. Virgin Islands, as part of the Leatherback Turtle Research and Conservation Project. The photographs were intended to serve as a backup method of identification in case flipper tags were lost.

METHODS

Photographs were taken of the dorsal surface of the head, from a distance of about three feet directly above each turtle. Photographs of all "new" (i.e. untagged) turtles for each year were compared to all previous years' photographs.

RESULTS

After 1986, when only three turtles were photographed, coverage has ranged from 63% - 91%, with coverage of "new" (untagged) turtles ranging from 62% - 94%. Out of 197 turtles, 26 individuals previously reported as "new" were identified from photographs. One turtle lost two complete sets of tags and was misidentified twice. We estimate that at least 17% of the 329 "new" turtles tagged at Sandy Point from 1979 to 1994 were actually remigrants. This number is probably higher, since pink spot photography essentially did not begin until 1987, and photographic coverage was never complete. Also, some turtles may not have been identified during photographic analysis.

Remigration rates are consistently higher (in some cases 20% higher) than previously thought. Flipper tag data alone from 1989 - 1994 show remigration rates of 27.3% - 43.6%. A combination of flipper tags and photoidentification shows rates of 33.3% - 50.9%. The percentage of remigrants misidentified as "new" in any one season was as high as 27.5%.

Most tag retention studies likely underestimate tag loss as they do not take into account turtles that lose all tags between sightings. Photoidentification of Sandy Point turtles has enabled many of these tags to be accounted for, allowing more accurate estimates of tag retention to be developed.

DISCUSSION

Photoidentification has shown that the SPNWR nesting population is smaller than previously thought. Since tag retention is found to be so low for leatherbacks, estimates based on flipper tags of other leatherback populations may also be overestimates. Photoidentification has also shown that remigration is higher than previously reported, and many individuals thought lost to the population, some first recorded in 1981, are still returning to nest.

Under the right circumstances, photoidentification can be a useful backup to flipper tags for identifying leatherback turtles. Photographic distance and angle should be standardized. The head should be cleaned of excess sand, and the identification card should be placed well behind the head so as not to obscure markings. However, pink spots could be recognized, and turtles identified, even from less-than-ideal photographs. This method is most useful on beaches where most or all nesting females can be photographed through a minimum of 3 - 4 nesting seasons, preferably more.

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ACKNOWLEDGEMENTS

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COMPARATIVE BEHAVIOR OF HATCHLING SEA TURTLES

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The comparative method has had a long and productive history in behavioral research. Similarities and differences between closely related species reveal how natural selection has acted to allow each species to succeed in their niche. The comparative method is particularly important when studying animals outside their natural environment because the laboratory environment is unnatural for each species under study, but differences in their reactions to experimental situations reflect differences in their biology. As Krebs and Davies (1987) put it, "The idea of comparison lies at the heart of most hypotheses about adaptation. Using the comparative method is rather like looking at the result of experiments done by natural selection over evolutionary time" (p.25). We believe that comparative studies of hatchling sea turtles in captivity provide us with important clues concerning their behavior in the natural environment.

Here we summarize our findings concerning three species of hatchling sea turtles, green (Chelonia mydas), hawksbill (Eretmochelys imbricata) and loggerhead (Caretta caretta) during three study periods in 1992, '93 and '94 in Mexico. The oldest hatchlings studied were 35 days post emergence, but most were younger, 1-12 days. They were held in tanks with sea water drawn directly from the Caribbean and circulating through them. The hatchlings were part of a live tagging program conducted by the Centro de Investigaciones de Quintana Roo.

GENERAL ACTIVITY

Green hatchlings are more active than the loggerheads or hawksbills. We have measured activity in several ways. One way was to mark a square in the center of the tank and record the number of turtles crossing through the square over a fixed time period (e.g., 15 min.). Another way was to observe marked hatchlings once every minute for 30 min. and code their behavior as actively swimming or immobile. Both methods produced analogous results, although in 1992 when we tested some hawksbill hatchlings that were older (35 days) than most of our clutches, they showed activity levels comparable to green hatchlings, suggesting there may be developmental changes over a wider age spread than we have been able to study.

FEEDING

Green hatchlings appear to be more selective in initiating feeding on novel foods (fresh fish) than are hawksbill hatchlings. Green hatchlings, when given food hidden from sight, learned to locate the food and improved with practice. Hawksbill hatchlings did not show a systematic improvement in food finding. Green hatchlings also appear to be more selective than hawskbill hatchlings in that when presented with an oily piece of tar (enclosed in a mesh bag) green hatchlings never gaped or struck at the tar whereas hawksbill hatchlings often did so. (Mellgren, Mann and Zurita, 1994). Witherington (1994b) has reported that young loggerheads have tar in and around their mouths in the natural environment.

HABITAT SELECTION

When offered a choice between open water or an artificial weedbed, green turtles stayed in open water, but hawksbill and loggerhead turtles congregated in the weeds. In fact, the green hatchlings show an active avoidance of the weeds. The difference in habitat selection may reflect the differences in activity noted above since the green hatchlings spend more time actively swimming (which they could not do in the middle of artificial weeds) and the hawksbill and loggerhead hatchlings are often immobile for extended periods of time (Mellgren, Mann, Bushong, Harkins and Krumke, 1994).

ANTIPREDATOR BEHAVIOR

To simulate an attack by a predator we picked-up the hatchling and then put it back in the water and recorded the time it took for the hatchling to move. Loggerhead hatchlings showed a tonic immobility, the "tuck" position (Wyneken, Goff and Glenn, 1994), to the simulated attack, but green hatchlings swam away when placed back in the water. The hawksbill hatchlings were somewhat inconsistent in their response, sometimes fleeing and sometimes remaining immobile.

OTHER BEHAVIORAL CHARACTERISTICS

The green hatchlings seem to be more agile swimmers than either the loggerhead or hawksbill hatchlings. The greens would swim upside down when circumstances warranted, but we never saw the hawksbill or loggerhead do so under the same conditions. The green hatchlings also swam backwards, and we never saw the other two species behave similarly. The green hatchlings often appeared to scan the world outside the tank by lifting the head above the water surface. Sudden movement by the human would typically result in a power dive for the green hatchling. We never noticed hawksbill or loggerhead hatchlings behaving in an analogous manner.

IMPLICATIONS

Comparisons between these species of hatchling sea turtles suggest that they react very differently to particular situations. Differences are greatest between the green hatchlings and the other two species. The loggerhead and hawksbill hatchlings show some differences between each other but also some similarities in their behavior. While the differences are quite obvious at this young age, it will be important to assess developmental changes and determine if the differences persist during the pelagic stage of development. Our data suggest that green hatchlings will be found away from weeds, actively swimming, but loggerhead and hawksbill hatchlings will be found floating in weeds, largely remaining immobile. Existing data from the natural environment is consistent with our suggestion for loggerheads (Witherington, 1994a). Our data also suggest that it will be more difficult to find green hatchlings than loggerheads because of their tendency to swim in open water and actively escape when threatened.

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SEA TURTLE CONSERVATION EFFORTS BY SCOUTS

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In the past few years The World Scout Organization and Boy Scouts of America (B.S.A.) has begun to realize that conservation of our natural resources has become an integral part of life. Because of this realization, more and more international scouting expeditions have been related to protecting the sea turtles of North and Central America. The importance of sea turtle conservation has even been presented to scouts world-wide through several articles in the national scout magazine "Boy's Life."

Scouts have been involved in the preservation of many species of sea turtle. From the Green Sea Turtles (*Chelonia mydas*) and occasional Hawksbill Sea Turtles (*Eretmochelys imbricata*) of Mexico to the Loggerhead Sea Turtles (*Caretta caretta*) and Leatherback Sea Turtles (*Dermochelys coriacea*) of Pacific Costa Rica, scouts have been there to help out in their protection.

The extent of involvement for the scouts has varied greatly from country to country and from marine biologist to marine biologist. Involvement has also varied depending on the length of time spent working with the biologists. The tasks performed by the scouts ranged from patrolling the nesting beaches and watching for sea turtles returning to their nesting beach to actually doing 'live-shell tagging' on the hatchlings.

Scouts of the U.S. and other countries are an under utilized manpower resource. Scout units are eager to travel to locations around the world when they learn of this type of service opportunity. Those units not in coastal areas are even more exited about these opportunities. Also, scouts travel as a unit, complete with leaders and insurance provided by B.S.A. is available to registered American scouts throughout the world.

Some of the many incentives that intice scouts into assisting with sea turtle conservation are the scores of awards available for activities involving conservation. One of the more competitive awards is the William T. Hornaday Award. Named after the former director of the New York Zoological Park, the award was created to inspire scouts to work constructively for conservation. Since it's inception in 1914 less than 1,500 scouts have earned the award. The award requires that several intense service projects be planned and carried out by the applicant. Some of the sea turtle related projects that have been carried out by scouts in the Sam Houston Area Council of Houston, Texas include: collecting and recording information on nesting turtles, transferring eggs from the nesting beach to protected artificial nests, transferring hatchlings from protected artificial nests to growth tanks, feeding adolescent turtles, tagging turtles, releasing hatchlings and adolescents, and reforestation of nesting beaches (to control access to vehicles and prohibit easy access to egg hunters). The possibilities for scout programs are limitless. However, strict selection processes for applicants is always necessary for working with such endangered species as sea turtles.

MORPHOMETRIC MODEL FOR THE SEX ASSESSMENT IN SEA TURTLES OLIVE RIDLEY HATCHLINGS

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The conservation strategy used for the protection of sea turtles in all the world is based on the protection of gravid females in nesting areas and nest transportations to hatchering beaches or storyfoam boxes. However, this nest transportation to a same place which may have temperatures different to those ones present in natural conditions probabily affects the population sexual proportion in an unknown way.

In that sense, the hatchling sea turtle olive ridley phenotipic variability was investigated, in order to determin meristic and morphometric characteristics for the assessment of sexual dimorphism. This allowed to establish an non lethal sex assessment method to estimate the sex proportion in artificial or natural conditions.

METHODS

Four nest of olive ridley were collected during August 15 1990 in El Verde Camacho, Sinaloa beach. The incubation was done in the Centro Regional de Investigaciones Pesqueras (CRIP) from Mazatlán. 40 eggs were selected in random way of each nest incubating half-part under females temperatures (32°C) and the another portion under male temperatures (28°C) during embrionary development period, inside electric incubators in storyfoam boxes with vermiculate, recording the incubation temperatures daily.

In the 112 selectioned hatchlings (54 females and 58 males) 51 variables were recorded: 21 meristic (number of scales and nails) and 30 morphometric (corporal meassurements) incluiding truss measurements known as triangulations to get a better shape estimation (Strauss & Bookstein, 1982) (Fig. 1). The reference corporal points were take from Frazier (1983). In order to verify the sex ratio, method of glicerine cleared gonads (Van Der Heiden et al., 1985) was used. A total correspondence between expected sex (by the incubation temperatures) and the real sex (gonadal view) was found in all cases.

For each one of the 51 variables the frequency distribution was compared between sexs using the Kolmogorov-Smirnov test (Zar, 1984).

Discriminant analysis (Morrison, 1976) was applied in order to obtain a quantitative assessment of sex, based in morphometric measurements.

RESULTS AND DISCUSSION

The use of a discriminant function based on all measured morphometric characteristics, allowed perfect sex assessment. Such sex assessment was not possible for any of the variables in an univariate approach.

With the main objective of design a simple and low-cost method for sea turtle conservation programs, the variables number was decreased to nine, and a new discriminant function was obtained wich allows the sex estimation with 95% confiability (Fig. 2).

The nine selected variables were: Carapace lenght curve (CLC), carapace straight width (CSW), carapace curve width (CCW), head width (HW), front left flipper lenght (FLFL), plastron straight length (PSL), weight (W), measuring from B to C point in carapace (BC) and from D to F point in plastron (PDF).

The proposed method must be tested under natural conditions and inside the protection program activities for this sea turtle species to incorporate the morphometric variables records as a common practice for the sexual proportion assessment.

The observed morphometric sexual dimorphism could be exist also in other species of sea turtles and even in other reptilian families. The proposed methodology could be succesfully used in such cases.

ACKNOWLEDGMENTS

To Biol. Daniel Rios Olmeda from Centro Regional de Investigaciones Pesqueras, Mazatlán. Biol. Raquel Briseño Dueñas and Dr. Alberto Abreu G. from Instituto de Ciencias del Mar y Limnologia, UNAM for their colaboration and support and M.Sc. Francisco de Asis Silva Batiz for his comments.

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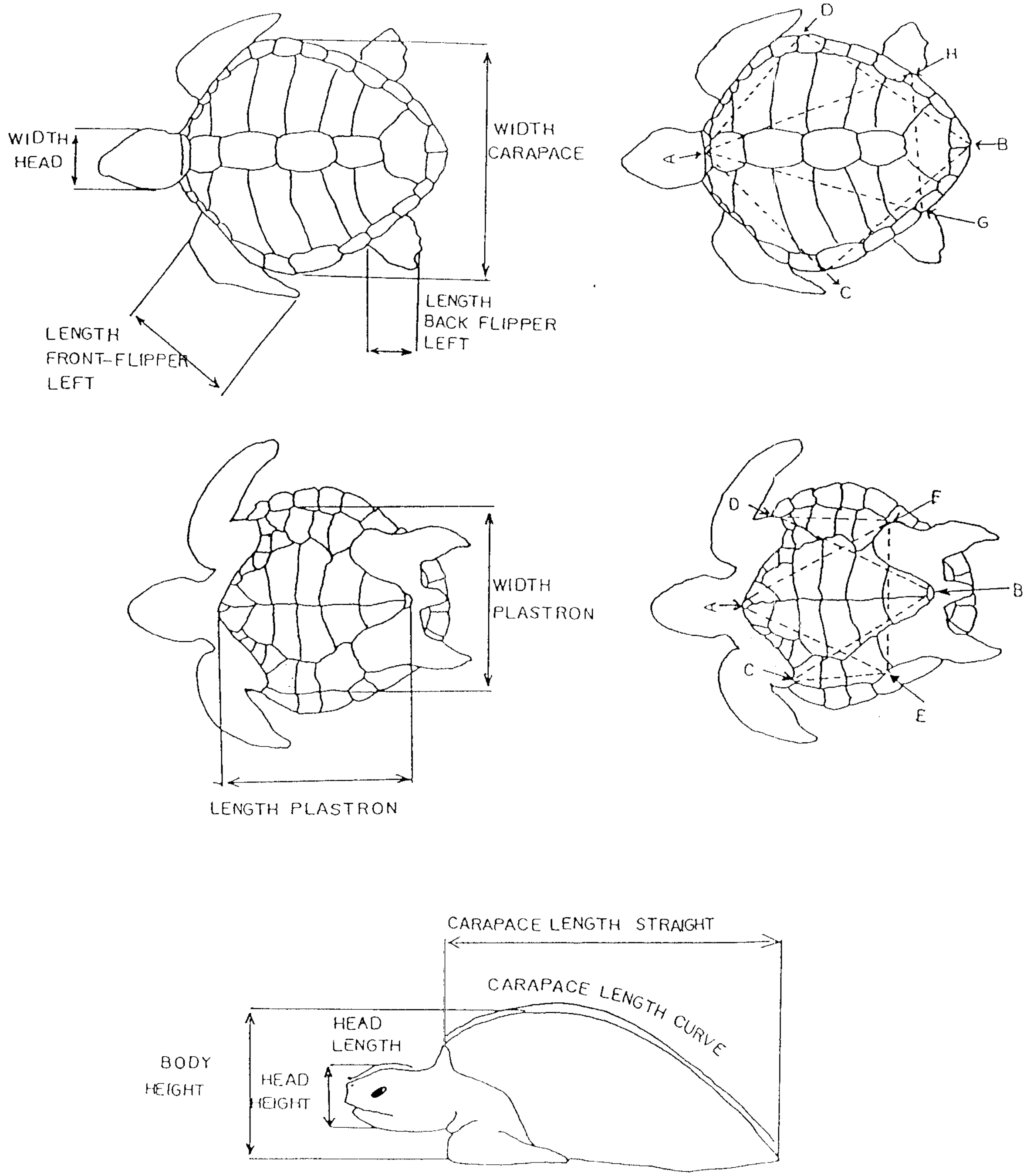

Morphometric measurements recorded in sea turtle olive ridley hatchlings.

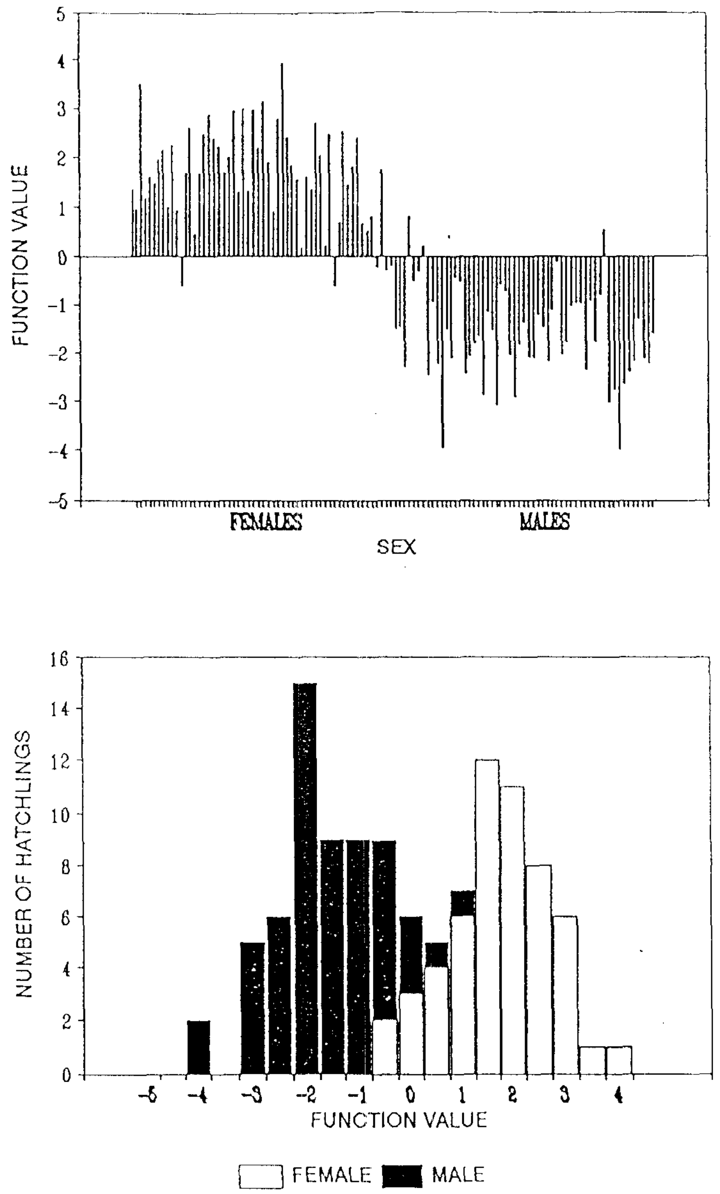

FIG.2. Discriminant function with nine variables

$$FD = (1.6368*CLC)+(-5.9143*CSW)+(-4.9544*CCW)+(-3.5474*HW)+(-2.7595*FLFL)+(3.5675*PSL)+(0.2975*W)+(3.2009*BC)+(-3.9472*PDF)+32.9980$$

HOW LONG DOES IT TAKE RELEASED TURTLES TO REACCLIMATE?

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Telemetry systems have become refined in the past 10 years and many studies have utilized this technique to examine the activities of free ranging sea turtles. We utilized sonic and radio telemetry to determine acclimation of trawled loggerhead turtles after release.

A shrimp trawler (R/V Georgia Bulldog) was fitted with two 60' trawl nets specially constructed to capture sea turtles. A 4 mm hole was drilled through the rear marginal scute of turtles selected for instrumentation and a combination radio (Telonics Mod 400 radio transmitter, 151-152 mHz) and sonic (Sonotronics DT-88-L-32/40 sonic transmitter, 25-45 Hz) transmitter was attached to the turtle. The sonic and radio transmitters were connected together and fitted in a float which provided positive buoyancy.

Radio signals can be detected at distances of 1 - 6 km, while sonic range is usually less than 2 km. Since radio waves do not travel through sea water, signals were only received when the transmitter's antenna was out of water. Thus, radio signals were used for long range location of turtles and for determination of exact surface duration. Sonic signals can be monitored continuously, and the inter-pulse interval of the sonic transmitters varied with pressure (depth); vertical movement of turtles within the water column could be recorded.

Turtles were released near the capture site. Time and duration of surfacing and diving were determined from the presence or absence of radio signals. A directional sonic receiver (Sonotronics USR-91) was attached to an interpulse timer (Sonotronics DR-92 Decoder) which was linked to a laptop computer. The computer continuously monitored transmitter depth directly from the sonic system, and also recorded typed input, such as presence or absence of radio signals (surface and submersion times), location of turtle, comments, etc.

Surface and dive durations were calculated from the radio data, and dive profiles were derived from the sonic data. When weather did not allow at-sea monitoring of sonic signals, surface behavior was monitored via radio signals from a shore station.

Fourteen turtles were monitored immediately after release to determine the amount of time the turtles took to acclimate. Although there are many parameters we could have used to determine acclimation time (eg. amount of time submerged, amount of time at the surface, mean dive duration, etc.), we chose to use the number of surfacings per hour.

To determine whether there were daily variation in surfacing behavior, the first 72 hours after release were examined. It was apparent that turtles exhibited 'abnormal' behavior immediately after release (Figure 1). One turtle surfaced 35 times the first hour after release, then subsequently surfaced less than 7 times per hour (Figure 2). The turtle which took the longest to acclimate surfaced 27 times per hour for the first hour after release, and surfacings became less frequent, until 5-6 hours after release, when the turtle appeared to behave consistently (Figure 3).

The diving (depth) behavior was also recorded. After release, the turtles rarely dove to the bottom, making short, shallow dives. After acclimation, turtles usually spent the majority of time at the bottom, only coming to the surface to breath.

Researchers who utilize telemetry to study turtle behavior have been aware of 'abnormal' behavior immediately after release, yet there has been no determination of how long turtles take to resume 'normal' behavior after release. Our data, using number of surfacings per hour as a measure of behavior, suggest that turtles may acclimate in as little as 1 hour. However, turtles may take up to 6 hours to acclimate. To be conservative, researchers measuring sea turtle's behavior should disregard data for the first 6 hours after release.

MIGRATIONS OF MARINE TURTLES IN THE CUBAN SHELF

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INTRODUCTION

The objective of this paper is to give the results of the study of the migrations in Cuba of Green Turtles (Chelonia mydas), Loggerheads (Caretta caretta), and Hawksbills (Eretmochelys imbricata). This work is based on tagging work started in 1989 and of animals recaptured in Cuba marked in other regions. Data presented here are those collected up to 1992.

A total of 356 green turtles, 277 hawksbills and 87 loggerheads of both sexes were tagged in four fishery areas and two nesting sites of the Cuban shelf (figure 1). The following results were obtained:

RESULTS

Green turtles

A total of 16 turtles equivalent to 4.4% of recaptures were made between 2 and 270 days interval. Thirteen were recaptured in different sites of the Cuban shelf moving towards the east along the northern coast and towards the west along the south. Three were recaptured in international waters in Florida, Honduras and Nicaragua. Estimated daily mean velocities varied between 3.3 and 22.8 km and the majority of turtles swam with the current (figure 2).

Loggerheads

A total of 7 loggerheads (or 8.0%) were recaptured between 5 and 1033 days after initial tagging. Two were found along the north coast at Pinar del Rio after having been tagged in the northeastern region. Of three turtles tagged in this region, twomoved west and one turtle moved east, that is against prevailing currents. Two turtles tagged at Isla de la Juventud moved towards the west and were recaptured 44 and 57 days after initial tagging. Mean daily velocities varied between 11.1 and 21.1 km per day. Turtles moved with as well as against the current.

Hawksbills

Thirtyfour turtles or 12.2% of tagged turtles were recaptured. Of 26 turtles tagged in the northeastern fisheries zone, some moved towards the east along the north coast and to the west along the south coast, with time intervals between captures of 5 to 58 days. Velocities varied from 0.8 to 18.8 km per day. Eight turtles tagged in the Cayeria de las Doce Leguas were recaptured practically in the same location of tagging, with time intervals of 120 to 720 days.

With regards to the capture in Cuba of turtles tagged elsewhere, this has shed some light on the migration of animals along the Cuban shelf. For the green turtle, animals have been observed all along the Cuban shelf from Tortuguero Costa Rica, Florida, Cayman Islands, Bahamas, Isla Aves and Virgin Islands. Loggerheads have been observed along the north coast of Cuba, originating from Florida and Mexico.

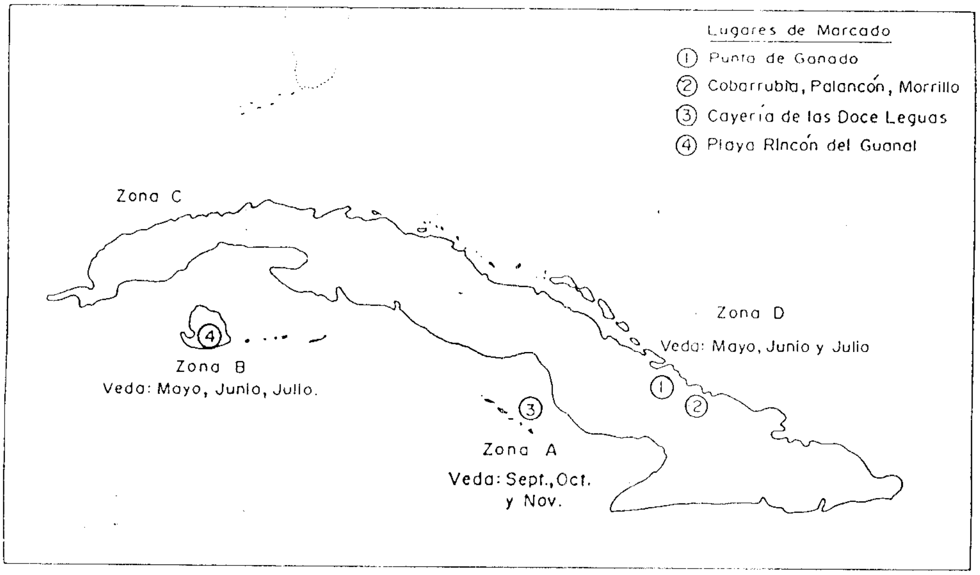


Fig 1. Lugcres de marcado en la plataforme cubana

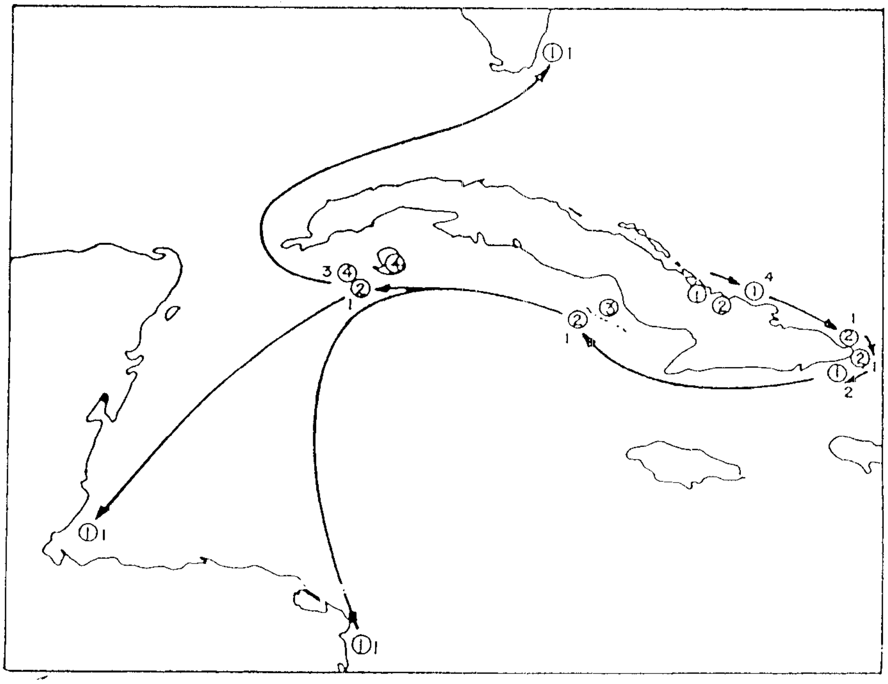


Fig. 2. Recapturas y posibles recorridos de las tortugas verdes marcados en Cuba

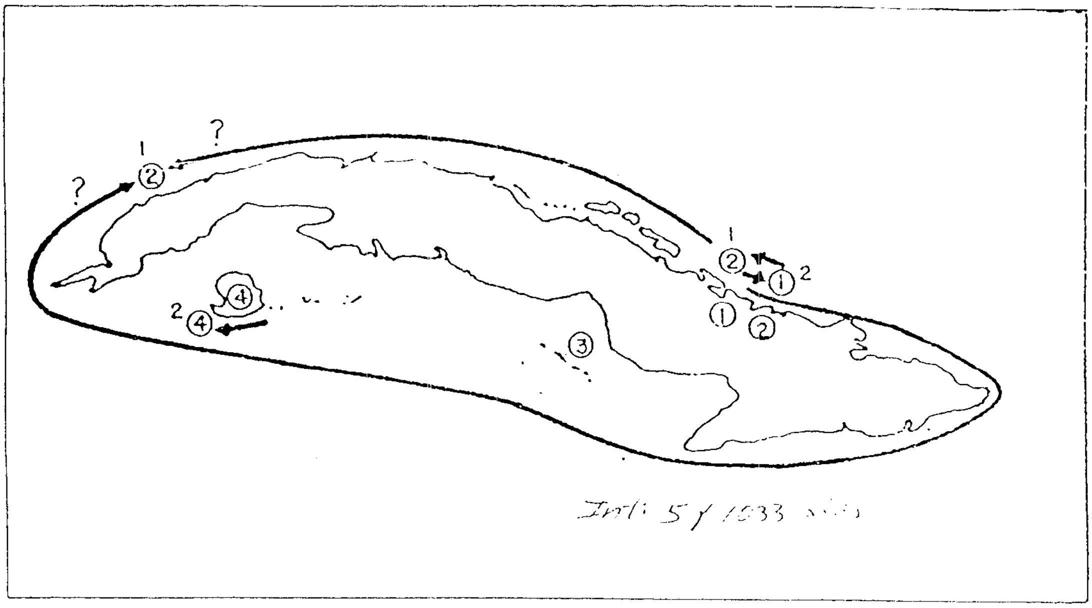


Fig. 3. Recaptura y posibles recorridos de las caguamas marcadas en Cuba

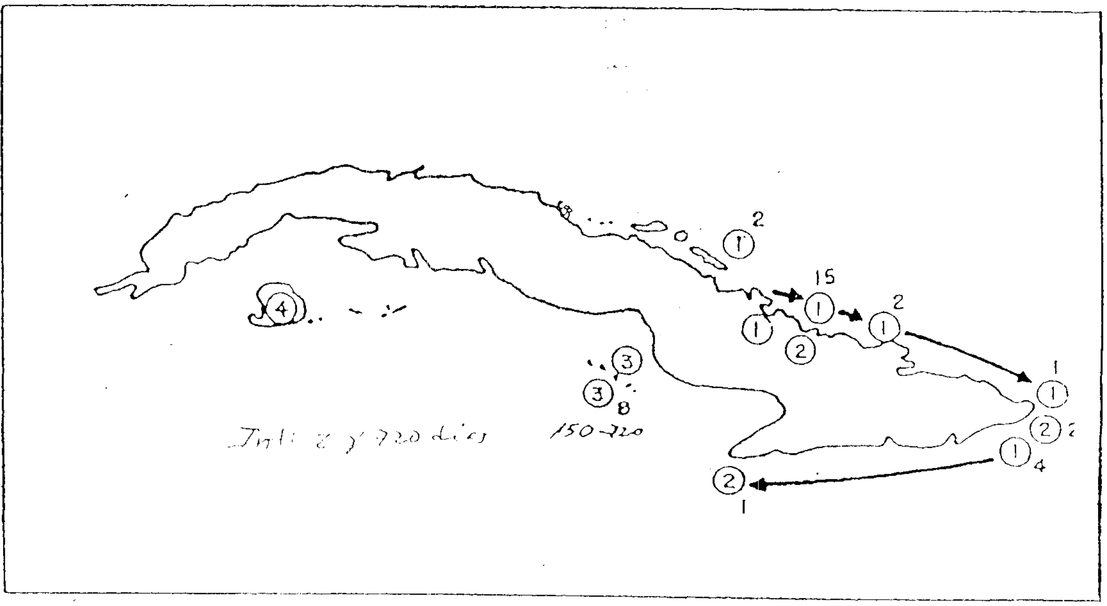


Fig. 4. Recapturas y posibles recorridos de los careyes marcados en Cuba

OCCASIONAL CATCH AND SOME BIOLOGICAL ASPECTS OF DERMOCHELYS CORIACEA IN CUBA

Felix Moncada, Omar Rodriguez

Centro de Investigaciones Pesqueras

INTRODUCTION

The leatherback is a species found rather infrequently in Cuban waters, but is occasionally caught. However, it is not an important fisheries resource like other marine turtles. The objective of this paper is to present an analysis of the biological fisheries information collected in Cuba during more than 10 years as a contribution to the better understanding of this species. The information used was obtained from occasional leatherback capture data on a yearly and monthly basis from 1980 and 1993, nationally as well as for each fishery zone on the Cuban coastal shelf. Figure 1 illustrates the our fisheries zones in which the Cuban shelf can be divided. Zone A: the southeast region, zone B: the southwest region, zone C: to the northwest, and zone D: the northeast region.

RESULTS

The occasional capture at the national level from 1980 to 1993 had a fluctuating values of between 4.0 and 78 metric tons, with a mean of 25.8 tons. In 1981 and 82 the highest values were observed when adding the contributions of other fisheries which have the capacity of catching turtles offshore. This situation prompted actions to protect the species, allowing in the following years only the landing of leatherbacks captured in nets set for other marine turtles.

Analyzing this capture by fishing zone we can see a notable difference between the north coast (zones C and D) and the south (zones A and B). High numbers are found along C and D and considerably less at A and B. We can observe that 63.6% of captures are form zone C, which indicates this zone has the highest occurrence of leatherbacks in the Cuban shelf (figure 2).

Figure 3 shows the national capture statistics by month or season and we can observe that leatherbacks are caught throughout the year with peaks in December and January. Monthly variation by fishing zone illustrates that in zones C and D the majority of turtles are caught in December and January, in zone B during September and January, and in zone A during September and December.

Biological aspects of sizes and body weights

Leatherbacks ranged from 108-183 cm in females with a mean of 143 cm and from 143-160 cm in males with a mean of 154 cm. Body weights of females varied from 113 to 428 kg with a mean of 236 kg, males weighed from 220 to 283 kg with a mean of 259 kg.

The length-weight equation from 31 individuals with a correlation coefficient of 0.831 was $W=0.000105 L^{2.4705}$, which is significant at the 95% confidence level. Length versus width relation was determined and a linear relation was found with the same sample size: $Width= 1.2376 + 0.5137 L$, with a correlation coefficient of 0.76 and significant at the 95% confidence level.

Sex ratio

Sex ratio observed was 77.4% females and 22.6% males which coincides with the results of other species in Cuban waters in which a female bias is found.

Sex ratio observed was 77.4% females and 22.6% males which coincides with the results of other species in Cuban waters in which a female bias is found.

Nesting

Leatherback nesting in Cuba is extremely rare. Surveys show that the species nests occasionally in the Peninsula de Guanahacabibes (southwest region), in Cayo Blanco and Cayo Caguama in the southeastern region.

Recaptures

Four leatherbacks recaptured in the southeast region of the island tagged outside of Cuba indicate that turtles from other areas arrive at the Cuban shelf, which confirms the highly migratory nature of this species.

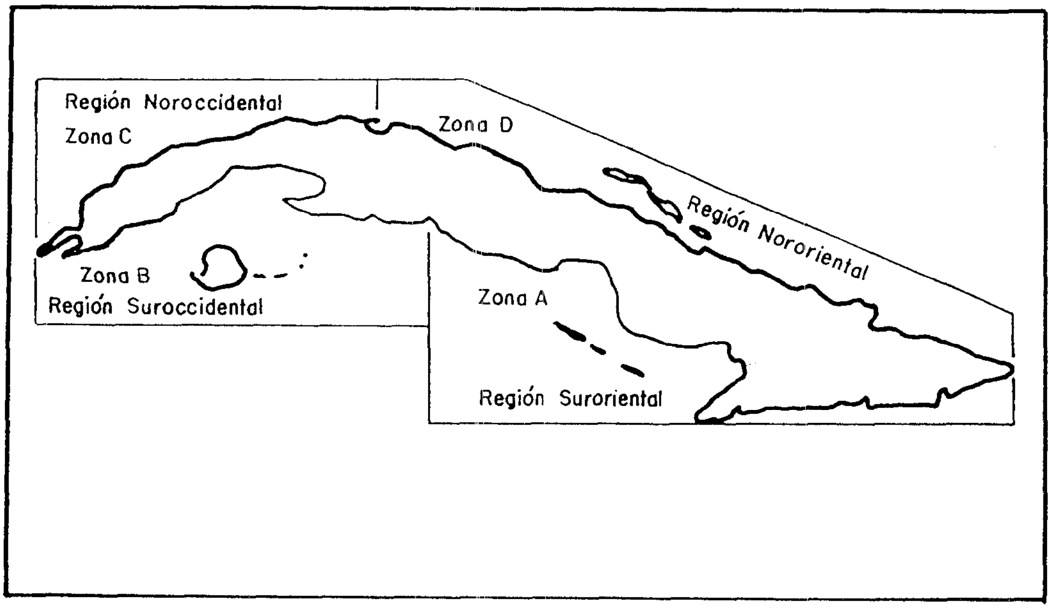


Fig.1 - Zonas o regiones de pesca de la plataforma cubana.

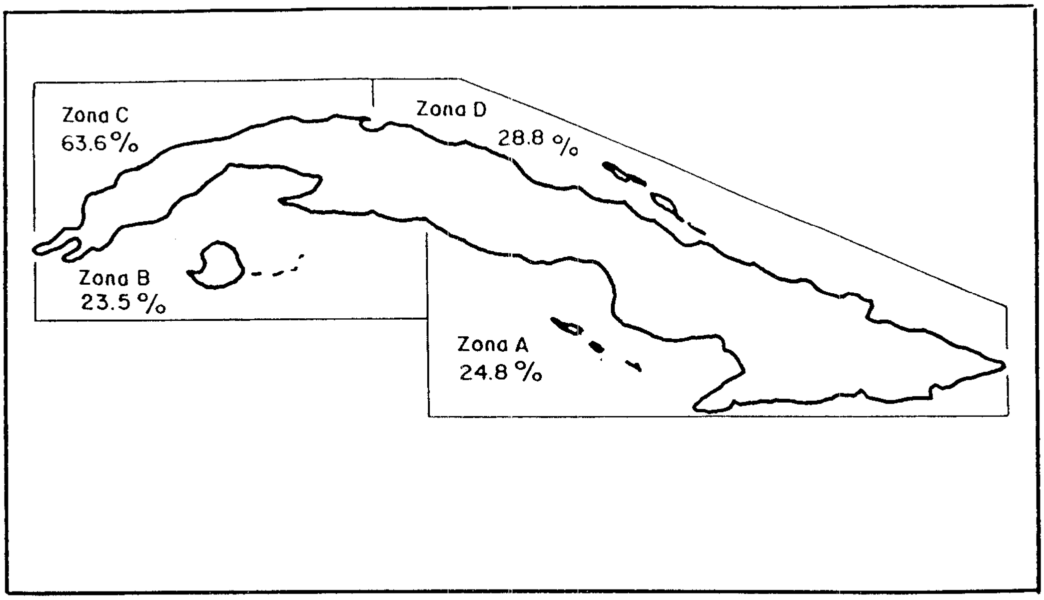
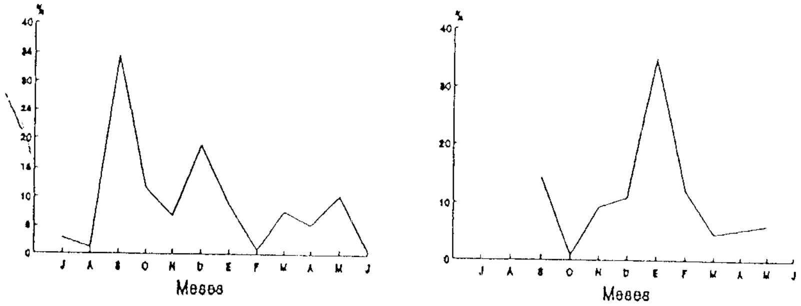
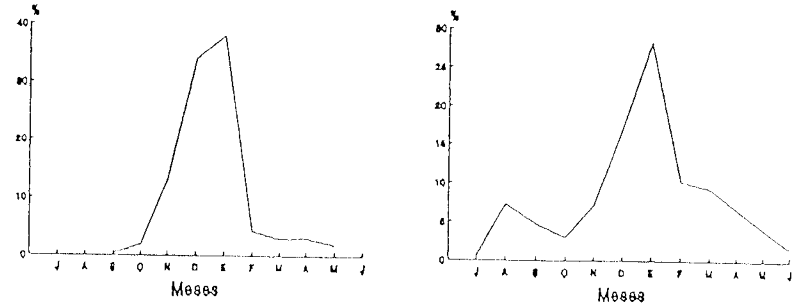


Fig.2- Porciento que representa cada zona de pesca en la captura ocasional de tinglado.



a. Zona A

b. Zona B



c. Zona C.

d. Zona D

Figura 3.- Variacion mensual de la captura ocasional de tinglado por zona de pesca expresada en por ciento (1980-1993).

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FATTY ACIDS IN DEPOT FAT OF JUVENILE GREEN TURTLES FEEDING AT DIFFERENT LOCATIONS IN THE HAWAIIAN ISLANDS

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Locations of feeding grounds and types of food available to marine turtles are important conservation considerations. The green turtle, Chelonia mydas, is unique among marine turtles in that as an adult in the wild, it is preferentially an herbivore, feeding on sea grasses and algae (Ross 1985, Bjorndal 1981, Mortimer 1981, Balazs, 1980).

Dietary fatty acids may be incorporated directly into depot fat, in addition to the fatty acids biosynthesized by the animal. Joseph et al. (1985) described the effects of diet on the depot fatty acid composition of the green turtle. Differences were noted between the fatty acid composition of depot fat of a Caribbean green turtle, feeding primarily on sea grass, and that of a green turtle captured in the Hawaiian Islands. The authors suggested that the inclusion of algae, and possibly jellyfish, in the diet of the Hawaiian green may account for this difference.

Hawaiian green turtles spend most of their lives residing in coastal areas of the large volcanic islands at the southeastern end of the archipelago. Research at numerous sites in these nearshore waters is ongoing to gather baseline data on growth rates, food sources, movements, health status, habitat characteristics, and population trends (Russell and Balazs 1994, Balazs et al. 1994, Balazs 1991, Balazs et al. 1987, Balazs 1980). The habitat characteristics of these foraging pastures differ considerably and cause variations in feeding strategy and behavior. We undertook a study to determine if depot fatty acid composition could be used to identify feeding locations for Hawaiian green turtles. We collected depot fat samples from juvenile turtles from two distinct feeding populations. The initial phase of the study, described in this report, is a comparison of the depot fatty acid composition of 22 turtles captured at Ahu-O-Laka in Kaneohe Bay, Oahu with those of 24 animals from Kiholo Bay, Island of Hawaii. Though both turtles with and without fibropapillomatosis were caught and sampled, only apparently healthy animals are addressed in this phase of the study.

STUDY SITES

Kiholo Bay is a small bay on the Kona Coast of the Island of Hawaii. The turtles sleep under the rocky outcrops of the shore of the bay at night and feed on the red alga Gelidium pusilium from nearby lava rock substrate during the day. Ahu-O-Laka is a submerged sandbar in the middle of Kaneohe Bay on Oahu. Resident turtles are thought to feed primarily on Halophila hawaiiensis, a sea grass which grows abundantly in the sandy substrate. Turtles also have the opportunity in Kaneohe Bay to feed on Hypnea, Acanthophora, Codium, and Ulva, but these algae have not been found in significant amounts in stomach flushings or in the mouths of turtles caught at Ahu-O-Laka (Balazs et al. 1993). Many of the turtles captured at Ahu-O-Laka still had blades of Halophila in their mouths when apprehended. There is no overlap between Kiholo Bay and Ahu-O-Laka in availability of plant food items.

MATERIALS AND METHODS

Turtles were caught at Kiholo Bay on Hawaii and at Kaneohe Bay on Oahu. Kiholo animals were caught by hand while snorkeling along the rocky shore of the bay at night. Kaneohe Bay animals were caught by hand by diving from the bow of a small boat while motoring slowly along the sandbar-grazing area known as Ahu-O-Laka. Tissue biopsies were taken from the fat pocket located just dorsal to the insertion of the right hind flipper. The area was deadened with lidocaine and rinsed with betadine before a small incision was made with a scalpel, and 1-5 g fat was teased out using a scalpel and hemostat. The incision was closed with 1-2 stitches, and the turtle was returned to the water (Balazs 1985, Balazs and Morris unpublished data). Halophila hawaiiensis was collected at Ahu-O-Laka, and Gelidium pusilium was collected at Kiholo.

Fat and dietary samples were frozen on dry ice immediately after collection and stored at -20°C until analyzed. Lipids were extracted from samples with chloroform/methanol (Folch, 1957) and fatty acid methyl esters were prepared as described by Christopherson and Glass (1969). The resulting fatty acid methyl esters (FAME) were analyzed on an HP5890 gas chromatograph fitted with a 30 m DB225 capillary column and a flame ionization detector. Peaks were identified by comparison of their retention times with those of primary and secondary standards, argentation TLC, and GC/MS.

RESULTS AND DISCUSSION

Though the habitats, and therefore the dietary items, were distinctly different at Kiholo and Ahu-O-Laka, these differences were not reflected in the composition of the depot fat of the animals feeding in these two locations. A correlation was observed between depot fatty acid profile and the size of the turtle (SCL), regardless of feeding location. The Type 2 profile (Fig. 1), typical of the larger animals, had marked similarities to those found for depot fat of an adult Caribbean green turtle (Joseph et al, 1985) and both Hawaiian and Caribbean green turtle egg lipids (Seaborn and Moore, unpublished data). The typical profile found for the smaller turtles may indicate differences in lipid metabolism or, to some extent, their diet in the pelagic stage. If site-dependant differences exist in the depot fatty acid composition of the turtles feeding at the two sites, they were masked by the striking differences associated with turtle size (Fig. 2). Although this study did not show a definitive relationship between diet and depot fatty acid composition, it does suggest opportunities for studies in predator/prey relationships and lipid metabolism.

ACKNOWLEDGEMENTS

The authors would like to gratefully acknowledge the help of Shawn K. Koga, Connie Sears, Marc Rice, George Watson, and students of the Hawaiian Preparatory Academy.

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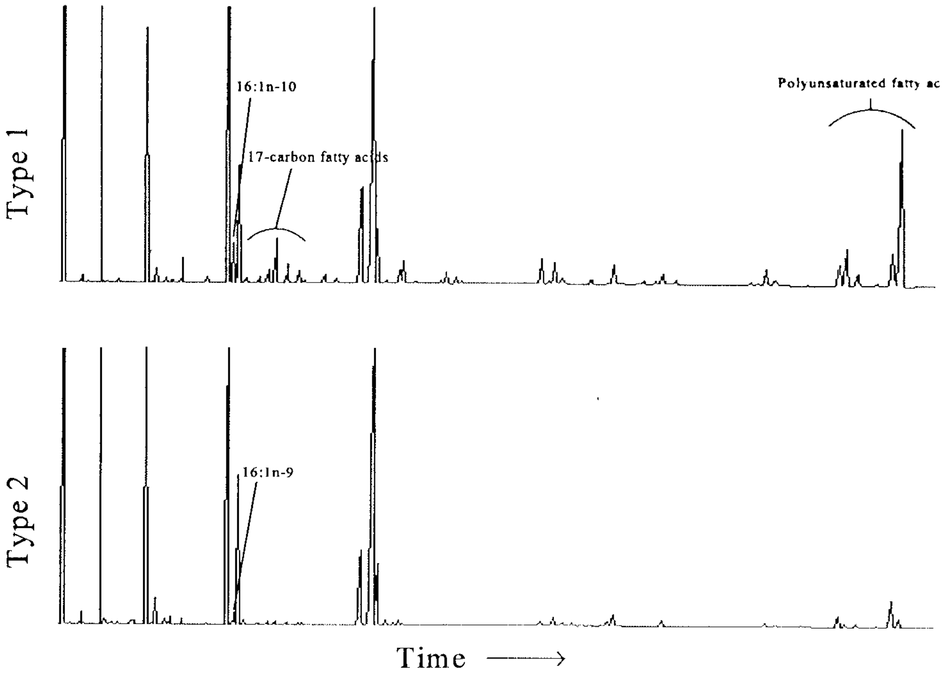

Figure 1. Typical chromatographic profiles from analysis of turtle depot fat. Elution time is directly related to the identity of each component; peak size is directly proportional to the amount of each componenet in the sample. Although considerable variations were found in the fatty acid profiles of turtles from both locations, most of the animals could be categorized as having one of two profile types. We arbitrarily designated these as Type 1 and Type 2. 20 Kaneohe Bay turtles and 11 Kiholo turtles were classified as Type 1. 9 of the Kiholo Turtles were classified as Type 2, with 3 Kiholo and 2 Kaneohe Bay animals classified as intermediate between the two profiles. Major differences between the two profile types were exhibited in the 16-carbon monoenes, the 17-carbon fatty acids, and the polyunsaturated fatty acids.

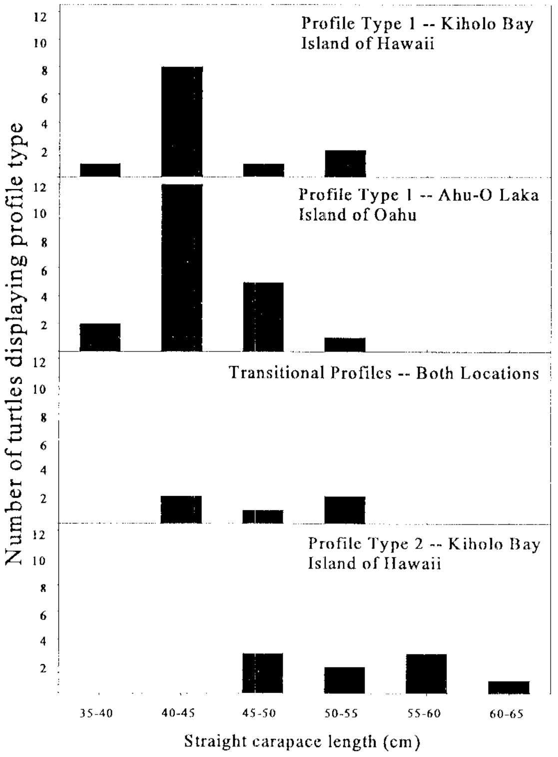

Figure 2. Size distribution based on straight carapace length (SCL) for each type of turtle and each location. Turtles classified as Type 1 were predominantly those with SCL of 40-45 cm, while those classified as Type 2 had SCL>45 cm. Turtles with a fatty acid profile intermediate between the two were also of intermediate size.

1994 NESTING SEA TURTLE SURVEY, NEST PROTECTION AND PREDATOR REMOVAL, CUMBERLAND ISLAND NATIONAL SEASHORE

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Cumberland Island National Seashore was established in 1971 and is on the largest, southernmost barrier island along the Georgia coast. In order to protect sea turtle nests from predation, to enhance and measure nesting success, and to establish the nesting sea turtle database, the National Park hired two biotechs to monitor the 27 km long nesting beach. The entire length of the National Seashore was not surveyed through a complete nesting season until 1992. Because the first two years of monitoring detected high predation by racoons (52% in 1992, 38% in 1993), nest protection was deemed necessary this year. New activities included probing nests to confirm locations for screening and active predator control.

METHODS

Daily monitoring using 4-wheel all-terrain motorcycles was conducted. Each nesting crawl above high tide was documented. Potential nesting crawls were probed with a rounded 9.5 mm diameter wooden dowel. If a nest cavity was encountered, a 1.2 m square section of welded wire with a 5 X 10 cm mesh size was placed above the uppermost eggs and centered directly over the nest. The screen was covered with sand to original grade.

Direct predator removal included live trapping and euthanizing racoons. Hav-A-Hart traps were distributed along the beach when racoon tracks were detected. Eighteen days after nesting began, feral hogs began to depredate sea turtle nests for the first time in a decade. Eight days later, park personnel initiated nightly and early morning patrols to hunt the pigs.

RESULTS AND DISCUSSION

There were a higher number of nesting activities and confirmed nests this year as compared to the previous two years: 164 confirmed nests in 1992, 92 in 1993, and 248 in 1994. Nesting was not uniformly distributed along the beach. The highest density of nesting (48.8%) was along a 5 km long section on the north end of the island.

One hundred sixty eight (67.7%) of the nests hatched. The loggerhead sea turtle (*Caretta caretta*) was the only sea turtle to nest on Cumberland Island this year. The average incubation period of each clutch was 65.7 days (55-81). The average clutch size was 101 eggs (28-152).

Hatchling emergence success was 63.3%. Emergence success was reduced by predation and poor nest site selection. Twelve nests were lost to storms and 14 were lost to inundation of seawater. Forty nests were lost to predation. Racoons depredated 16 nests (6.4%). Few nests (2 of 16) depredated by racoons were completely depredated. Feral pigs depredated 22 nests (8.8%). All but one of the 22 nests were completely depredated.

Screening of the nests and direct predator removal did significantly reduce predation thus increase emergence success. For the first time, the park screened nests (187 or 75.4%) to protect them from racoon predation. Emergence success of the nests screened for the entire incubation period (147/248) was 58.8%. Sixty-one nests were not screened. Emergence success for the unscreened nests was 74.7%. The reason for this difference has not been determined. Active predator removal was also undertaken for the first time. Sixty-nine feral hogs were shot over 69 days. Twenty-six racoons were caught and euthanized over a total of approximately 116 trap nights.

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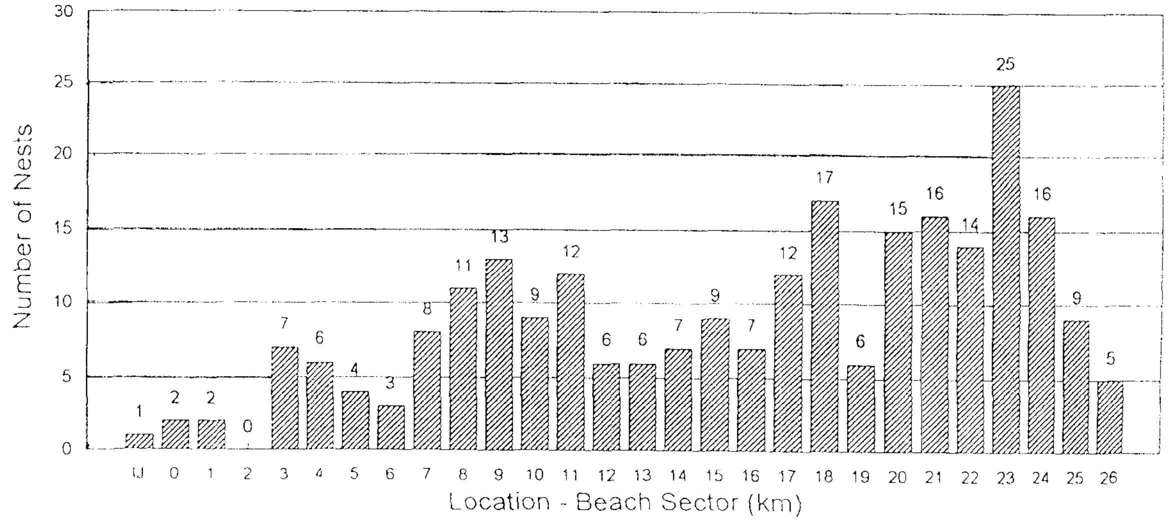
Spacial Distribution of Nests

Cumberland Island, 1994



Number of Confirmed nests = 248

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MEET AND PROTECT THE SEA TURTLES

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INTRODUCTION

In Mexico the urgent ambition to create turistic and urban developments forgot the importance of the natural resources damage creating the environmental education like a important strategy.

The Environmental education role is based in the use of different ways of communications between the different socials sectors for the agreement to participate in the possible solutions against the environmental conflicts.

Thinking in those problems arise the creation of didactical material about environmental education due this is one of the most simple ways to make the communities to participate in the knowledge and to take advantage of the natural resources conservation.

The didactical material include the creations of different forms of printed materials, because with this kind of didactical resources is possible to communicate in a simple language and sensitize at the same time the diferent social sectors about the present situation in general of the natural resources and directly to the sea turtles in Mexico, that has been protected by gouvernamental agencys, universities, socials and civil organizations in spite of all these effort the sea turtle population abundance in Mexico is decreasing for irrational explotation.

OBJECTIVE

This environmental education notebook was created directly for elementary school students with the principal purpose to show them some biologycs common aspects about the sea turtles biology and trying to get conscience directed to the explotation of the sea turtles.

The Centro de Ecologia Costera (C.E.C.) before known Centro de Estudios de la Costa (C.E.C.) of University of Guadalajara to date has done environmental education activities for communicate the recent situation of the regional natural resources dedicated to the infantile populations through audio-visuals, talks, videos with the students and researches collaborations.

RESULTS

Talks and activities about sea turtles were generates explaining the generals biologyc aspects including natural-predators and non-natural predators mentioned in the environmental education notebook based in illustrations like cartoons, pictures, slides and some play-cards getting the child attention directed to the care and the protection of the sea turtle. Those talks were imparted for different students from the village near to nesting beaches and in the jalisco coast including San Patricio, Melaque; Jaluco, El Aguacate and Pto. Vallarta.

Editors note, contact the authors for a copy of the book.

SUBADULT LOGGERHEAD BEHAVIOR IN KINGS BAY, GEORGIA, USA

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Annual maintenance dredging of coastal navigation channels is required to maintain the depth necessary for the passage of large commercial and military ship traffic. Sea turtles and other threatened and endangered species may become entrained in the hopper dredge intake pipes causing them to be crushed or drowned. To assess the causes and to prevent the entrainment of sea turtles by hopper dredges, studies were undertaken. One focus area of these studies was to examine the behavior of sea turtles in dredged channels to determine their baseline diving behavior and to determine if the turtle behavior is amenable to proposed entrainment preventive measures .

METHODS

This study was conducted in the Fernandina Harbor entrance channel (Kings Bay)located on the southeastern Atlantic coast on the boundary line of the states of Florida and Georgia. Turtles were captured by conducting repetitive 15-30 minute (total time) tows in the channel. The trawler was fitted with two 60 foot trawling nets constructed from 8 inch mesh (stretch). All captured turtles were identified, measured, and tagged on each front flipper with a NMFS inconel tag. Trovan Passive Integrated Transponder (PIT) tag was injected subcutaneously in the wrist area of the right front flipper. Measurements were taken according to the protocol detailed in Pritchard et al. (1983). At a minimum, straight line length, straight line width, tail length, and weight were taken. Turtles were released back into the channel near the point of capture as soon as possible following measurement and tagging. Captured turtles were instrumented with both radio and sonic transmitters for biotelemetry studies. The radio and sonic tags were embedded in syntactic foam for flotation and attached to a tether. The tether with an erodible link and breakaway link were attached to the posterior marginal scute of the turtle. The vertical position of the turtle in the water column was recorded through the use of depth sensitive sonic transmitters.

Telemetry studies were conducted continuously for approximately 30 days during the spring, summer, and fall seasons. Initially each day, the channel was surveyed for the presence of instrumented turtles. Locations were determined by positioning a boat directly over an instrumented turtle and recording the GPS coordinates. Each turtle was variance (ANOVA) with alpha set at 0.05. All time intervals were measured in seconds. Raw data were first transformed prior to analysis. Surface and bottom interval data were transformed using the log(x+1) transformation (Zar 1984). Tukey's multiple comparison test was used to determine significant differences in surface interval and bottom time among individual turtles. Analyses were conducted using SPSS for Windows version 6.1.

RESULTS AND DISCUSSION

The percent of the time spent on the bottom for spring was less than for summer or fall (Figure 1). Percent of time spent at mid-water depths and at the surface was greater in the spring than in the summer or fall. The percent of time spent at mid-depth primarily reflect ascent and descent time, although turtles monitored during spring spent a higher percent of time at mid-depths than during other seasons.

The 24 day was divided into 6 each 4 hour time groups beginning at 00:01 and ending at 24:00 (Figure 2). Bottom time was largest from 20:01 to 04:00 (night) and significantly less from 08:00 to 16:00 ($p \leq 0.05$)(day). Dawn (04:01-08:00) and Dusk (16:01-20:00) had mean bottom times intermediate between day and night.

Diving patterns varied widely among individual turtles. Mean bottom time for all turtles combined was 1557.1 ± 71.5 seconds(n = 844, mean, ± SE). Mean surface interval was 169.8 ± 14.0 seconds (n = 1150, mean, ± SE). Mean bottom time was significantly greater in fall (3258.6 sec, SE = 216.7, n = 222) than in the spring (983.0 sec, SE = 143.4, n = 101)and summer(943.1 sec, SE = 30.3, n = 521)($p \leq 0.05$)(Figure 3). Mean surface time was significantly greater in the spring (510 sec, SE = 98.4, n = 131) than in the fall (203.9 sec, SE = 25.7, n = 271) and summer(97.8 sec, SE = 6.7, n = 749)($p \leq 0.05$) (Figure 4). Mean surface time in the fall significantly greater than mean surface time in summer.

Additional analyses are being conducted, but preliminary results suggest that if the dredging season must be expanded outside the winter season, spring is when turtles spend less time on bottom thus less susceptible to entrainment.

ACKNOWLEDGEMENTS

This work was funded by the U.S. Army Corps of Engineers Division, South Atlantic and the U. S. Navy Trident Submarine Base, Kings Bay. Assistance in the field was provided by Chuck Dickerson, Kevin Reine, Jerry Moss, Craig Theriot, George Moncrief, Deborah Shafer, Dawn Kelly, Adrian Brown, John Keinath, Chris Starbird, Dena Dickerson, Michael Gulbeaux, Stephen George, Peter Villa, and Bill Brostoff. Turtles were captured with the assistance crew of the trawlers "Georgia Bulldog" and "Mary Ann." Computer programs were written by Chuck Dickerson.

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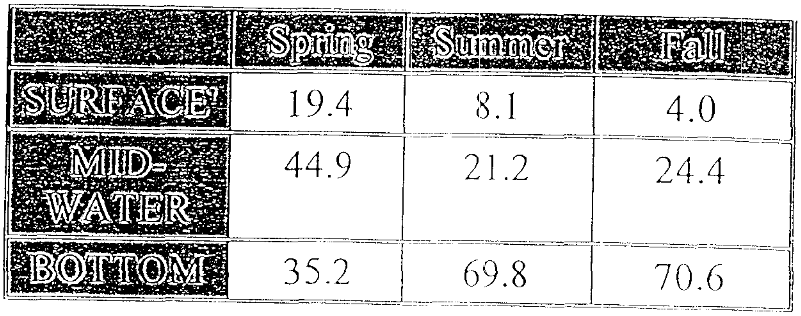

	Spring	Summer	Fall
SURFACE	19.4	8.1	4.0
MID-WATER	44.9	21.2	24.4
BOTTOM	35.2	69.8	70.6

Figure 1 Percent of time spent at the surface, mid-water, and bottom for spring, summer, and fall.

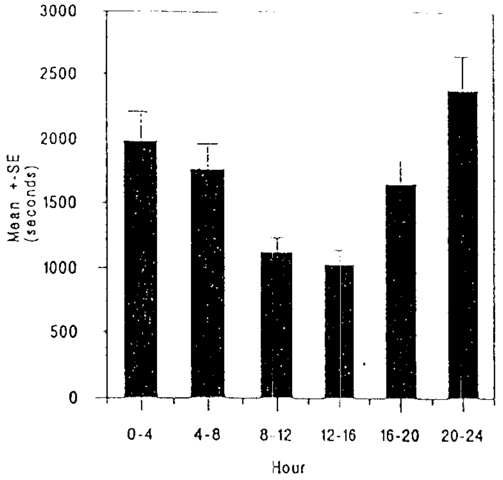

Figure 2 Mean time spent on the bottom for 4-hour time intervals, data for all turtles combined

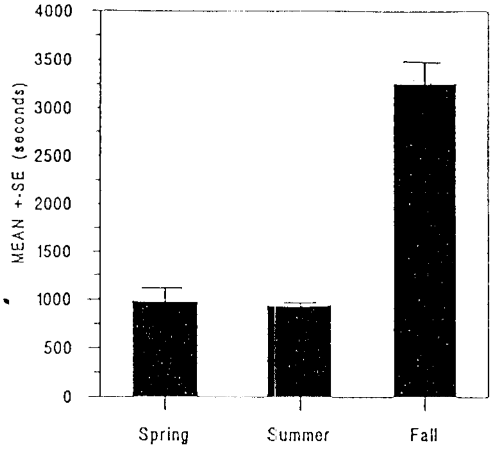

Figure 3. Mean bottom times for spring, summer, and fall.

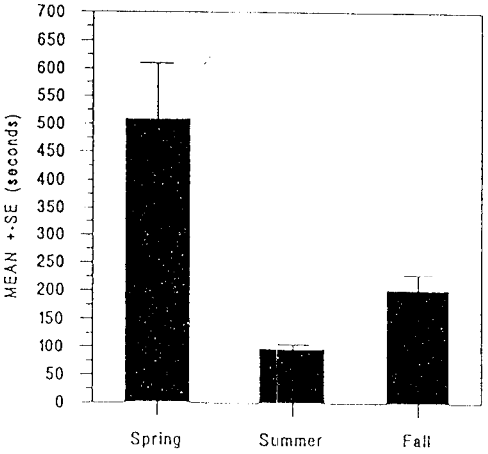

Figure 4. Mean surface times for spring, summer, and fall

THE IMPACT OF TEDS ON THE SHRIMP FISHERY IN CAMPECHE, MEXICO

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In February 1993 the use of Turtle Excluder Devices (TEDs) was made obligatory for Mexican shrimp trawlers in the Gulf of Mexico and Caribbean. This action, in response to an imminent shrimp embargo by the US, was taken before making an adequate evaluation of the impact of TEDs on various aspects of the shrimp fishery. The present study provides an analysis of the affect of TEDs on shrimp capture, as well as on the exclusion of turtles and other bycatch.

STUDY AREA AND METHODS

Ciudad del Carmen, Campeche (CdC), with more than 200 shrimp boats, has one of the most important Mexican fleets in the Gulf of Mexico. Boat captains in CdC were interviewed to characterize the fleet. The most usual boat is 72 feet long and steel hulled. All boats use 4 nets, on both sides an inner and an outer net: each net with a head rope 42 feet long. The entire fleet uses Morrison, soft TEDs.

Hawksbill and Green turtles nest in Campeche from April to September, with peaks in June and July, respectively. Between 5 June and 20 July, 1994, two cruises were made on two different commercial shrimp trawlers, representative of the CdC fleet. A total of 41 trawls were made along the coasts of Campeche and Tabasco; they ranged from 4 to 8 hours, averaging 5 hours. TEDs were either "working" (installed as designed) or "closed" (unsewn from the top of the trawl, and the escape hole sewn shut).

The first cruise began with 10 control trawls, in which all 4 TEDs were working. Thereafter, during each trawl 2 TEDs were left working and 2 were closed. At the end of each trawl, the contents of each net were collected separately and sorted by species. The catch of each species was weighed, the number of individuals counted, and 10 randomly selected individuals of each species were measured.

RESULTS

There was no significant difference in catches of inner and outer nets when all TEDs were working. During the first cruise, nets with closed and working TEDs had no significant difference in the weight of shrimp captured (Fig. 1). However, there was significantly less bycatch in nets with working TEDs. The front flipper of a Ridley turtle was the only evidence of turtle captures during the first cruise.

The TEDs in use by the second trawler were in poor condition, and before the cruise, the starboard outer TED was replaced with a new one. The results of this cruise were comparable to those from the first cruise, when the new TED was working (Fig. 2). Otherwise, there was a significant loss of shrimp from nets with old TEDs. Exclusion of bycatch was significant in all nets, whether TEDs were new or old. One Hawksbill was captured in a net with a closed TED.

During the first cruise the overall, average percent retention for shrimp was 99%; for bycatch, it was 59%. During the second cruise the results with shrimp retention were similar if the new TED was working. When old TEDs were working, the shrimp retention was 86% (or a 14% loss). Bycatch retention was 67% for old TEDs and 83% for new (Table 1).

Nets with closed TEDs caught a total of 43 species of bycatch, and nets with working TEDs caught a total of 40 species. An ANOVA showed no significant difference between closed and working TEDs in the numbers of bycatch species caught.

Four species of bycatch, with different body forms, were: sole (Cyclopsetta chitendeni), squid (Loliginidae sp.) "raton" (Menticirrhus americanus) and snapper (Lutjanus campechanus). For the first three species there was no significant difference in body size between catches with working and closed TEDs; significantly larger snappers were caught in nets with closed

TEDs (Fig. 3).

CONCLUSIONS

Based on the results of 41 trawls during 2 commercial cruises, totaling 250 hours of trawl time, it can be concluded that: a) the loss of shrimp in nets with TEDs is insignificant, IF the TEDs are in adequate condition; b) the ability of the net to retain shrimp is related to the condition of the TED; c) the exclusion of bycatch in nets with TEDs is highly significant; d) bycatch species of small body size and with benthic habits have less chance of escaping through the TED; e) the incidental capture of marine turtles in the Campeche Bight is relatively unimportant.

The FAO (Alverson et al., 1994) calculated that on a world level, 29 million m tons of bycatch are captured yearly; of this, 27 million m tons are discarded. The shrimp fishery contributes to 32% of the unutilized bycatch. The annual bycatch in the Central West Atlantic is estimated at 1.3 million m tons, of which 97% is discarded; this includes commercially important species of snapper (Lutjanidae) and jackfish (Carangidae).

The significance of TEDs is much greater than just eliminating marine turtles. If fishermen understood the benefits to them in using TEDs, and using them correctly, this could reduce the destruction of millions of tons of bycatch every year, and help protect numerous marine resources and marine ecosystems.

If simply excluding turtles is the primary reason to use TEDs, it will be difficult to get fishermen to collaborate. And, if turtles are not a significant part of the bycatch, there will be no good reason to use a gear modification which is just a Turtle Excluder Device.

RECOMMENDATIONS

Further work on TEDs in the southern Gulf of Mexico needs to cover several points: a) increase the sample size of trawls, to determine if the results obtained are representative of a wider area, larger period of time, and other boats and conditions; b) experiment with smaller mesh sizes in soft TEDs to further reduce bycatch; c) experiment with other types of excluders to evaluate their ease of operation and efficiency in shrimp capture and bycatch exclusion; d) assess the incidental capture problem (including sea turtles) in finfish trawls; d) work directly with fishermen in explaining the use and benefits of TEDs.

The work was carried out under permission from the Secretaría de Pesca, and supported by the Fauna and Flora Preservation Society, Earth Island Institute, Caribbean Conservation Programme, and the U.S. Fish and Wildlife Service.

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Table 1. Retention ratios of shrimp and bycatch: nets with working TEDs/nets with closed TEDs.

CRUISE	WORKING TED	CATCH	RETENTION RATIOS				
			PORT	(n)	STARBOARD	(n)	AVERAGE
FIRST	OUTER	SHRIMP	1.01	(18)	0.94	(14)	0.98
		BYCATCH	0.57	(18)	0.73	(14)	0.65
	INNER	SHRIMP	1.07	(18)	0.95	(14)	1.01
		BYCATCH	0.51	(18)	0.54	(14)	0.52
SECOND	OUTER (new TED)	SHRIMP	0.90	(10)	1.05	(14)	0.98
		BYCATCH	0.82	(10)	0.83	(14)	0.83
	INNER (old TEDs)	SHRIMP	0.85	(18)	0.86	(14)	0.86
		BYCATCH	0.63	(18)	0.70	(14)	0.67

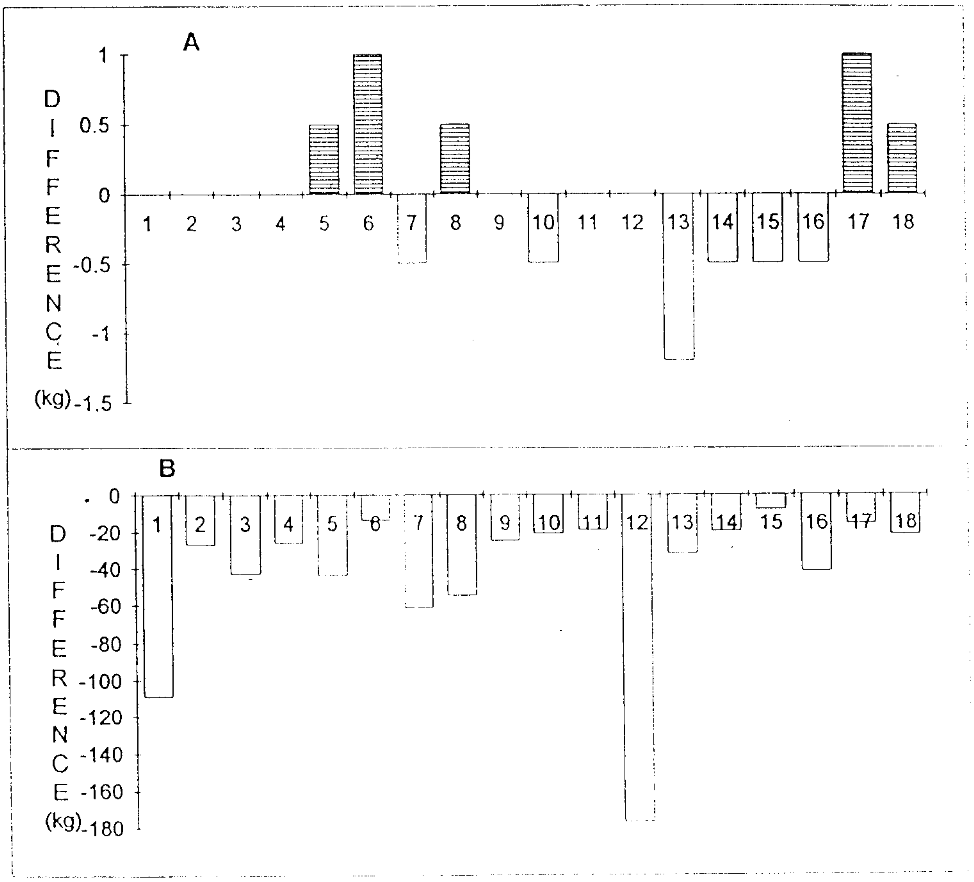

Figure 1. Difference in catch in nets with working TEDs - nets with closed TEDs (in kg); first cruise, trawls 1 to 18: A) shrimp: $t = 0.08$; d.f. = 17; $p > 0.05$; B) bycatch: $t = 4.37$; d.f. = 17; $p < 0.01$.

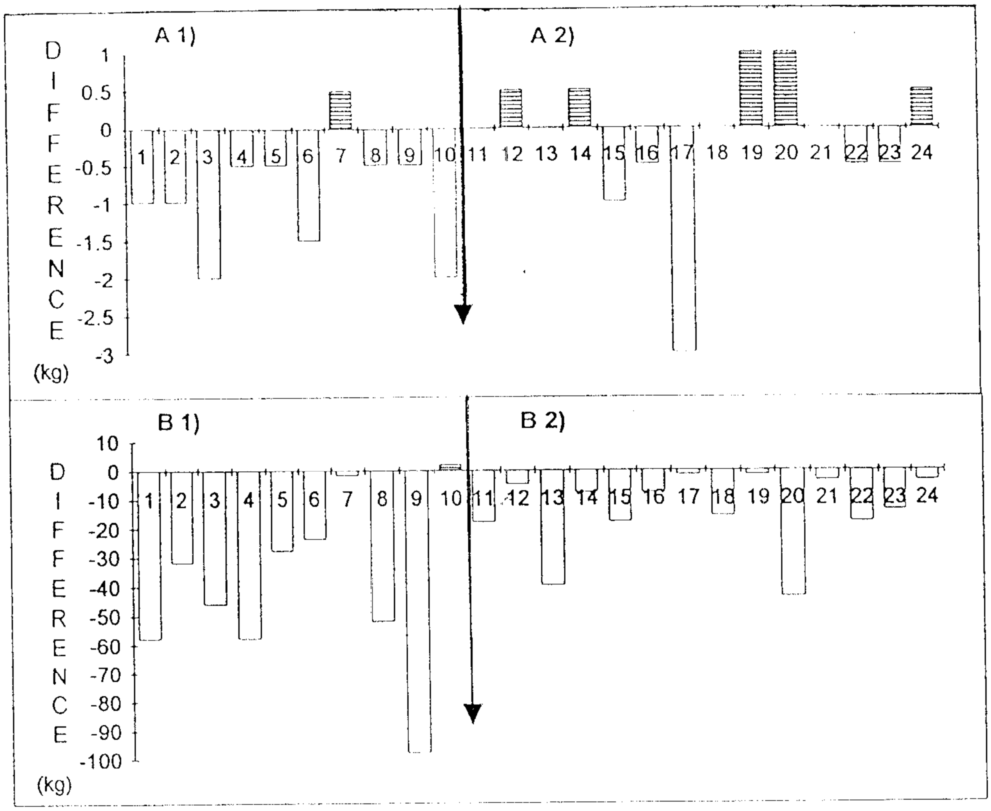

Figure 2. Difference in catch in nets with working TEDs-nets with closed TEDs (in kg); second cruise, trawls 1 to 24: A) shrimp: 1) working TED old: t = 3.67; d.f. = 9; $p < 0.01$; 2) working TED new: t = 0.53; d.f.= 13; $p > 0.05$; B) bycatch: 1) working TED old: t = 4.24; d.f .= 9: $p < 0.01$; 2) working TED new: t = -4.06; d.f. = 13; $p < 0.01$.

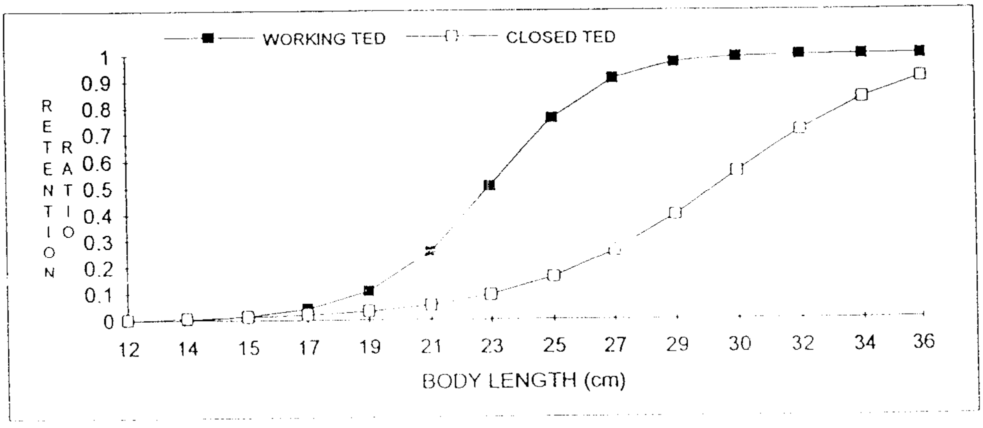

Figure 3. Retention ratio of snapper, Lutjanus campechanus, in nets with working TEDs and nets with closed TEDs, by body length (cm).

THE EFFECTS OF TEMPERATURE AND PRESSURE ON ENZYMES OF ECTOTHERMIC DEEP-DIVING REPTILES.

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The effects of temperature and hydrostatic pressure were measured on lactate dehydrogenase (LDH) and malate dehydrogenase activity (MDH) in pectoralis muscle of Dermochelys coriacea (leatherback) and Trachemys scripta elegans (red-eared slider). The enzymes were analyzed at 5°, 10° and 20°C and 1, 136 and 272 atmospheres of pressure using cofactor concentrations of 0.150 and 0.030mM NADH. The results indicate that the LDH of the deep-diving leatherback is stable at 20°C and 0.150mM NADH but seems to be slightly pressure and temperature sensitive at 5° and 10°C at that cofactor concentration. At 0.030mM NADH the LDH enzyme is stable at 10°C but only up to a pressure of 136 atmospheres, otherwise it exhibits some pressure and temperature sensitivity. In comparison the LDH of the shallow-diving red-eared slider is stable at 20°C and 0.150mM NADH up to 136 atmospheres of pressure and similar to the leatherback, the slider LDH is pressure and temperature sensitive at 5° and 10°C. The MDH of the leatherback is relatively stable at all three temperatures at 0.150mM NADH but seems to be pressure and temperature sensitive at the lower cofactor substrate concentration of 0.030mM NADH. At 0.150mM NADH the MDH of the red-eared slider is more pressure - and temperature - sensitive than the leatherback enzyme. At 0.030mM NADH concentration the slider MDH also is more pressure and temperature - sensitive than the leatherback MDH.

These results from muscle tissue homogenates indicate that the leatherback LDH enzymes are adapted to very high pressures at 20°C which is probably the lower extreme for the core body temperature that these animals maintain in tropical waters and in the Arctic. For leatherback MDH, an enzyme which is more involved with aerobic processes, this protein is both temperature and pressure adapted. These results indicate that in the core of these giant turtles where body temperatures are defended and maintained above 20°C LDH, has adapted to high pressures. In the periphery and extremities where temperatures may drop in response to cold Arctic waters, aerobic processes in the muscles seem to predominate and may be the reason for the temperature and pressure adaptation of MDH. For the slider it appears that there is some adaptation of both LDH and MDH to pressures up to 136 atmospheres at 20°C but at greater pressures and lower temperatures the activity of these enzymes is reduced.

METHODS

Leatherback turtles were restrained on the beach in Costa Rica after they had laid their eggs. A 5 - 10gm biopsy of pectoral muscle was surgically removed aseptically, immediately put on ice, and then the turtles were sutured, given a dose of 10 mg/kg Amakacin antibiotic and then released. Within one hour of removal the tissues were frozen using liquid nitrogen and were then stored cryo vials in a super cold (- 80°C) freezer until they could be analyzed. The frozen cryo vials were transported by air on dry ice to laboratories in the U.S. The tissue samples were analyzed within three months of extraction. The red-eared slider, a shallow-living, fresh water aquatic turtle was used for comparison. These turtles were obtained from Carolina Biological. A 5 - 10gm biopsy of pectoral muscle was taken from each turtle. This turtle is similar to the leatherback in that it too is primarily aquatic, only coming on land to nest. It is a much smaller turtle, however, only weighing about 3 kilograms with maximum dives of about 20 meters deep.

All tissues were kept frozen until the analysis was done. The muscle tissue was homogenized by hand in a conical glass homogenizer, having ground - glass contact surfaces, at 0° to 4°C ("Duall type 23"; Kontes Glass Co., Vineland, New Jersey, USA) using a buffer of ice-cold 10mM Tris/HCl (pH 7.5 at 10°C). The muscle was homogenized in a 1:10 dilution (wt:vol) using approximately 0.5 grams of muscle. These solutions were too concentrated and were diluted an additional 1:5 (vol:vol) for LDH of both turtles and MDH of the red-eared slider. The leatherback had less MDH activity and so was diluted 1:2 instead. The homogenates were centrifuged at 12,000 rpm for 2 minutes and the supernatants were removed for analysis.

Enzymes studied are involved in the anaerobic (glycolytic) and aerobic (citric acid cycle) pathways. Measurements were obtained using a high-pressure optical cell at 5°, 10° and 20°C and at 1, 136 and 272 atmospheres of pressure. The cell was mounted in a Perkin-Elmer Lambda 3B spectrophotometer and the reactions were followed as a decrease in absorbance at 340nm.

The assay medium contained 80 mM Tris/HCl (pH 7.5 at 10°C), 100 mM KCl, 0.2 mM oxalacetate and 0.150 mM NADH. This reaction was also run at 0.030 mM NADH as for LDH to test different saturation levels. A 10 microliter aliquot of supernatant was added to the medium and the decrease in absorbance was followed at 340nm. The measurements in this study are expressed in International Units (IU), which are micromoles of substrate converted to product per minute per gram wet weight of tissue, calculated by the equation: IU/g muscle =(Absorbance change/minute)(mls assay)(dilution)(100) / 6.22

RESULTS

The enzyme activity (micromoles substrate converted to product per minute) was standardized to grams per wet weight of tissue to allow comparison of the relative activities for the two different turtle species. Dry tissue weight and protein content in the homogenate of the supernatant are two methods often used in enzyme analysis but were not used in this study because there can be too much variation between species especially when the size (mass) of the animals being compared is very different. Additionally protein content in these comparisons can be highly variable as was shown by Gibbs and Somero (1990). This study demonstrated that the protein content of fish can be highly variable. It can also give unreliable results with muscle tissue since soluble and mitochondrial protein may only be a very small part of the total muscle protein. By standardizing our enzymic activity by wet weight of tissue we are better able to correlate our results with values found for other aquatic animals.

The activities of LDH and MDH of the pectoral muscles of leatherback turtles and red-eared sliders for the pressure cell experiments are given in Tables 1-4 as functions of pressure. The values given in the tables are the mean values of all runs per turtle species and condition (n=3) with the standard deviations given in parentheses. Table 1 shows that for leatherback turtles the lactate dehydrogenase enzyme at a 0.150 mM NADH concentration exhibits a 29% decrease in activity at 5°C between 1 and 136 atmospheres but only 1% between 136 and 272 atmospheres. This effect is less pronounced at 10°C with an 18% drop between 1 and 136 atmospheres and only a 5% decrease between 136 and 272 atmospheres. At 20°C there is virtually no effect due to pressure at all, with a 5% drop between 1 and 136 atmospheres and a 4% decrease between 136 and 272 atmospheres. At a 0.030 mM NADH concentration, however, there is an effect of pressure seen at 5°C throughout our range of pressures, 25% drop between 1 and 136 atmospheres and 9% between 136 and 272 atmospheres. At 10°C there is only a 6% decrease activity between 1 and 136 atmospheres with a 17% decrease between 136 and 272 atmospheres. At 20°C there is a dramatic decrease in activity throughout the pressure range, with a 34% decline in activity between 1 and 136 atmospheres and a 21% decrease between 136 and 272 atmospheres.

The red-eared slider (Table 2) shows that there is a 19% decrease in LDH activity at 5°C and 0.150 mM NADH between 1 and 136 atmospheres and an 8% decrease between 136 and 272 atmospheres. At 10°C there is less change than at 5°C with a slight pressure effect seen in the 1 to 136 atmosphere range, showing an 18% decrease and only a 4% drop between 136 and 272 atmospheres. At 20°C, however, the reverse is true. There is only a 7% decrease between 1 and 136 atmospheres of pressure but a 16% decline between 136 and 272 atmospheres. At the lower 0.030 mM NADH concentration and 5°C, there is a 19% decrease in activity between 1 and 136 atmospheres with only an 8% decrease between 136 and 272 atmospheres. This pressure effect changes slightly at 10°C, with 17% and 12% decreases, respectively. There is a strong pressure effect seen for the lower NADH concentration at 20°C, with a 22% decrease in activity between 1 and 136 atmospheres and a 24% drop between 136 and 272 atmospheres.

Malate dehydrogenase in the leatherback turtle can be seen to be much less pressure sensitive (Table 3). At 0.150 mM NADH concentration there is an 8% decrease in activity between 1 and 136 atmospheres at 5°C and an 11% decrease at 10°C but virtually no effect (2% for 5°C and no change at 10°C) between 136 and 272 atmospheres. For this cofactor concentration at 20°C there is only a 4% decrease between 1 and 136 atmospheres with a 9% drop in activity between 136 and 272 atmospheres. At the 0.030 mM NADH there is a very dramatic pressure effect between all pressure ranges studied. At 5°C activity decrease 21% between 1 and 136 atmospheres and 8% between 136 and 272 atmospheres. At 10°C these decreases are 11% and 9%, respectively, and at 20°C they are 12% and 12%.

At 0.150 mM NADH concentration, malate dehydrogenase in red-eared sliders shows a slight pressure effect in all pressure ranges used (Table 4). At 5°C there is a 15% decrease in activity between 1 and 136 atmospheres with only a 3% decline between 136 and 272 atmospheres. These results at 10°C show only a 7% drop between 1 and 136 atmospheres with a 6% decrease between 136 and 272 atmospheres. While for 20°C there is a steady decrease throughout the pressure ranges, with an 8% drop between 1 and 136 atmospheres and another 8% drop between 136 and 272 atmospheres. The enzyme at 0.030 mM NADH concentration also appears to be the most stable at 10°C. Results at 5°C show a 17% decrease between 1 and 136 atmospheres and a 13% decrease between 136 and 272 atmospheres while at 10°C there is an 11% drop between 1 and 136 atmospheres and only a 6% decrease between 136 and 272 atmospheres. At 20°C, however, there is a 33% decline between 1 and 136 atmospheres with a 32% decrease between 136 and 272 atmospheres.

DISCUSSION

Lactate dehydrogenase activity in both turtles can be seen to be similar at all temperatures and pressures studied. These high values show the pectoralis muscle of both turtles have a strong capacity for anaerobic activity. High LDH activity values can mean the animal has the capability of short bursts of high speed swimming. Animals that utilize anaerobiosis as a means of metabolism tend to have low levels of anaerobic enzymes in their systems, since they only need enough to keep their metabolism going at a steady or low rate when oxygen is not available. Anaerobic animals don't tend to do burst swimming which would rapidly deplete their energy stores (Bartholomew et al. 1976, Gleeson and Delessio 1990). Leatherbacks probably don't switch to anaerobic activity when they dive but they may use the glycolytic pathway during high speed swimming when they must rapidly dive and return to the surface and thus need short bursts of energy.

Burst swimming is a type of swimming used by fish and reptiles to propel the animal away from a predator. Adult leatherbacks have no known predators, except man, but can use burst swimming to give them the momentum they need for their deep dives. Studies done on alligators show that they do their fastest burst swimming when they are completely submerged and are not using their legs for paddles. They do their slowest burst swimming when they use their legs for paddles and when they are breaching the surface of the water (Turner et al. 1985). Leatherbacks probably don't have these two speeds of burst swimming as the alligators do. They glide down as they dive and so probably only use burst swimming to surface where by using their legs they come up faster than they go down.

The leatherback turtle maintains its body temperature at about 20°C but our studies indicate that its K_m would not be completely conserved as pressure increases. This would seem to indicate that the LDH in the leatherback has not been fully adapted to maintain its function under high pressure and the body temperature is not high enough to completely counteract the pressure effects. This may mean that the leatherback does not need the LDH enzyme to be completely adapted for diving because it may be using the enzyme for burst swimming and more for the propulsion coming up than going down. The red-eared slider maintains its body temperature at about 15°C and our data on Table 2 show that this is probably where we would get the best value for the apparent K_m. Since we didn't do 15°C we can't really say whether K_m would be conserved but since the enzyme seems to follow the same trends as in the leatherback it probably would not.

Malate dehydrogenase is an enzyme involved in the citric acid cycle and electron transport. Since it is involved primarily in reactions that are aerobic it is present at high activities in muscle that is primarily aerobic and at low activities in muscle that has a high capacity for anaerobic ability. The malate dehydrogenase activities of the leatherback and red-eared sliders (Tables 3 and 4) show that at the 0.150 mM NADH substrate concentration there is no effect of temperature on the pressure effect. Sometimes if LDH is present in high concentrations it can interfere with the measurement of MDH activity (Dahlhoff and Somero 1991). The enzyme would need to be purified to make sure this wasn't causing any discrepancies in the activities in this case.

Malate dehydrogenase is known to be a pressure - sensitive enzyme and it has been shown that fish exhibit adaptations to pressure. In studies of shallow - and deep - living teleost fish it was discovered that only species living below 500 - 1000 meters had pressure-resistant enzymes (Siebenaller 1987). This same adaptation has been shown to occur in deep - sea invertebrates. The change in K_m by increasing pressure differs greatly between fish and invertebrates with shallow - living fish being much more sensitive to increased pressure than shallow - living invertebrates (Dahlhoff and Somero 1991). Since neither the leatherback nor the red-eared slider lives below 500-1000 meters for extended periods of time it would be expected that their MDH would be pressure - sensitive. As can be seen from Tables 7 and 8 and Figures 29-32 neither turtle shows much temperature or pressure sensitivity at 0.150mM NADH but both turtles show some evidence of sensitivity at 0.030 mM NADH, with the red-eared slider showing a stronger effect. This would seem to indicate that there has been some adaptation by this enzyme to counteract the pressure effects, possibly by increasing substrate concentrations in the metabolic pathway.

In comparison to the results for these two turtles, pelagic marine fish that live below 500m are pressure and temperature adapted and have been shown to have LDH activities below 50 and MDH activities below 5 (Childress and Somero 1979). The leatherback turtles and the red-eared sliders both have high lactate and malate dehydrogenase activity so probably both have dominant aerobic metabolism with the capacity for short bursts of rapid anaerobic activity. The LDH in both turtles seem to be slightly pressure sensitive so they don't seem to have changed their primary structure to maintain their function at the physiological temperature of the turtles under the changing pressures of their dives. This may indicate that leatherbacks are primarily operating aerobically at a low metabolic rate while on deep dives and are not going anaerobic. This is supported by the fact that the MDH seems to be much less sensitive and so has somehow adapted to changing temperatures and pressure. It would be interesting to do further studies on purified MDH at different cofactor concentrations to see at what cofactor concentrations the enzyme becomes pressure sensitive. That might give us a better idea of how these enzymes are adapting to the changing pressures.

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Table 1. Leatherback Turtle LDH.
Enzyme Activity in I.U. Unit G Wet WT^{-1} (± SD)

Temperature	Cofactor Concentration [NADH]	Pressure[atm] 1	136	272
5°C	0.150mM	79(1.9)	56(5.6)	55(3.8)
	0.030mM	65(5.0)	49(3.8)	43(1.9)
10°C	0.150mM	101(8.7)	83(3.8)	78(3.8)
	0.030mM	71(6.8)	67(3.8)	55.(1.9)
20°C	0.150mM	220(8.1)	209(0.0)	200(6.0)
	0.030mM	113(0.0)	75(3.8)	51(1.9)

Table 2. Red-earred Slider LDH.
Enzyme Activity in I.U. Unit G Wet WT^{-1} (± SD)

		Pressure [atm]		
Temperature	Cofactor Concentration [NADH]	1	136	272
5°C	0.150mM	81(9.5)	68(5.7)	59(8.3)
	0.030mM	64(6.5)	52(0.0)	47(3.8)
10°C	0.150mM	115(2.0)	94(6.0)	90(6.0)
	0.030mM	77(6.8)	64(3.3)	55(1.9)
20°C	0.150mM	220(13.4)	205(18.0)	169(8.0)
	0.030mM	92(4.0)	72(0.0)	50(3.5)

Table 3. Leatherback Turtle MDH.
Enzyme Activity in I.U. Units G Wet WT^{-1} (±SD)

		Pressure [atm]		
Temperature	Cofactor Concentration [NADH]	1	136	272
5°C	0.150mM	49(5.0)	45(3.8)	44(3.3)
	0.030mM	28(0.0)	22(2.0)	20(0.0)
10°C	0.150mM	64(0.0)	57(1.9)	57(1.9)
	0.030mM	45(1.9)	40(3.3)	36(3.3)
20°C	0.150mM	102(9.5)	98(6.8)	87(10.6)
	0.030mM	68(0.0)	60(0.0)	52(0.0)

Table 4. Red-earred Slider MDH.
Enzyme Activity in I.U. Units G Wet WT^{-1} (± SD)

		Pressure [atm]		
Temperature	Cofactor Concentration [NADH]	1	136	272
5°C	0.150mM	88(5.7)	75(10.0)	72(6.5)
	0.030mM	53(3.8)	44(3.3)	37(3.8)
10°C	0.150mM	109(6.5)	101(3.2)	95(8.3)
	0.030mM	98(7.6)	87(5.0)	81(5.0)
20°C	0.150mM	237(2.9)	217(2.9)	200(7.7)
	0.030mM	130(6.8)	87(5.0)	45(5.0)

SKELETOCHRONOLOGY OF LOGGERHEAD SEA TURTLES - A REASSESSMENT

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Zug et al.(1986) examined the skeletal elements of loggerhead sea turtles from Cumberland Island, Georgia in an attempt to estimate ages using skeletochronology. This study reexamines and expands that data set with the intent to develop a more robust estimate for average age at sexual maturity. In addition to the Average Width protocol used in Zug et al. (1986), this study introduces two new techniques, the Regression and Correction protocol to estimate the number of growth layers lost to reorption. The Correction protocol is determined to generate the most accurate age estimates. Using the average age of nesting females as an approximation of the average size at sexual maturity, this study estimates the average age at sexual maturity to be between 20 and 24 years. This estimate is comparable to those of other studies that use a size of maturity that is based on the average adult.

Mark and Recapture Studies	Estimated Age at Sexual Maturity	Straight Carapace Length Used
Frazer, 1983	22	?
Frazer and Ehrhart, 1985	12-30	74.0 to 92.0 cm

Skeltochronology Studies	Estimated Age at Sexual Maturity	Straigh Carapace Length Used
Klinger and Musick, 1995	22	92.5 cm
Present Study	20-24	92.4 cm

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ENCOUNTER WITH A JUVENILE HAWKSBILL TURTLE OFFSHORE SAPELO ISLAND, GEORGIA

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INTRODUCTION

It is well known that information regarding the pelagic stage ("lost year") of sea turtle development for all species is limited. There is evidence in the literature (Carr, 1957; Carr, et. al. 1984; Carr,1986; Witham, 1980; Meylan, 1984 a; Fletemeyer, 1978; Keinath, Musick, Swingle, 1991) as well as data collected by the National Marine Fisheries Service (Wendy Teas, personal communication) of encounters with "lost year" stage loggerhead (Caretta caretta), green (Chelonia mydas) kemps ridley (Lepidochelvs kempi) and the hawksbill (Eretmochelys imbricata) sea turtles on the U.S. East and Gulf Coasts. Sightings of pelagic stage loggerhead turtles dominate the existing literature and records for this region. Carr suggested (Carr, 1986) that this may be due to the large nesting aggregates of loggerhead turtles utilizing beaches in the Southeastern U.S. and the proximity of these nesting beaches to the western edge of the Gulf Stream, which is the major current that flows from the Gulf of Mexico Northeast along the US East Coast. The number of recorded sightings for the pelagic stage hawksbill turtle in this region follows the loggerhead turtle (Carr, 1986 and Wendy Teas, NMFS, personal communication). The sightings of "lost year" stage hawksbill turtles between 1981 and 1994 include pelagic encounters in Massachusetts, Virginia, North Carolina and Georgia and strandings in southern Florida and Mustang Island, Texas (Figure 1). The hawksbill turtle is a tropical species, whose foraging habitat has been determined to be coral reefs where it primarily ingests specific species of sponges (Meylan, 1984b; Pritchard, 1979). The primary nesting rookeries for the hawksbill turtle in the Western Atlantic are scattered throughout the Caribbean Basin (Carr, 1986; Meylan, 1984a; Richardson, 1993; Witzel, 1983). Nesting on the continental U.S. is rare with the only exceptions having been recorded on beaches in Southeast Florida (Carr, Hirth, Ogren, 1966; Pritchard, 1979). In this paper I describe an encounter by the crew of the R/V Georgia Bulldog with a pelagic stage hawksbill turtle floating in a Sargasso raft 37 nautical miles east of Sapelo Island, Georgia as well as the climatic and oceanic conditions prevailing prior to and during the encounter and discuss the results.

MATERIALS AND METHODS

One turtle was captured with a dip net tied to a 15' pole and lifted on board the R/V Georgia Bulldog during a research cruise to collect live fish specimens for the University of Georgia Skidaway Marine Extension Aquarium located in Savannah, Georgia. Morphometric parameters of the turtle were measured and recorded using a standard tape. The location of the encounter and of the release were determined by using a Furuno LP-1000 Loran System. All aspects of the encounter (Morphometric parameters, duration, time of day, sea conditions and observations) were video recorded as well as documented in the ship's log. Copies of the video tape were sent to sea turtle biologists for positive identification. Certified buoy data from the Savannah Light Station and Gulf Stream Analysis data were obtained from NOAA for the month of May, 1994 and descriptive analyses were conducted. A May 1994 Coast Pilot Chart prepared by the National Ocean Survey was also examined to determine the flow direction of the near shore currents in the area. Information regarding the possibility of seasonal cycles of

Sargasso raft occurrences in Georgia waters was obtained from observations recorded by Captain Judy Helmey, Ms. Judy's Charters, who has well over 20 years experience fishing off the Georgia Coast.

RESULTS

The turtle was encountered 37 nautical miles east of Sapelo Island, Georgia (31^0 23.12' North Latitude / 80^0 32.70' West Longitude) at 1545 EDT. The over-the-curve carapace length of the turtle was 22.86 cm (9") and curve carapace width was 19.05 cm (7 1/2"). Imbricated carapace coastal scutes were noted and video taped and five central scutes were counted as well as one nucal scute, four coastal scutes and two supracaudal scutes. Examination of the plastron revealed four pairs of inframarginals and a brownish colored patterning was noted. The turtle was kept on board approximately five minutes. From further study of the video footage shot during the encounter, it was determined that the head scale count (prefrontals - 2 pairs; frontal - 1; superaocular - 2; and parietal - 2) further substantiated the identification of the turtle as a hawksbill. It was released from the rear of the vessel in approximately the same location as it was captured. The turtle dove just beneath the surface and swam away from the vessel. The area had experienced moderately strong northeast winds (Mean Wind Direction: May 29 - 80^0, May 30 - 76^0, first 16 hours of May 31 - 68^0; Mean Wind Speed: May 29 - 17.36 kts., May 30 - 20.04 kts, first 16 hours of May 31 - - 16.68 kts) for 64 hours prior to the encounter (Tables 1 and 2). The range for the significant wave height for this 64 hour period was 1.7 meters to 1.1 meters (Table 3). Gulf Stream Analysis data indicated that the approximate location of the western edge of the stream just south of the encounter on May 24, 1994 was North Latitude 30^0 50'/80^0 80' West Longitude and on May 26 the location of the western edge just south of the encounter was approximately directly south of the encounter at 31^0 00' North Latitude / 80^0 32' West Longitude. On May 31, the western edge of the Gulf Stream (31^0 23.12' North Lat. / 80^0 00' W. Long.) was approximately 60 nautical miles east of the turtle's location (Table 4). The May 1994 Coast Pilot Chart showed a current flowing north just east of the 100 fathom line from the Gulf of Mexico to approximately 32^0 40' North Latitude 80^0 West Longitude where the current appears to diverge creating a south current that flows near shore from South Carolina to Florida (Figure 2). Captain Helmey reported that during the months of May, June and some years through July large, thick rafts of Sargasso weed are located 30 to 42 nautical miles off shore Coastal Georgia and appear to be flowing slowly southward. Captain Helmey's records indicate that this is an annual occurrence and that the rafts observed during these months on the Coast of Georgia are so dense that they form thick driftlines from Savannah, GA Southward.

DISCUSSION

Isolated from possible seasonal incidence of Sargasso driftlines off the coast of Georgia as well as the potential for seasonal cycles throughout the East and Gulf Coast Region, this data, the literature and existing records suggest that encounters with "lost year" turtles of all specie are possible but highly improbable given the vastness of the turtle's habitat, the ocean. (Carr, 1957; Carr, et. al. 1984; Carr, 1986; Witham, 1980; Meylan, 1984a; Pritchard, 1979). Climatic and Sea conditions present 64 hours prior to the encounter with the hawksbill turtle by the R/V Georgia Bulldog suggest that the raft carrying the turtle broke away from the Gulf Stream and drifted southward propelled by a south flowing current in the area as well as by moderately strong northeast winds.

The hawksbill turtle is classified by the U.S. Endangered Species Act as endangered and threatened with extinction throughout its range. Since it was suggested that the Georgia Coast experiences a seasonal presence of Sargasso driftlines from May through July, it appears that an opportunity to gather more information in regards to the "lost year" hawksbill turtle as well as all species may exist in Georgia waters.

Additional information can be gathered in regards to the cycle of Sargasso driftlines in the region. Based upon these findings, the commercial fisheries active in these waters could be encouraged to participate in the monitoring of these rafts for the presence of post-hatchling and "lost year" turtles. Since species identification information for post-hatchling and "lost year" turtles is limited, a detailed identification key denoting defining characteristics of all species of turtles would need to be produced and distributed. Instruction in a standardized data collection method with participating vessel captains would also be encouraged.

ACKNOWLEDGMENTS

Dave Harrington (U. GA Marine Extension Service); A.R. Kontos; Captain Judy Helmey (Ms. Judy's Charters); Skidaway Marine Aquarium staff: Pete Schlein, Heather Sarg, Bob Williams, and Sonia Mullenix; Crew of the R/V Georgia Bulldog: James Higgins, Jr., Paul Daniels; Wendy Teas (NMFS); J.A. Keinath (VIMS); Paruij Doari and Longwater & Company.

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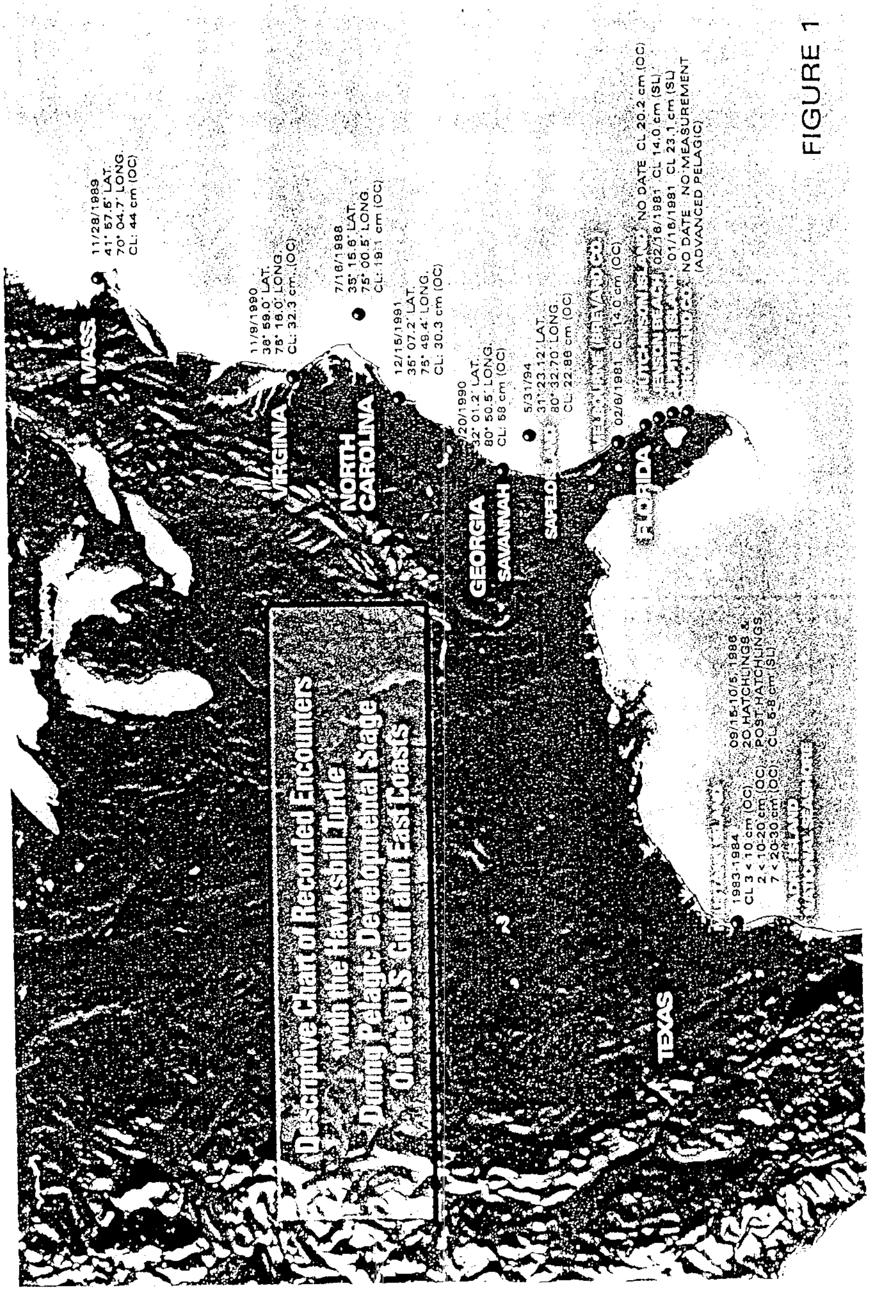

FIGURE 1

Descriptive Chart of Recorded Encounters with the Hawksbill Turtle During Pelagic Developmental Stage On the U.S. Gulf and East Coasts

FIGURE 2

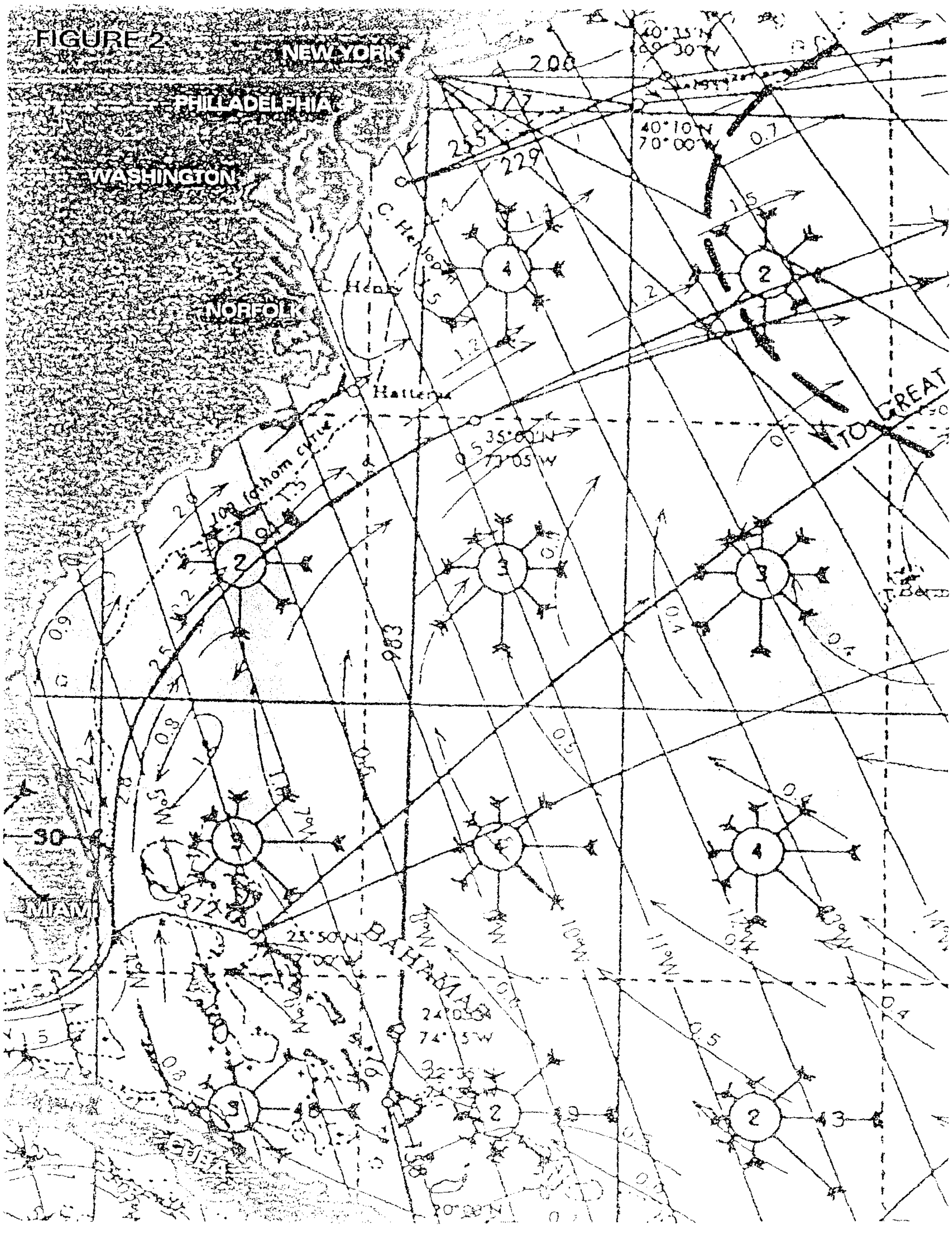
NEW YORK
PHILADELPHIA
WASHINGTON
NORFOLK
MIAMI
CUBA
BAHAMAS
C. Henlopen
C. Henry
Hatteras
100 fathom curve
TO GREAT
40°35'N
69°30'W
40°10'N
70°00'W
35°00'N
73°05'W
23°50'N
24°05'N
74°15'W
206
229
235
983
372

TABLE [illegible]

Mean Wind Direction (Deg.)

	May 24	May 25	May 26	May 27	May 28	May 29	May 30	May 31
Mean	212	199	202	238	158	80	76	68
Std. Dev.	30	18	24	71	104	12	22	9
Std. Error	6	4	5	14	22	3	5	2
Count	25	24	24	24	22	24	21	17
Minimum	166	168	170	4	52	62	54	44
Maximum	266	225	251	360	338	102	149	80

TABLE [illegible]

Mean Wind Speed (Kts.)

	May 24	May 25	May 26	May 27	May 28	May 29	May 30	May 31
Mean	11.85	16.82	17.64	17.03	13.40	17.36	20.04	16.68
Std. Dev.	3.73	2.11	4.03	6.36	8.60	2.12	2.89	6.81
Std. Error	.76	.43	.82	1.30	1.79	.43	.63	1.70
Count	24	24	24	24	23	24	21	16
Minimum	4.90	13.70	9.00	3.80	2.70	14.30	14.40	8.20
Maximum	17.20	21.20	22.90	24.80	28.30	21.70	24.40	25.60

TABLE [illegible]

Mean Sig Wave Ht. (M)

	May 24	May 25	May 26	May 27	May 28	May 29	May 30	May 31
Mean	.5	.9	.9	1.0	.9	1.3	1.4	1.4
Std. Dev.	.1	.1	.1	.3	.9	.1	.1	.2
Std. Error	1.5E-2	2.6E-2	1.8E-2	.1	.2	1.9E-2	2.2E-2	.1
Count	23	23	23	22	22	21	17	16
Minimum	.4	.6	.8	.5	.3	1.2	1.3	1.1
Maximum	.6	1.0	1.1	1.2	4.5	1.5	1.6	1.7

TABLE [illegible]

Western Edge of Gulf Stream Location near 31° 23.12 N. Lat. / 80° 32.70 W. Long.

May 24	30° 50' North Lat. / 80° 80' West Long.
May 26	31° 00' North Lat. / 80° 32' West Long.
May 31	31° 23.12' North Lat. / 80° 00' West Long.

EFFECTS OF BEACH NOURISHMENT ON THE PHYSICAL ATTRIBUTES OF A HIGH DENSITY NESTING BEACH, SEBASTIAN INLET, FLORIDA: ASSESSMENT OF YEAR 3 DATA

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In April 1992, the Sebastian Inlet Tax District contracted FIT to initiate a long-term physical attribute monitoring program that began in May, 1992. The project was designed to compare control (natural) and treatment (nourished) beaches using parameters thought to influence sea turtle nesting and hatching success. This report addresses the results of the 1994 data (year 3) and compares this data with that collected during the previous two years.

The control site (figure 1) is located approximately 3,000 ft north of Sebastian Inlet, a region noted for its high nesting density. The treatment site is located approximately 4,000 ft south of the inlet. The treatment site was most recently subjected to beach nourishment in Winter 1993. The specific aspects of the physical attributes monitoring program are summarized in table 1. Previous analysis has indicated that biweekly sampling did not significantly improve the sensitivity of the monitoring program. The general form of the null hypothesis for each physical attribute monitored during this project is:

The specific physical attribute of the control (natural) beach is not significantly different from the treatment (nourished) beach.

Statistical comparisons between the control and treatment beach were then conducted for each physical attribute to determine if the null hypothesis was accepted or rejected.

The results of the 1994 data are shown table 2. The data indicate some physical attributes are consistently different between beaches (i.e. compaction, mean sand size, temperature) while others are not. Inspection of the long-term data (table 3) indicates those attributes noted to be significantly different in 1994 where also different in the preceding two years of monitoring. This is of particular interest since nourishment of the treatment site occurred in 1993 and yet the differences were observed prior to (1992) and after (1994) project completion. It can also be observed that the remaining attributes are highly variable over time.

The results of this interim report suggest there is, at least for some physical attributes thought to influence sea turtle nesting and hatching success, a high degree of inter-annual and intra-annual variance between control and treatment beaches. Hence, discrete sampling may not be the most reliable method to assess a project's effects. A long-term data set will provide a more reliable basis for environmental impact assessment.

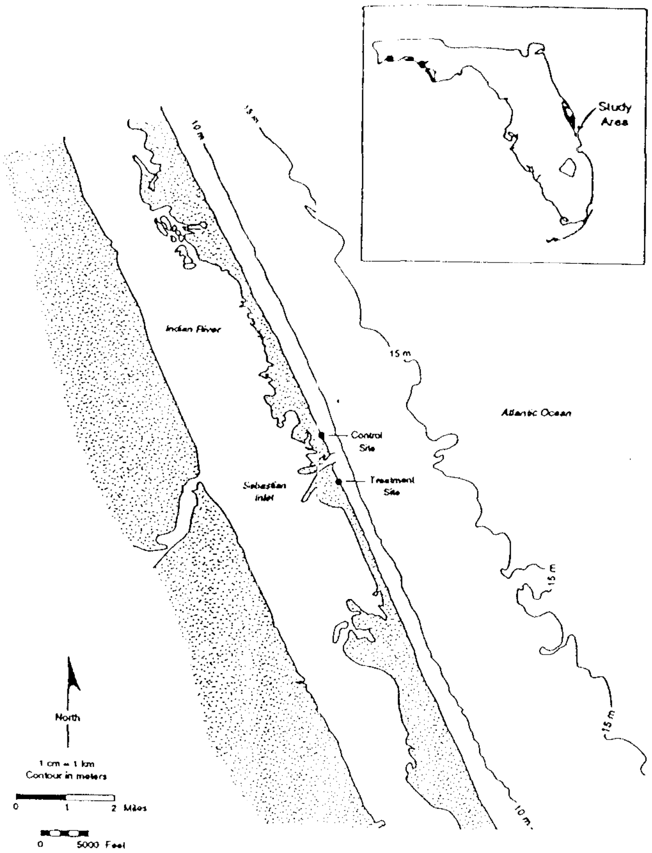

Figure 1 - Regional location map of study area showing position of control (natural) and treatment (nourished) beaches.

Physical Attribute	Sample Depth	Sample Frequency
Compaction	30, 60 cm	monthly
Grain size Gravel and Mud Sand-size Fraction	30, 60 cm	monthly
Moisture	30, 60 cm	monthly
Composition	30, 60 cm	Random
Temperature	30, 60 cm	monthly, for 24 hr period

Table 1: Summary of physical attributes monitored at control and treatment beaches between he months of May and October, 1994.

PHYSICAL ATTRIBUTE	SAMPLING DATE						Comments
	5/19/94	6/17/94	7/16/94	8/15/94	9/13/94	10/12/94	
MOISTURE							Control beach consistently has 1 to 2% less moisture
30 CM	***	NS	NS	**	NS	**	
60 CM	***	**	***	NS	***	*	
COMPACTION							Control beach consistently less compact at both depths than treatment beach by 200 to 300 psi
30 CM	**	***	**	**	***	*	
60 CM	***	***	***	***	***	***	
GRAINSIZE							
% gravel							Virtually no difference between beaches
30 CM	NS	NS	NS	NS	NS	NS	
60 CM	NS	NS	NS	NS	NS	NS	
% mud							Control beach has the same or about .5% less mud than treatment beach
30 CM	**	***	NS	NS	**	NS	
60 CM	**	*	**	*	**	**	
mean sand size							Control beach has approx. 0.3 mm greater mean grain size at both depths
30 CM	***	***	***	***	***	***	
60 CM	***	***	***	***	***	***	
TEMPERATURE							Control beach consistently warmer than treatment beach by approx. 1 degree
30 CM	***	***	***	***	***	***	
60 CM	NA	***	***	***	***	***	
COMPOSITION							Control beach consistently had at least 15% more carbonate than treatment beach
30 CM	NA	NA	***	NA	***	**	
60 CM	NA	NA	***	NA	***	***	

Table 2: Statistical significance of differences between control and treatment beaches for each physical parameter. Statistical significance: * = 95% confidence limit, ** = 99% confidence limit, *** = 99.9% confidence limit. NS = not significant, NA = data not available.

	1992				1993				1994			
Parameter	NS	*	**	***	NS	*	**	***	NS	*	**	***
Moisture												
30 cm	25	25	12	38		60	20	20	50		33	17
60 cm	38	12	38	12	20	20	40	20	17	17	16	50
Compaction												
30 cm				100				100	17		50	33
60 cm				100				100				100
Gravel												
30 cm	63	25	12		80		20		100			
60 cm	64	12	12	12	80	20			100			
Mud												
30 cm	25	25	12	38	20	40	40		50		33	17
60 cm	25		63	12	40	20	20	20		33	67	
Grain size												
30 cm				100				100				100
60 cm				100				100				100
Temperature												
30 cm				100		20		80				100
60 cm				100		20		80				100

Table 3: Long-term statistical significance of differences between control and treatment beaches. Percent occurrence shown beneath levels of significance (see Table 2 for symbol definitions). For example, the moisture difference measured at 30 cm was not significantly different 25% of the time in 1992.

A COMPARISON OF THE GENETIC STRUCTURE OF TWO NESTING POPULATIONS OF GREEN TURTLES

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Work done by Meylan et al (1990) and Bowen et al. (1992) using mitochondrial DNA has revealed that different nesting populations of green turtles (Chelonia mydas) show significant levels of genetic divergence. Because mitochondrial DNA is maternally inherited, these results provide information specifically about female behavior and suggest that they home to their natal beaches to nest.

In order to determine the precision of within-beach, natal homing in green turtles, we have used minisatellite multilocus DNA fingerprinting to examine the genetic structure within two nesting populations in the Western Atlantic. Results from Tortuguero, Costa Rica reveal a negative relationship between genetic similarity for pairs of nesting females and the distance apart that members of the pairs nested. This relationship holds for pairs of females nesting one or two years apart, and provides evidence that green turtles from Tortuguero have very low levels of natal dispersal. The second population (at Melbourne, Florida) showed no relationship between genetic similarity and distance for pairs of nesting females, and therefore provided no evidence of precise natal philopatry. The difference in genetic structure found for Tortuguero and Melbourne suggest that there is a difference in the homing precision of turtles from two different populations. Possible causes are discussed.

METHODS

We used multilocus minisatellite DNA fingerprinting (Jeffreys 1985) to examine the relationship between genetic similarity values and the spatial distribution for 29 individuals from Tortuguero, Costa Rica, and 16 individuals from Melbourne, Florida. Small blood samples from Tortuguero were collected during the 1991, 1992 and 1993 nesting seasons, and the Melbourne samples were collected in the 1994 nesting season. Hae III genomic digests were hybridized with Jeffreys probe 33.15. This technique detects multiple variable number tandem repeat (VNTR) loci containing a particular core sequence and produces individual-specific banding patterns. Since Jeffreys' probes screen dozens of hypervariable loci that assort in Mendelian fashion, they are widely used markers for addressing questions of genetic relatedness within populations. The proportion of bands that are shared between individuals is used as an index of genetic similarity and is higher for related pairs than for unrelated pairs (Piper and Parker 1992).

The Mantel test (Mantel 1967) was used to evaluate whether genetic similarity values and distance were correlated. We used two symmetric similarity matrices for each test (one for genetic similarity based on band-sharing values, and a corresponding matrix of distances between nests), and then assessed the significance of the Mantel test result through permutational analysis. This analysis randomly permutes the order of the elements of a matrix while holding the other constant and performs a Mantel test for each permutation.

RESULTS AND DISCUSSION

Figure 1 shows the relationship between genetic similarity values for pairs of nesting females, and the distance apart that members of the pairs nested during the 1991 nesting season in Tortuguero ($R^2 = 0.243$, $p < 0.001$). This shows that females nesting closer to one another are more closely related than are females that nest farther apart. The same relationship was found for pairs of females nesting one or two years apart (Fig. 2; $R^2 = 0.232$, $p < 0.001$). These results provide evidence that females are exhibiting within-beach natal philopatry and homing to within a narrow range of where their mothers nested.

The results from the Melbourne population reveal no relationship ($R^2 = 0.0187$, $p = 0.162$) between genetic similarity and distance. This lack of any distance-related genetic structure suggests that Melbourne females do not exhibit the same level of precision in natal homing as the Tortuguero turtles.

There are three possible causes of the differences in natal dispersal for the two populations. First, the high levels of beach development and artificial lighting along Melbourne beach may disturb turtles and cause them to move further down the beach to nest. This would elevate the average natal dispersal distance and disrupt any natural genetic structure. Second, the turtles from Tortuguero may be able to home with greater precision because better cues are available to them. If cues of comparable quality are unavailable on Florida beaches, Florida turtles would have greater natal dispersal distances. Third, if kin group associations contribute to the maintenance of the distance-related genetic structure of a nesting population, the lack of structure in the Melbourne population may be a result of reduced opportunity to associate with kin during development.

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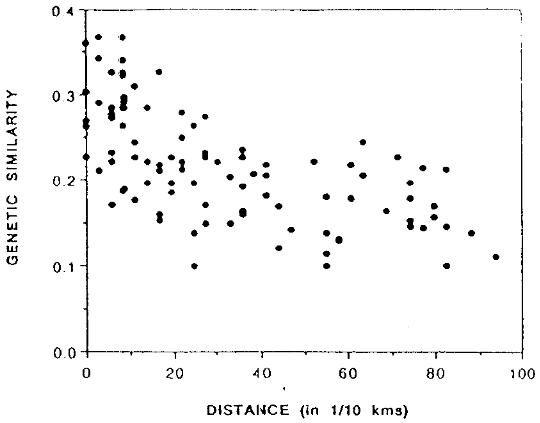

Fig. 1. The relationship between distance and relatedness for pairs of turtles nesting Tortuguero In 1991 ($R2 = 0.243, p < 0.001$)

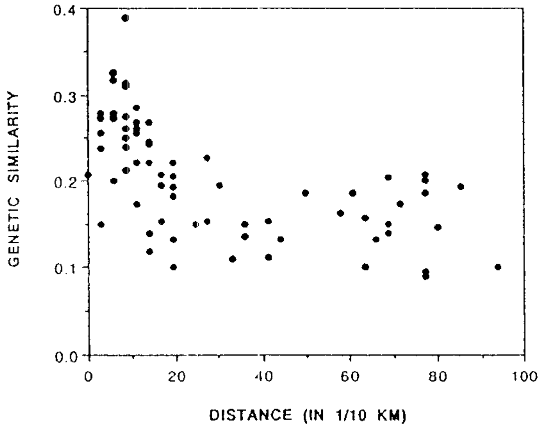

Fig. 2. The relationship between distance and relatedness for pairs of turtles nesting between years at Tortuguero from 1991-1993 ($R2 = 0.232, p < 0.001$)

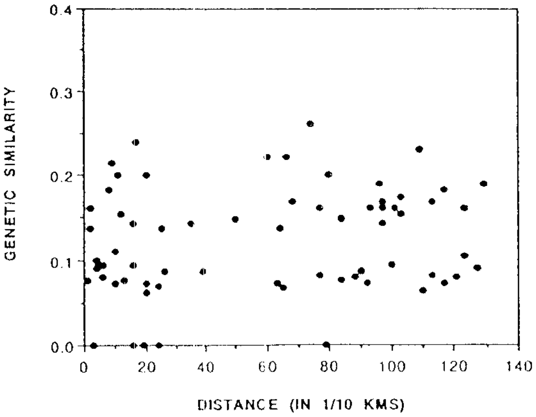

Fig. 3. The relationship between distance and relatedness for pairs of turtles nesting at Melbourne in 1994 ($R2 = 0.0187, p = 0.162$)

TEMPERATURE INDEPENDENT TISSUE METABOLIC RATE OF LEATHERBACK TURTLES, *DERMOCHELYS CORIACEA*, MUSCLE: A NOVEL VERTEBRATE ADAPTATION.

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[2]Department of Biological Sciences, Purdue University, Fort Wayne, IN, 46805, USA

To understand the role of muscle metabolism in the thermoregulatory strategy of leatherback turtles (*Dermochelys coriacea*), we measured the effect of temperature on oxygen consumption of muscle tissue from both leatherback and green turtles (*Chelonia mydas*). Metabolic rate of leatherback pectoralis muscle is independent of temperature from 5-35°C (Q_{10} = 1). Conversely, metabolic rate of muscles from green turtles exhibits a typical vertebrate response to temperature (Q_{10} = 1.3-3.0). Leatherbacks traverse waters with dramatic temperature differences in the course of their migrations from near the Arctic Circle to equatorial waters. This novel metabolic adaptation could help this pelagic reptile to swim actively in cold water and maintain constant body temperature in temperate or tropical oceans. Perfect metabolic compensation of leatherback turtle muscle over the range of temperatures this turtle normally encounters effectively uncouples muscle activity of the leatherback from thermal constraints typical of other vertebrates, and suggests that an unusual biochemical system controls cellular metabolism in its muscles. This unique muscle biochemistry may have important implications for our understanding of human physiology and ia another strong argument for the preservation of this endangered species.

RESIDENTS OR ROAMERS? AN IN-WATER SURVEY OF HAWKSBILL SEA TURTLES AT BUCK ISLAND REEF NATIONAL MONUMENT

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[1]51 Vista Mar, Christiansted, St. Croix, U.S.V.I., 00820

[2]National Park Service, Buck Island Reef National Monument, St. Croix, U.S.V.I. 00821

For the last 10 years research on the endangered hawksbill sea turtle (*Eretmochelys imbricata*) in the Caribbean has primarily focused on the adult female nesting populations. These studies have provided essential information on fidelity, remigration, and genetics which are helping us to understand the relationships between known Caribbean nesting hawksbill populations. The significance of the nesting beaches in the islands is obvious, however, limited surveys have been conducted to census the hawksbill populations inhabiting the near shore waters in the Virgin Islands (Boulon, 1994). In 1994 Limpus reported that *Caretta caretta* spend the greatest period of their lives within the developmental habitat and that their association with this site may last for decades; then, when they reach sexual maturity, adults leave these areas only for reproductive migrations (Limpus, 1994). In light of the limited amount of nearshore foraging habitat around the Virgin Islands as well as the concentration of human activities in these areas, it is essential to determine if hawksbill turtles in the Virgin Islands are exhibiting a similar strategy and utilizing nearshore foraging grounds in this same manner.

The Hawksbill Turtle Recovery Plan states that we need to know the abundance, and spacial and temporal distribution of hawksbills in the marine environment as well as information on genetic relationships among Caribbean populations if we are to adequately protect and enhance the survival of hawksbill turtles (NMFS, 1993).

It was felt that a study on the foraging population at the National Park Service's Buck Island Reef National Monument, St. Croix, U.S. Virgin Islands, would improve understanding of the regions hawksbill population. This study was modeled after on-going research by Robert van Dam and Carlos Diez at Mona Island, Puerto Rico, (van Dam, 1994) and in-water research methods developed by Colin Limpus, Queensland Turtle Research Program, Australia (Limpus, 1992). The permit to conduct surveys of hawksbill turtles in the nearshore environment at Buck Island and access the feasibility of in-water capture was approved.

Boat captains operating snorkel trips to Buck Island often reported sightings of turtles in the area of the Underwater Trail. However, during extensive marine studies carried out at the Monument the biologists rarely noted seeing turtles. To resolve this conflict and determine the presence or absence of hawksbill turtles, we began snorkel surveys where turtle sightings had been reported. Our time constraints only allowed for 1-2 snorkel surveys per week , typically after a hot day of excavating nests on Buck Island, and each survey lasted only 1-2 hours. From the result of our findings, we have decided that it requires a different looking strategy and that the biologist must have been concentrating on the corals and benthic organisms and not looking around because when you look carefully for the turtles, they are there.

Our survey area was approximately 1/2 kilometer square. These surveys extended from shallow shoreline reef with depths of 5-8 ', to lagoon backreef sites with depths ranging from 8-12 ', and out through cuts in the reef to the forereef, including the formations called Haystacks which are large mounds of some live but mostly dead <u>Acropora palmata</u> that now serve as substrate for new coral in water depths of about 40'.

When a hawksbill was sighted, we would position ourselves directly above it and free dive down. To capture the turtle we would grasp the carapace with one hand over the nuchal scute and the other on the post-marginals. Usually the turtles first reaction was to attempt a 180 degree turn, so the capture had to be firm and all in one motion. The turtle was then guided to the surface so that both turtle and researcher could get a breath, and snorkel back to the boat. Once aboard the boat, the animal was covered with a wet towel as needed to protect it from the heat. Data collection on behavioral observations includes time of sighting, location within the reef system, H2O depth, turtles depth, activity upon sighting, sea conditions and visibility and this was noted on both captured turtles and also the ones that got away and were sightings only. Diagnostic data on captured hawksbill turtles included curved carapace length and width, plastron length and width, tail measurments, weight, and blood sample for genetic analysis. Also, diagrams were made of all identifying characteristics and pattern of algal cover on the carapace so that future sightings of individuals from a distance might be matched to a carapace drawing for identification. The turtle was tagged with inconel tags in the left front flipper and the right hind flipper and the numbers recorded. Photographs were then taken of the carapace, both an overview and a close up of the posterior region, the plastron , and the head again to document the physical characteristics. Once everything was recorded, the turtle was released. The turtle was usually out of the water about an hour.

To date 14 juvenile hawksbill turtles have been tagged in approximately 40 hours of snorkel surveys resulting in a catch per unit effort rate for new turtles of 0.17 per hour. Five of these turtles have been resighted 4, 5, 7, 2, and 1 times respectively which brings the overall capture rate to 0.42 turtles per hour. Also, 27 more observations on hawksbill turtles around the Monument have been recorded (including 1 adult male), 7 of those were tagged but the number was not read (1 believed to be an adult female by number of tags described). This gives a total sighting of 35 individuals making an overall per unit effort rate of 0.72 turtles per hour. Blood samples have been collected on 13 of the individual hawksbill turtles captured. We are looking forward to the genetic analysis of these samples by Anna Bass and the comparison of the results to her findings with other Caribbean hawksbill populations and to the genetics of the female hawksbill turtles nesting at Buck Island Reef NM and Mona Island, Puerto Rico (Bass,et al., 1995).

We would like to continue this study at Buck Island and possibly extend it to St. Croix and attempt collection of blood sample from at least 40 individuals which are necessary for a statistically significant analysis. We would also like to add gastric lavage samples from each size class of turtle captured and compare stomach contents between the Buck Island and Mona Island hawksbill populations.

We hope this study will provide a more complete understanding of the hawksbill population dynamics at Buck Island Reef National Monument and the region, and ultimately establish the international responsibility for protection and long-term survival of the hawksbill sea turtle.

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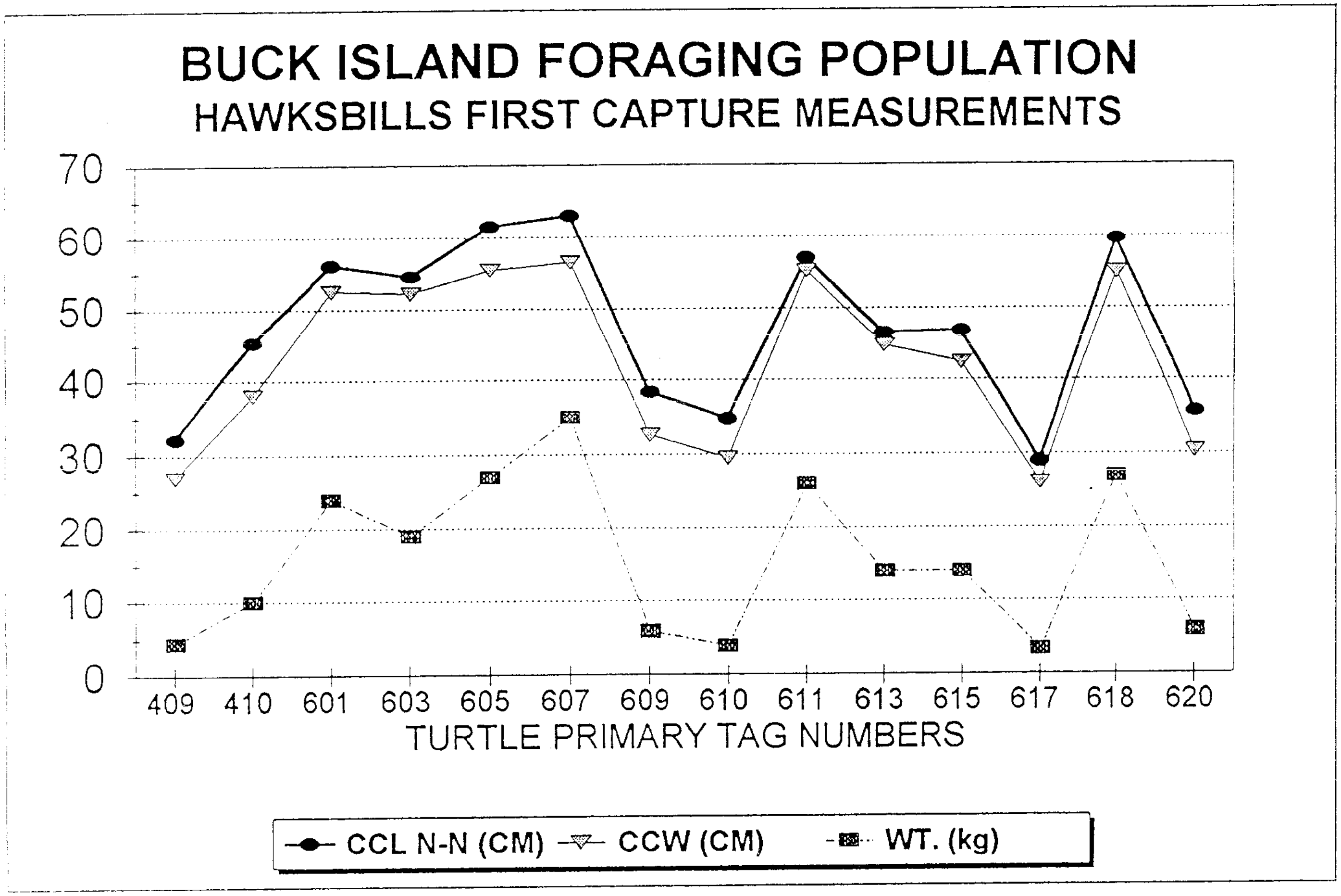
BUCK ISLAND FORAGING POPULATION
HAWKSBILLS FIRST CAPTURE MEASUREMENTS
70
60
50
40
30
20
10
0
409
410
601
603
605
607
609
610
611
613
615
617
618
620
TURTLE PRIMARY TAG NUMBERS
CCL N-N (CM)
CCW (CM)
WT. (kg)

===

A CASE STUDY OF INVASIVE MEDICAL TECHNIQUES EMPLOYED IN THE TREATMENT OF A SEVERELY HYPOTHERMIC KEMP'S RIDLEY SEA TURTLE

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An invasive protocol was initiated in the treatment of a severely cold-stunned Kemp's ridley (Lepidochelys kempii) sea turtle to address the primary problems of decreased cardiac output, hypoxia, shock and hypothermia. The turtle responded well to intubation and ventilation, and intravenous therapy of dextrose, warm Ringer's solution, atropine, dopamine, calcium gluconate and the corticosteroid Dexamethasone sodium phosphate. Although initially recovered, the turtle became anorexic and died 54 days after stranding. Early results of this treatment protocol, however, appear promising.

INTRODUCTION

Since 1982, the New York State Marine Mammal and Sea Turtle Stranding Program has recovered 201 hypothermic sea turtles from Long Island beaches. Sea turtles become cold-stunned when exposed for long periods to water temperatures of <10 ° C, resulting in a condition of torpor and floatation (Schwartz, 1978). Fifty four of the turtles retrieved were alive. Nineteen turtles (35%) subsequently died. Cold-stunned turtles are classified I through IV depending on the severity of hypothermia. To date, only 2 Class III turtles have been resuscitated. No Class IV turtles have been successfully rehabilitated. Treatment protocols are based on the classification assigned to each animal. In the past, the most invasive treatments, administrated to class IV turtles (animals exhibiting no response or apparent breathing), involved slow warming (1/2° C per hour) with indirect light, pumping of front flippers, and IP injection of 30cc sterile saline. Carotid sinus intravenous treatment was not administered to Class IV animals (Sadove, 1992).

CASE REPORT

On December 2, 1994, a juvenile Kemp's Ridley sea turtle was discovered on a beach in Southampton, New York. The turtle was assessed as a Class II cold stunning and routine rewarming therapy was initiated. Over the first few hours it became apparent that the turtle's condition was deteriorating rapidly. The turtle was reassessed as a Class III cold stunning.

The turtle's initial cloacal temperature was 9.3 degrees C (ambient water temperature at the time was 7.6 degrees C). Its blood glucose level was too low to register on a glucometer. The turtle was placed on an EKG monitor so that its heart rate could be constantly observed. At presentation the turtles heart rate was approximately nine beats per minute. The turtle had no visible respirations.

At this point the turtle was intubated and given positive pressure ventilation of O_2 at a rate of 6 breaths per minute. An indwelling I.V. catheter was placed in the carotid sinus. A bolus of 50% dextrose (1ml/kg) was delivered I.V. An I.V. drip of warm Ringer's solution was initiated to treat for shock as well as help slowly warm the patient internally. Dexamethasone sodium phosphate, a corticosteroid with rapid onset but a shorter duration of action, was used at a dose of 5mg/ kg I.V.

The bradycardia remained steady between 5-10 beats per minute for the first 30 minutes after initiating shock therapy and ventilation. A dose of atropine at .04mg/kg was given intratracheally and repeated two times I.V. The turtle's heart rate did not change significantly after receiving the atropine.

One hour after initiating therapy, dopamine was added to the I.V. fluids at a concentration of 20 mg/ml, and was delivered at a rate of approximately 5mg/kg per minute. In mammals, dopamine exerts an inotropic effect on the myocardium which results in an increased cardiac output. The turtle was also given calcium gluconate at 100 mg/kg I.V. Calcium is frequently used in cardiac arrest patients because it provides increased myocardial contractility and enhances ventricular excitability.

DISCUSSION

Within 15 minutes of initiating dopamine therapy the patients heart rate increased to 15 beats per minute. Over the first hour the rate gradually climbed to between 25-30 beats per minute. Similar rates have been recorded on apparently normal Kemp's ridley sea turtles at the Okeanos facility.

Two hours after initiating therapy the turtle began taking shallow breaths on its own. It was also beginning to respond better to external stimulation. Twenty four hours after initial presentation in severe hypothermic shock, the turtle was placed in a small tank with a water temperature of 22.7° C. The turtle was able to lift its head out of the water to breathe, and although still weak, was able to propel itself along the surface of the water when stimulated.

The turtle's strength gradually improved. On the 10th day post treatment, the turtle was observed swimming at the bottom of its three foot deep tank. Blood chemistry panels performed on December 12, 1994 and January 3, 1995 were within normal parameters. Although the turtle appeared strong and was able to spend long periods of time submerged, it refused to eat over the next 45 days. Despite force feeding squid as well as a commercially available liquid diet for debilitated birds, the turtle continued to lose weight and eventually became severely anemic. The turtle died approximately two months after the initial cold stunning. Necropsy findings were unremarkable except for a low grade chronic pyelonephritis with renal fibrosis. It was of interest to find that the liquid diet was moving well through the entire GI tract whereas the force-fed squid had not moved from the stomach for about a weeks time and appeared undigested. Unfortunately the bone marrow was not evaluated for signs of myelosuppression.

CONCLUSIONS

The goals of this treatment protocol aim at addressing each of a cold stunned turtle's primary problems; decreased cardiac output, hypoxia, shock and hypothermia. The early results are promising but a lot more work needs to be done. Severe cold stunned turtles often become anorexic for long periods of time. Improved methods of post cold stunning nutritional support need to be investigated.

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UPS AND DOWNS IN THE LIFE OF THE OLIVE RIDLEY TURTLE: BREEDING VERSUS POST-REPRODUCTIVE DIVING BEHAVIOR

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We attached radio (VHF) and satellite (UHF) transmitters (Telonics, Inc. models MOD-400, ST-3, and ST-6) to reproductively active female (n = 22) and male (n = 11) olive ridley turtles (*Lepidochelys olivacea*). Post-nesting females were captured on Nancite Beach, Guanacaste, Costa Rica, during large arribadas and males mounted on females were captured by hand in the Gulf of Papagayo, adjacent to Nancite Beach. Females stayed in the Gulf of Papagayo during the inter-nesting period and were relatively inactive. Females made few submergences ($\bar{x}$ = 21.6 submergences\ 12 h), the mean time submerged was long ($\bar{x}$ = 54.3 min), and they spent little time at the surface ($\bar{x}$ = 39.3 min\12 h). The males also stayed in the Gulf of Papagayo following transmitter attachment, but were significantly more active than inter-nesting females. Breeding males made more submergences ($\bar{x}$ = 42.2 submergences\12 h) (Mann-Whitney test, $p = 0.0233$), the mean time submerged was shorter ($\bar{x}$ = 28.6 min\12 h) ($p = 0.0083$), and they spent more time at the surface ($\bar{x}$ = 139.8 min\12 h) ($p = 0.0008$) than inter-nesting females. After the breeding season, post-reproductive females and males departed the Gulf of Papagayo and migrated throughout the eastern Pacific Ocean, traversing hundreds of km over a very broad geographic area (from Mexico to Peru and > 3,000 km west of Costa Rica). The females were significantly more active during their migrations than during the inter-nesting period. Post-nesting females made more submergences ($\bar{x}$ = 55.7 submergences\12 h) ($p < 0.0001$), the mean time submerged was shorter ($\bar{x}$ = 23.5 min) ($p = 0.0001$), and they spent more time at the surface ($\bar{x}$ = 89.1 min\12 h) ($p < 0.0001$) than during the inter-nesting period. The males were more active during their migrations than during the breeding period, however these differences were not significant. Post-breeding males made more submergences ($\bar{x}$ = 68.1 submergences\12 h), the mean time submerged was shorter ($\bar{x}$ = 20.5 min), and they spent less time at the surface ($\bar{x}$ = 89.5 min) than during the breeding period.

MOSAIC AND THE WORLD WIDE WEB: A MECHANISM OF INTEGRATING AND DISTRIBUTING SITE SPECIFIC INFORMATION ON SEA TURTLE BIOLOGY AND CONSERVATION; JOHN F. KENNEDY SPACE CENTER, A CASE STUDY

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As with other species in decline, particularly those with ranges crossing many political boundaries, rapid dissemination of data on sea turtle biology is essential to conservation efforts. For several years, we have contemplated the creation of a global Geographic Information Systems (GIS) database relevant to sea turtle conservation. Our experiences with the development and maintenance of a GIS at the John F. Kennedy Space Center (KSC) for ecological monitoring both encouraged and dissuaded us from pursuing the aggressive development of the idea. Several hurdles were obvious including, initial cost of building the data layers, cost of maintaining the system, politics of "who" would be responsible for the long term commitment to these duties, potential territoriality and ethics of data sharing within the sea turtle scientific community, political and managerial territoriality of various nations etc.. Other issues regarding the specifics about the data were also considered including, quality control, metadata, and formatting.

This paper discusses one mechanism that provides an option of distributing site specific, regional or global information on sea turtle biology and conservation as well as assisting in the more rapid development of a GIS for marine turtles. It leaves the responsibilities of data transmission and communication squarely on the shoulders of those researchers possessing data sets of importance to the conservation needs. It stands in contrast to some of our historical use of grey literature and the sometimes arduous journey through scientific publications. The peer-review process will always be necessary in scientific communication but current conservation needs require rapid communication of well collected and analyzed data.

The effort of dissemination can be enhanced through the use of the Internet and its public domain tools, such as Mosaic. Mosaic is one of several networked information discovery, retrieval, and collaboration tools. The World Wide Web (WWW) browser, that was developed by the National Center for Supercomputing Applications (NCSA), is funded by the National Science Foundation (NSF). Mosaic provides a simple hypertext interface, the HyperText Markup Language (HTML), and accesses the global Internet via HyperText Transport Protocol (HTTP). Mosaic has the capability of linking text, images, documents, sound and video through the use of highlighted links, called hyperlinks. These hyperlinks can jump to items local to that machine or items that are located on machines residing elsewhere on the Internet. Mosaic is supported on several platforms including personal computers, Macintoshes, and UNIX workstations.

METHODS

A World Wide Web HTML home page was created in November 1994 for the KSC Environmental Program (http://www.ksc.nasa.gov) that incorporated the majority of environmental information collected as part of the KSC Long Term Environmental Monitoring and Research Program. A subset of this home page included information (images, text, and graphs) pertaining to local sea turtle biology. Data were reduced from the KSC marine turtle database and Merritt Island National Wildlife Refuge files. Data of interest were nesting beaches, disorientation, predation, estuarine population data, collaborative efforts, a bibliography as well as general background information. For demonstration purposes, both the complete KSC home page and the home page developed for sea turtles were ported to a 60 MHz Gateway Pentium personal computer with 16 Mb of RAM and a 540 Mb hard drive. Text data that were incorporated into the home page were imported as simple ASCII files and then the hyperlinks created where appropriate. Images were scanned using a JX610 Sharp flatbed scanner and Pixel!Fx 2.5 image manipulating software. Images were saved in a JPEG format at a range of 300 to 600 dpi and then were converted to GIF format for incorporation into the existing home page. To demonstrate the utility of hypertext links to other web servers, trend data from Canaveral National Seashore (CNS), Cape Canaveral Air Station (CCAS), and University of Central Florida were also collected.

RESULTS AND DISCUSSION

The HTML for the sea turtle home page accounted for approximately 7 Mb of information including text and images and ran successfully on a 60 MHz Gateway Pentium personal computer. The home page presented information for sea turtle nesting at KSC/MINWR, CNS and CCAS. The section on mortality which was to incorporate data on strandings from the state of Florida remained "under construction" at the time of the home page presentation. Some of the data that were displayed are included in the following descriptions. Graphs were used to display the predictable spatial distribution of loggerhead nests along the KSC beach where densities ranged from 90 to 175 nests per kilometer. The cyclical, yet increasing trend in the number of loggerhead nests from 1983-1994 was displayed for each of the three federal beaches. These data were also displayed in combination to show the temporal trends over the decade. The combined annual values ranged from 4,000 to 8,500 nests each year. Predation rates at KSC were displayed in a histogram for the period 1978-1993 with values showing a sharp decline from the 63% level in the early 1980's to less than 5% by 1985. Other data were also displayed for the various categories listed in the methods section including photographic images line charts, histograms, and tables.

A successful illustration of the utility of hypertext links to other web servers was made possible with the integration of mock home pages that were created for Canaveral National Seashore (CNS), Cape Canaveral Air Station (CCAS), and the University of Central Florida (UCF).

CONCLUSION

There is no doubt that one of the prime links to the survival of these unique species is education. How quickly each of us, individually and as a community, can educate our children and our legislators depends greatly on the speed with which we can collect, quantify, and then disseminate information. Granted, we all don't have access to computers and many that do perhaps do not yet access the Internet. We should not let what we don't have today dictate how we should plan for the future. The Internet grew from around 235 users in 1983 to over 3.6 million users in April of 1994. Clearly, the technology is growing and is here to stay in some capacity. Computers will continue to become faster and cheaper. Access to the Internet will become easier. It is important to understand this and be ready and willing to utilize the Internet to its potential for the education of people and ultimately the survival of these amazing marine reptiles. We encourage all members of this society to take the time to view the Internet and consider this option available to you. There is a famous quote "knowledge is power". We should realize that the rapid dissemination of knowledge can greatly enhance power. The power to educate, the power to make good decisions, the power to make a difference.

A COMPARISON OF LETHAL AND NONLETHAL TECHNIQUES TO REDUCE RACCOON DEPREDATION OF SEA TURTLE NESTS

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Ecosystem management and endangered species management objectives may sometimes conflict. A case in point is the relationship between raccoons (Procyon lotor) and sea turtles in coastal ecosystems. Raccoons are native predators in these ecosystems but the damage they can inflict on sea turtle nests can directly impact turtle recovery plans. We conducted a study at Canaveral National Seashore (CANA) to examine three different methods that may alleviate this conflict between native predators and endangered and threatened sea turtles.

We used a randomized complete block design to divide CANA into four experimental blocks or sections of the beach. Within each 6 mile block, four levels of nest protection were provided: no protection (controls), raccoon removal, nest screening and conditioned taste aversion. Between March and August of 1993 and 1994, 262 raccoons were trapped and removed from removal areas within each block. In screening areas, nests were screened with 4 ft. x 4 ft. wire screen with 2 in. x 4 in. mesh. Estrogen-treated chicken eggs were placed in 60 artificial nests in conditioned taste aversion areas. All turtle nests were marked with a unique number and monitored for signs of depredation from night of deposition until hatchling emergence or nest failure.

Analysis of variance indicated that the depredation rate for screened nests ($\bar{x}$ = 6.5%) was significantly different than for control nests ($\bar{x}$ = 24.2%), nests in raccoon removal areas ($\bar{x}$ = 27.3%), or nests in conditioned taste aversion areas ($\bar{x}$ = 35.9%) at $p < .05$. Removal of at least 50% of the raccoons using the beach at CANA (based on mark-recapture estimates) did not significantly reduce nest depredation. Conditioned taste aversion was not effective in inducing an aversion to turtle eggs at the large spatial scale associated with this study. Nest screening is labor-intensive but this method was effective at reducing nest depredation and leaves native predators in place. An ecosystem management perspective for nesting beaches should incorporate an understanding of the importance of native predators as well as the sea turtle species utilizing those beaches.

A POPULATION OF JUVENILE GREEN TURTLES UTILIZING THE TRIDENT SUBMARINE BASIN, PORT CANAVERAL, FLORIDA

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The Trident Submarine Basin opens onto the ship channel at Port Canaveral, Florida. The presence of a significant number of juvenile green turtles (*Chelonia mydas*) in the basin contrasts with the adjacent ship channel where Henwood and Ogren (1987) reported that over 98 % of the captured marine turtles were loggerheads (*Caretta caretta*). An initial study to characterize that green turtle population was conducted from July, 1993 to March, 1994. A preliminary feeding ecology study was also conducted.

METHODS

Tangle nets were used to capture turtles for study. The nets were deployed for five consecutive days during each of the months of July, December, January, and March. Eight standard morphometric measurements and weight was recorded for each capture. Food samples were obtained by esophageal lavage. Blood samples were obtained for sex determination. All captures were released back into the basin.

RESULTS AND DISCUSSION

There were 55 initial captures and 34 recaptures, all green turtles. The standard carapace length (SCL) measurements of initial captures ranged from 22.9 to 48.1 cm with a mean of 32.9 cm. The lack of individuals greater than 50 cm SCL is notable. Reports of juvenile green turtles in other developmental habitats in Florida all include individuals greater than 50 cm in carapace length (Carr and Caldwell, 1956; Wells and Bellmund, 1990; Wershoven and Wershoven, 1989; Ernest et al., 1989; Schroeder et al., 1990; Redfoot et al., 1992). Of the 67 lavage samples obtained, 58 contained algae, 5 both algae and jellyfish, 2 only jellyfish, 1 algae and unidentified animal tissue, and 1 fish scales and fish muscle tissue. The algae in the lavage samples were identical in color and internal and external morphology to species comprising the algal mat growing on the rock liner of the basin. The limited biomass of the algal mat may explain the lack on individuals greater than 50 cm SCL. Although there have been three long distance recoveries 70, 80, and 220 km south of the basin on Florida's east coast, there is some degree of residency in the basin. Of the July initial captures, 25% were recaptured in December and 12.5% in March. Testosterone assays of the indicated 8% of the captures were males, 87% females, and 5% could not be determined. None of the captures exhibited any sign of fibropapillomas.

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TURNING ON THE TEARS: SALT GLAND FUNCTION IN CHELONIA MYDAS.

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The secretory rate and sodium concentration of secretions from the lachrymal salt gland of hatchling green sea turtles *Chelonia mydas* were measured under a number of experimental conditions. Possible peptidergic and cholinergic influences on salt gland activity were examined.

Hatchlings responded rapidly to a salt load of 2700 mmoles Na$^+$.(100g bodyweight)$^{-1}$ injected into the thoracic cavity, with tear secretion from the salt gland commencing 5-15 minutes after salt loading. Injection of the same volume of saline isotonic with the blood did not produce any secretory response. The concentration of tears produced ranged from 1600 to 2000 mosmol.kg^{-1}, approximately 97% of which consisted of Na$^+$ and Cl$^-$ with the balance being mainly K$^+$. Total Na$^+$ secretion rates from a single gland following salt loading averaged 381 mmoles Na$^+$.hr^{-1}.(100g bodyweight)$^{-1}$ in the first hour of secretion with approximately one third of the injected salt load being secreted during this time.

The compounds tested for salt gland regulatory activity were Arginine Vasotocin 30 ng.kg bodyweight^{-1} (AVT), Vasoactive Intestinal Peptide 3.5-300 ng.kg^{-1} (VIP), Atrial Natriuretic Peptide 30-60 ng.kg^{-1} (ANP) and a cholinergic agonist Methacholine (methylcholine chloride) 2-20 mg.kg^{-1}. None of these substances elicited a secretory response from the salt gland in the absence of a salt load. VIP and ANP did not change the characteristics of secretion when injected either simultaneously with a salt load or 20 minutes after secretion had been initiated by a salt load. When AVT was injected under this latter condition, it reduced the secretory rate, although this suppression of secretion was abolished within 15 minutes. The injection of methacholine simultaneous with a salt load delayed the onset of the secretory response by 35-45 minutes. When injected 20 minutes after secretion had been initiated by a salt load, methacholine abolished secretion within 2 minutes of application. Secretion did not resume during the subsequent 40 minutes of the experimental period.

The results indicate that activity of the sea turtle salt gland is inhibited by a cholinergic agonist. Of the osmoregulatory peptides examined, only AVT was able to influence the secretory response by causing a transient depression of secretory activity.

MOVEMENT OF SEA TURTLES CAPTURED NEAR HOPPER-DREDGED CHANNELS IN TEXAS AND LOUISIANA: 1993-1994

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During a two year period, 77 Kemp's ridley (Lepidochelys kempii) and 4 loggerhead (Caretta caretta) turtles were tracked near hopper dredged channels along the upper Texas and western Louisiana coasts using radio, sonic and satellite telemetry. Turtles were captured and released at Bolivar Roads and Sabine Passes in Texas and at Calcasieu Pass, Louisiana. Size and weight of turtles ranged between 26.4-65.6 cm straight carapace length (SCL) and 2.7-42.6 kg. Turtles were tracked as far east as the Florida Keys and to the west off northern Mexico. Tracking data will determine short term fidelity to jettied passes, use of hopper dredged channels and long range movements by turtles. Data from this work will be analyzed and published elsewhere. You may contact the authors directly if you have specific questions.

ENHANCED GEO-LOCATION AND DATA TELEMETRY BY SATELLITE FOR ANIMAL TRACKING

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Argos, a satellite-based data collection and location system, provides the capability to geographically locate and obtain measurements from sensor equipment anywhere on the earth's surface.

Since it first operated in the late 1970s, Argos has undergone continuous enhancement to address the varied requirements of system users worldwide. This includes establishing additional regional and global processing centers, continually upgrading hardware, developing application-specific software, and greatly improving methods of data dissemination. Manufacturers have adapted Argos-based equipment for many applications, vastly improving performance while generally reducing size, weight and cost. Enhancements continue and more are planned to meet user requirements through the 1990s and into the next century. For example, equipment carried aboard future satellites is expected to quadruple current capacity of the system. Frequency measurement accuracy and receiver sensitivity will also both increase thereby improving the accuracy of geographic positioning.

Wildlife tracking by satellite has expanded rapidly in many countries since 1989, with a number of manufacturers producing suitable, reliable, realistically-priced hardware. Service Argos has incorporated many biologist comments, and continuously reviews all processes with a view to new, more flexible services that will better match user needs.

This paper describes the Argos system and its most recent improvements. Special emphasis is placed on requirements of the biological community with particular regard to the new Argos location, the new orbiting constellation and some updates on the offered possibilities available with the Automatic Distribution System.

Editors note: This 20 page document can be obtained by writing to the author.

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NEW C.I.T.E.S. SEA TURTLE RANCHING CRITERIA: AN OPPORTUNITY FOR REGIONAL CONSERVATION.

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At a meeting in Fort Lauderdale in November 1994, the 120 member nations of CITES approved a rigorous set of guidelines interpreting the CITES regulations for ranched specimens (Conf. Res. 3.15) as they pertain to sea turtles. A major component of the new guidelines is the inclusion of requirements for "...the effective implementation of a national management plan for sea turtles", and that, "A party submitting a ranching proposal shall take the lead in the development and effective implementation of a regional management protocol designed to enhance the conservation of the population". Details for biological information needed, trade control mechanisms, ranch operation procedures, a statement describing conservation benefits, and regular reporting are specified.

The new guidelines tighten and more strictly define the criteria by which proposals to engage in trade in ranched sea turtle products will be judged by CITES. Adoption of the guidelines will not immediately change the situation with regard to sea turtle trade. All species remain on appendix I of CITES and only properly permitted international transfer for scientific or educational purposes is allowed. However, it is anticipated that several countries with a long term interest in sea turtle ranching may submit proposals to list their sea turtle populations on Appendix II for trade in ranched sea turtle products. The new guidelines clarify the points which must be addressed in any such proposals and, most importantly, place a requirement for a firm linkage with positive conservation benefits throughout the range of a sea turtle population. To address concerns about the possible detrimental effects of trade expansion, the guidelines contain stringent requirements for marking products and, tracking and control of trade. Any proposals that are submitted will still have to face the scrutiny of scientific judgement from the parties and interested NGO's and the final decision to open sea turtle trade will need a 2/3 vote of CITES Convention.

The new guidelines could provide a vehicle for encouraging regional cooperation for the conservation of sea turtle populations. Recent population models suggest that the high mortality in the younger age classes of sea turtles (eggs and hatchlings) has a relatively small effect on recruitment or population growth (Congdon et al., 1993, Crouse et al., 1987). There is also a steadily accumulating baseline of genetic information from DNA analysis that allows the clear differentiation of sea turtle stocks into functional units (e.g. Bowen et al., 1992, 1993, Broderick et al., 1994). Combining these two pieces of information suggests that removing a small proportion of the eggs for raising in ranches will have a negligible effect on a population. At the same time, the new criteria mandate that such ranching activities must extend an umbrella of protection to the population throughout its range. The net effect may be to effectively `tax' the population a safe number eggs, in return for improving protection for other age classes in other parts of the range.

The situation is not entirely secure or certain. The wording of the new criteria are ambiguous in places and the evaluation of what constitutes an adequate `national management plan', or an `effectively implemented regional management protocol', remain open to interpretation. It will continue to be necessary, as it was in the past, for biologists and other interested parties to closely scrutinize proposals for trade in ranched sea turtles and ensure that sea turtle conservation requirements are met. On the other hand the new criteria provide an impetus, backed by an effective international treaty (CITES), for countries to communicate and cooperate in the management and conservation of sea turtle populations.

We anticipate that a number of nations will submit ranching proposals to CITES in the next few years. Among these are possibly Cuba (Eretmochelys imbricata), Suriname (C. mydas), UK/Cayman Islands (C. mydas), Solomons (E. imbricata) and Indonesia (E. imbricata and C. mydas). For any such proposals we should evaluate:

- If the genetic stock has been adequately identified and its range defined?
- Is there an effective management plan, involving most or all of the range states, to protect the population such that its status throughout the range is secure?
- Are there any significant gaps or omissions in the regional management protocol that compromise the effectiveness of conservation?
- Are there adequate trade controls to ensure that the trade in ranched specimens does not lead to detrimental trade in wild specimens of that population or other populations?

It is noteworthy that the answers to these questions lie more in the realm of international agreements, national regulations and trade regulations, rather than the basic biology of sea turtles. A basis of reliable scientific information is clearly needed to identify stocks and assess impacts of human activities. Studies of reproductive success, mortality (both natural and human induced), distribution, growth and migration will continue to be valuable. However the consideration of how this information is applied to conservation goals, and in particular the effectiveness of local authorities in regulating harvest, becomes a major consideration. It may be feasible to argue in some circumstances that a little information applied in an effective and internationally comprehensive manner, may be more successful at conserving sea turtles that detailed information applied in an ineffective or geographically restricted way.

Some future problems can be anticipated. Several sea turtle conservation programs have identified the participation of local people, and the return of economic benefits to them, as a vital component of conservation. Few, if any sea turtle populations occur in only one country and the question of equitably allocating both responsibilities and benefits to competing local interests will need to be resolved. As an example, who should get the benefit, and who is responsible for the management costs, of conserving the Tortuguero Green turtle population? Costa Rica where they nest or Nicaragua (and other countries) where they live? Resolving such questions will require international negotiation. The down side of such complexity is its daunting difficulty, the advantage is the potential to bring under control the many different factors responsible for population decline throughout the range. The new ranching criteria give us a tool that until now we have lacked to address such issues. We must not shrink from the complexity of the task just as we do not shrink from addressing sea turtles complex life history.

The potential for effective regional management and conservation is a powerful incentive to try.

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TAIL OF A MISBEGOTTEN RIDLEY

Jack Rudloe

This conference began with Kristin Siemann's presentation on the forthcoming Gutting of the Endangered Species Act by the 104th Congress. The truth is that it's a lousy act, and that many biologists who work with endangered species will cheer on one hand and cry on the other. The ESA seldom protects habitats, forests are being cleared away wholesale, and it enables career bureaucrats to harasses and impedes scientific work by creating an unwieldy, complicated and ever growing permit system. Biologists make easy targets, developers and commercial fishing interests are a lot harder, but the ESA is all we have.

And I'd like to share our plans on how to protect it. For our part my wife and I are writing a new book called RED WOLF, WHITE WINE, An Endangered Species Cookbook.

By way of background, we fought the Private Property Rights Act in Florida last year, and effectively killed the bill in committee by creating the Coalition to Pave Florida, and the Paver's Bill of Rights. We came up with this idea af ter the recreational boating industry introduced the Beater's Bill of Rights that would have relaxed manatee protection in Florida waters. Fortunately it failed.

The bill we presented to the legislator's called for paving of Florida from the state line, all the way from Georgia, Alabama boarder, creating a level grade clean to Key West. It dissolved the Department of Environmental Regulation and replaced it with the Department of Surface Improvement. It called for the licensing of trees, fines imposed for trees littering, the confining of all wild animals to zoos,and so on.

We held a press conference in the House of Representatives and unveiled a concrete model of Florida mounted on an astro-turf stand, urging that this weak and insipid private property rights act be dropped in favor of our Paver's Bill of Rights. We told reporters and legislators that the Private Property Rights Act didn't go far enough, and that our's was an honest bill.

When people started laughing, the Property Rights bill died instantly. It went from steam rolling along with 52 sponsors to getting stalled in committee and then dropped entirely. Certainly we weren't' totally responsible for its demise, there were a lot of hard working environmentalists behind the scenes trying to kill it, but it sure helped. And our plan is to do the same with our cook book and the Endangered Species Act.

EXAMPLE OF SAMPLE RECIPE

A RIDLEY REPAST

Every since humans climbed out of the trees and went down to the seashore, they've been eating sea turtle. What other creature crawls out of the sea,and presents itself at your feet, a living can of meat and a factory of delicious eggs? Ah the romance of the Spanish galleons sailing the Caribbean with their holds full of turtle.

In the last twenty years it I s become increasingly dif f icult to get turtle because of all these bothersome regulations. Only shrimpers still enjoy them in the privacy of their vessels miles from shore. And their favorite is the Kemp's Ridley.

All three stages of the Kemp's Ridley turtle Is life cycle provide tasty morsels for year round noshing. Adults are found only in the Gulf of Mexico, but juveniles range throughout shallow coastal waters along the Atlantic shores as far north as Massachusetts. There used to be plenty of them, but massive harvest to of their eggs (great for your sex'life they say,) and adults for meat and leather has caused their decline, as has drowning in shrimp nets.

They only breed in Mexico, on a small stretch of beach called Rancho Nuevo, so you'll have to go down there to have a beach roast, although after the Endangered Species Act is history, you'll have no trouble having fresh ridley meat and eggs flown in. A word of caution however. In 1947 roughly 40,000 turtles nested on the beaches of Rancho Neuvo. Now less than 600 females come ashore, so if you want to dine on Kemp's Ridley before they're all gone, you'd better get your orders in now, and sign up for the ridley bakes.

For a light dinner try a meatless repast of <u>Frittatine Ripiene Di Ricotta e Fungi</u> with a mixed bitter green salad and fresh baked seven grain bread. A chilled dry white wine, if desired makes a more romantic evening.

A frittatine is an easy Italian crepe\omelet. Although Kemp's Ridley eggs have the richest, most succulent and nourishing taste, any of other seven endangered species of sea turtles will do in a pinch. Hawksbill eggs, I must admit run a close second, followed by greens.

FRITTATINE RIPIENE

8 Kemp's Ridley Eggs

1/4 cup milk

2 Tablespoons Flour

Salt and Pepper to taste 1 cup butter 1/2 pound mushrooms 1 Tablespoon Sherry 3 Tablespoons Romano Cheese nutmeg to taste chopped garlic to taste.

The recipe goes on to describe how to beat the eggs with a whisk, add milk and whisk until frothy, slowly add flour, a pinch of salt and freshly ground white pepper. , etc ... time doesn't permit the total recounting of the recipes here, and if it did, I wouldn't. But they'll hopefully they will be available in published form.

However I want to read a few words to the Introduction of RED WOLF, WHITE WINE.

"A new mood is sweeping the country. People are getting fed up with tree huggers, bleeding heart environmentalists and their endangered species. Right now there are terrible fines and even prison sentences for eating bald eagles, or even wearing their feathers even on the Forth of July! The new congress is mustering an all out effort to de-authorize the Endangered Species Act. And if they succeed, the nation will be faced with a problem. What will we do with all these endangered species?

Simple. Eat them!

The little known fact is that many are delicious, with a little culinary imagination, they are a softrce of unique and wonderful dining experience. It's the ultimate treasure hunt, the needle in the haystack, the ultimate quest. You could roam the forests for a lifetime and still never shoot a Florida panther. What an outing, getting out with the loggers in the Pacific northwest, watching the great trees come crashing down and looking for spotted owl nests for a delectable omelette. And nothing promotes family values more than a good family dinner of fried crocodile bagged by a father-son team in the Everglades.

Ranging from simple family dinners of savory desert tortoise stew to exciting formal banquets and large political fund raising dinners offering Blue Whale and Ricotta Endangered Texas Wild Rice bake with Gulf Sturgeon caviar, this book will be a guide not only to a good inner but to a new lifestyle as well. It will take you around the world, dining on panda liver in China, Dugong in Indonesia, and the adventures you encounter in bringing home the beacon will provide the best of dinner table conversations.

Many of the recipes will be named in honor of congress persons working to gut the ESA. TOUZIN'S RIDLEY FIN FRITTERS would be a good example, or DON YOUNG'S BARBECUED PANTHER PAWS, or BARBARA CUBINIS WYOMING TOAD IN CHERRY TOMATOES.

But seriously, how did it come about that we feel compelled to write such a ridiculous book and take such measures? of course pressure on the Endangered Species Act comes from an accelerating population, and widespread belief that the highest and best use of land is to provide shelter and food for people. But there's also a pathological attitude that's developed, a polarity between conservation and development interests. An alliance of commercial fishermen, loggers and developers has been created that threatens to destroy the ESA and all conservation measures and it didn't spring out of nowhere. I believe that we share some of the blame.

So I'm going to tell you the story of a misbegotten ridley. over the years, we built a large data base, with several hundred Kemp's being brought in. The project was initiated by Archie Carr, who said, get every turtle you can. They're gold! He got together with Ben Phipps of the Caribbean Conservation Corporation and came up with "bounty money" for us to buy turtles from commercial fishermen, instead of having them eat them. We pestered them for shirts that says SAVE THE TURTLES instead."

These are people who are close to the line. Twenty five bucks for a turtle was money that brought food for some families, beer and cigarettes for others, or a tank of gas to go out and try. I couldn't envision them getting excited about a yuppie tee shirt.

So ended our turtle salvage project. When I told these regulators that a lot of Kemp's ridleys would be butchered, a law enforcement official from the U.S. Fish and Wildlife Service told me that it was my duty to report them and they'd have them arrested.

Was prepared to offer me 24 hour a day protection, or keep the offenders from burning my house down, or sinking my boat?

"Of course not," he said, "We don't have the resources."

Never will I forget the expression of anger and disgust on the face of one grizzled fishermen brought when'he brought in a sub adult Kemp's ridley and was told that we were no longer allowed to pay for them, and that the funding that National Marine Fisheries Service provided had been withdrawn.

"Fine," he said tightly, "I reckon he'll look just fine on a bed of rice and gravy." And with that he stomped of f with the turtle under his arm.

I complained to the State Regulators, and urged them to change their mind and reinstate the program. Instead they called the marine patrol in for a crackdown. That involved roaring around in speed boats, issuing hundred dollar fines to shrimpers for not having their boat numbers improperly spaced on their bow, or failing to have written designation mounted in a conspicuous place as to who is the official garbage collector on board.

So we complied with the law and quit trafficking in endangered species. A few turtles still came in anyway. I leaned on some of our suppliers and got turtles for free. We have a unique situation in Panacea. We have Gulf Specimen Marine Laboratories, Inc. a nonprofit organization that sells, and yes I say sells.. marine life to schools and research laboratories, and occasionally public aquariums. That means that we buy horseshoe crabs, octopuses, starfish, squid, and other creatures that the fishermen bring in. They tell me when they eat turtle, and I know they sew up the openings in their TEDS now and then when the shrimp are running. I've heard horrible tales of huge loggerheads and leatherbacks drowned, with their heads jammed through the excluder grid. But they're afraid to report it, afraid that even offshore shrimping will be shut down.I drink coffee with these men and women in the morning at the cafe, their kids play with my kids, I've gone to some of their weddings and funerals.

This year, I am going to see all of these people put out of business because of the May 8th constitutional amendment to Ban the Nets. When I see the desperation and anger in their eyes, and the fact that there will be no more mullet fishery, that shrimping is terminated, and that they have families to feed, I feel rotten and ashamed that I live in a society that favors play (recreational fishing) over work. I see more alcoholism coming, more drug use, more misery and suffering, and a growing hatred for endangered species and tree huggers. The dialog and rapport that could have been established with the fishing industry has turned into an ugly war. More and more turtles are being found in stranded with their heads bashed in.

It's not the turtles they wish to bash, it's the mainstream educated people, it's you and me. But at two o'clock in the morning, five miles off shore, it's the turtle who's going to get it. They want to make a statement to a society that rejects them. And while I abhor it, I can understand it.

The fact is whether a sea turtles lives or dies on a shrimp boat rests entirely with the captain and his crew. In truth there is no coast guard out there, no marine patrol. Unless they're stoned out of their minds or drunk, anyone can throw a butchered turtle overboard and clear the evidence off their deck before the marine patrol or coast guard boat gets to them.

Right now I know fishermen who still eat ridleys, only with relish but with vengeance. Put them in jail, you say. build more prisons. Well many have already been in jail, it's nothing new to them. And when they get out, the water is all they have.

The fact is that we turtle people are swamped with contradictions. It's okay for indigenous people to eat turtles in the south Pacific or Nicaragua, we say. But let's ban the nets in Florida, and close the inshore waters to protect fish so recreational fishermen can catch them. We have terminated the problem and saved turtles, right?

Wrong.

Most of the big seafood producing companies I know are busy moving to Central America, especially Nicaragua, setting up operations down there for crabs, fin fish and shrimp. All we've done is move the problem and made it worse. There is less protection down there and more turtles. And international agreements aside, I personally don't believe we're going to make them use TEDS.And even if we do make the use TEDS, are TEDS all they're cracked up to be? Judging from the strandings on the Texas and Georgia Coasts, with more dead turtles washing ashore than ever, I have my doubts.

So what can our regulators do about it? Why go af ter the biologists and make sure they fill out their permits properly.

On May 8, 1994 a medium sized Kemp's Ridley was caught off our 300 foot pier in Dickerson Bay, Panacea, Florida in the Florida panhandle. For whatever reason, Dickerson Bay attracts Kemp's. In 1990 we did an in depth netting and tagging study,and found more Kemp's in front of our house, than almost any comparable area. We caught a total of 13 turtles there, netting once a week over a year's period. The only placed that rivaled it was Levy Bay, which is really the south end of Dickerson Bay.

But this isn't an account of the distribution of Kemp's ridleys, we did all that a two years ago at the Turtle meeting in iekyll Island. This is the story of the single ridley that was caught on hook and line on May 8th. By no means was this the first, at least two others had been caught in the previous two years and all by a friend, who likes to fish there. He says you can tell a Ridley from a sting ray, because even though it has the same dead pull, you get a rhythmic beat from the flippers coming up the line.

When I was drafting this, I put in his name, but then quickly dropped it, because Jim (oops!) doesn't' have a permit,and we haven't bothered to list him. So as the record goes, the turtle magically appeared in our tanks. Even now turtles still magically appear in our tanks, and I have no idea where they come from and this is one of them.

The hook was lodged deep in his.gullet, too deep for us to reach in with forceps and pull it out as we have on some Kemp's in the past. We took the turtle to Dr. Jerry Deloney, a vet with a busy practice in Tallahassee who rehabilitates wild animals,and he x-rayed it and found the hook lodged deep in tne stomach. Now what to do?

He said keep it in the tanks, feed it and maybe it would pass the hook. We tried, and the turtle wouldn't eat. Feeding it crushed up crabs it still wouldn't eat. And after a ten days of trying, we went back to Dr. Deloney who again X rayed it and found the hook had moved down into the intestines. This was a grave sign, so carrying all our permits, we drove the turtle down to Elliot Jacobson's shop at the University of Florida where Dr. Lee Young took possession of the turtle.

Now I wish I had a slide of the Wakulla News column. It has a series of pictures of my wife, Anne on the dock, with our eleven year old son Cypress and his 13 year old friend Ty Romeka. Their expressions, their eagerness, and excitement as they set the turtle free after its ordeal came right through the pages. In this day and age of robberies, murders, rapes, it was a "Feel Good" piece that could easily be cooped by the Mormon Church commercial to promote family values.

We were all feeling pretty good about this turtle. The thousands of dollars spent on it by all concerned, driving it up and down the highway, delivering it to Gainesville, picking it up from Orlando's Sea World and returning it to Panacea suddenly made it seem all worthwhile.

Then come a letter of reprimand from the Florida Department of Environemntal Protection, admonishing us that the kids who were releasing the turtles were not listed on our permit. I f ear that we were not the only violator of the law in this audience, that others are not in compliance. And I fear that one day we may all be made to account for our sins. I envision breaking rocks in the penitentiary with cutthroats, robbers, rapists, etc. A big grizzley inmate asks, "What are you in for, sweety-pie?"

"Violating my turtle permit," I answer tremulously backing against a wall.

Not a good situation. Let us move quickly to build a turtle violator's prison for permit offendors. We could create a penal colony on Cumberland Island, or maybe Tortuguero or Ostional, and we could continue this conference indefinitely.

NESTING SURVEYS AND NEST SURVIVABILITIES FOR SEA TURTLES ON JUNO/JUPITER BEACH, FLORIDA DURING 1990-1994

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The Marinelife Center has been responsible for surveying Sea Turtle nesting activity on a 5.3 mile section of Juno/Jupiter Beach. located in northern Palm Beach County, since 1990. This beach area is relatively undeveloped with beachfront condominiums located in four one-half mile zones, private homes in two zones, and natural dunes for the remaining five zones. There are no major structures anywhere on the beach that present an obstacle to nesting. This beach is heavily nested by Loggerhead Turtles (Caretta caretta) with fewer numbers of both Green (Chelonia mydas) and Leatherback (Dermochelys coriacia) species. In 1994, record numbers of Green and Leatherback Sea Turtles nested in the survey zones since nesting records were begun in 1990. The recorded number of Green and Leatherback nests for 1994 was 328 and 51 respectively of which 163 Green and 14 Leatherback nests were evaluated for survivability studies according to Florida Department of Environmental Protection guidelines.

The Marinelife Center surveys the beach daily from March 1 through October 31 and records the nesting activity in each of eleven one-half mile zones. The survey records nests, false crawls. and false nests (egg chamber dug, no eggs) for each of the three species of sea turtles. Due to high Loggerhead nesting activity. the nests are left unmarked in situ. Both Green and Leatherback nests are marked with one wooden stake on the nest site and one on the adjacent dune line of the beach. These nests are monitored for first emergence and the hatch site is marked with a dated stake in order to perform subsequent survivability studies three days after the first emergence.

The average number of Loggerhead nests per year in our survey area is 48% with yearly totals of 4634, 5424, 5301, 3778, and 5377 for the years 1990 through 1994 respectively. The average false crawl per nest ratio (FC/N) is 0.78 and does not appear to significantly vary from zone to zone regardless of the number of people on the beach. In fact, some of the most remote zones have the highest FC/N ratios indicating that nesting Loggerheads are false crawling for reasons other than being frightened by humans on the beach. Peak nesting activity occurs in May, June, and July with the highest activity in June. Dramatically smaller numbers of nesting females were recorded in April and August.

The average number of Green nests is 159 per year however there is a high fluctuation from year to year, for example 1991 and 1993 are "low" nesting years with less than 10% of the nests seen in the other years. The number of Green turtle nests recorded from 1990 through 1994 was 268, 18, 168, 17, and 328 respectively. In a similar fashion to the Loggerhead data, the Green Turtle FC/N ratio does not correlate with human beach activity. Again, the more remote zones have higher FC/N ratios than the populated zones. Peak nesting activity for Green turtles occurs in June. July, and August with the highest activity recorded in July. Interestingly, when the nesting data was broken down into zones, the nesting activity appeared to be cyclic over approximately two-week periods in several zones.

The average number of Leatherback nests recorded from 1990 to 1994 was 26 with 18, 28, 21, 13, and 51 nests recorded each year respectively. False crawls were rare or nonexistent from zone to zone with an average FC/N ratio of 0.1 or one false crawl for every ten nests. The numbers are too small on a zone to zone basis to obtain meaningful data on the FC/N ratios. The nesting activity, when the nesting data was broken down into zones, appeared to be cyclic with an approximate 20 day period between nests.

Of note is the fact that one of the eleven zones surveyed consistently produces twice as many nest for all nesting species than the next highest nested zone. Zone 10 produced 18.9%. of all Loggerhead. 18.3% of all Green, and 21.6% of all Leatherback nests. Roughly, twenty percent of the sea turtles are nesting on 10%. of the beach area surveyed. Zone 10 is an isolated area with only private homes on the dune line that are largely unoccupied in the nesting season. The reason for nesting preference in this area is not understood as other zones are more remote with fewer people. Further investigation of features such as the underwater topography will be required to understand the reasons for preference of this zone. Clearly, this of all the zones in the survey area is unique for an as yet unknown reason.

Nest survivability studies were conducted on 163 of the marked 328 Green turtle nests (49.7% of the nest evaluated) following emergence in 1994. The Green Turtle nests had an average incubation time of 55 days (+/- 1.8 days) which varied between 58.2 days in zone 11 to 52.3 days in zone 7. An average of 118 eggs per nest was recorded with an overall total of 19169 eggs counted of which 16658 hatched giving an overall viability of 86.9%. Interestingly, there appeared to be a significant increase in the ratio of pipped/total eggs in zones with more development close to the beach (zones 7 and 8). The actual cause for this is unknown although it may be due to inundation of the nests by rainwater runoff from the buildings as the worst nests were located near drainage sites. These nests were wet and had a very strong odor indicating advanced decomposition prior to emergence. The unhatched(infertile)/total egg ratio did not follow this pattern which would be expected if the fertility of the eggs is not related to where the nest was located. An average of 1.7 live and 1.9 dead hatchlings were found per nest.

The Leatherback nests (n=14) had an average incubation time of 65.3 days (+/- 7.1 days) which varied between 82 days in zone 9 to 58 days in zones 8 and 11. An average of 72.6 eggs per nest was recorded with an overall total of 1017 eggs counted of which 568 hatched giving an overall viability of 55.9%. Spacers, the smaller, yolkless, infertile eggs, were not included in the egg count although there was an average of 29.1 spacers in each nest. The percentage of pipped/total eggs was 12.9%. whereas the percentage of unhatched(infertile)/total eggs was 31.3% indicating that the low viability is due to low fertility. An average of 2.6 live and 1.6 dead hatchlings was found per nest.

As the 1995 nesting season is expected to be a "low" season for Green Turtles, the Marinelife Center will use this year to mark a representative number of Loggerhead nests for survivability studies. Particular attention will be paid to the developed zones (6, 7. and 8) for high pipped/total egg ratios as was seen for the Green nests in 1994. Additionally, the impact of the potential construction of a seawall in zone 6 will be evaluated. Because of the undeveloped nature of the beach survey area in the last five years. the Marinelife Center is in a good position to evaluate the impact of any new structure on sea turtle nesting.

THE SEA TURTLES FROM ARCHIPELAGO REVILLAGIGEDO, COLIMA, MEXICO

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The Archipelago Revillagigedo provides habitat for numerous marine species. Consisting reports of sea turtles sightings suggest the presence of a significant number of sea turtles around this remote islands. The lack of more detailed information on the sea turtle populations around the Revillagigedo Islands was the principal motive of this project, which seeked to determine species and abundance of sea turtles inhabiting the area, determining the importance of the Archipelago for these species. The beaches in Isla Socorro and Isla Clarión (the largest islands of the archipelago) were visited to observe tracks left by nesting females, carcasses and nests; sea surveys were done around Socorro using a fiberglass outboard motorboat and scuba diving to look for turtles in adjacent waters.

Three species were observed: *Chelonia mydas agassizi* (black turtle), *Eretmochelys imbricata* (hawksbill) and *Lepidochelys olivacea* (olive ridley); reports from fishermen indicated also the presence of *Dermochelys coriacea* (leatherback). Evidence of nesting was obtained only for *Ch. mydas agassizi*, besides the observation of all the life stages for this species in the area suggesting that this is a local population. Nesting was recorded throughout most of the year. Juvenile hawksbill turtles were observed in the area, which provides them with shelter and foraging grounds. No adult hawksbills were found. The olive ridley is occasionally observed near the archipelago; previous reports show that it can nest in the islands, but no ridley nests were found during this study. The leatherback is also an occasional visitor that might feed in the area around the archipelago.

SOME ASPECTS OF THE NESTING BEHAVIOR OF SEA TURTLES IN MEXICO

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INTRODUCTION

The studies of the nesting behavior of sea turtles which describe aspects such as time of permanence in the beach, nest ubication or distance traveled by females along the beach, can provide useful information for the design and improvement of conservation techniques in the nesting beaches (Hendrickson, 1981), as well as they constitute a basis for new research projects. In this study we evaluated some of the behavioral patterns mentioned above in the following sea turtle species that nest in Mexico: *Lepidochelys olivacea* (olive ridley), *L. kempii* (kemp's ridley), *Caretta caretta* (loggerhead), *Chelonia mydas mydas* (green turtle), *C. m. agassizi* (black turtle) and *Dermochelys coriacea* (leatherback). The objectives of this work were to register the most frequent hour for nesting of each species, the duration of different behavioral patterns and the total nesting time, the orientation of each female during oviposition, the most frequent zone for nesting in the width of the beach, the typical shape of the track, the kind of impressions on the track, and the nesting success for each species studied.

METHODS

The nesting beaches visited were Rancho Nuevo, Tamaulipas; Xcacel and TanKah, Q. Roo; Escobilla, Oaxaca; Colola and Mexiquillo, Michoacán. All the beaches were patrolled looking for nesting females, starting each night at 20:00 hrs. except in the case of Rancho Nuevo where activities started at 8:00 hrs. due to the daytime nesting of the kemp's ridley. Once a female was located, notes were made on the hour and the turtle's activity at that moment. The nesting process was divided in ten behavioral patterns (Hailman and Elowson, 1992), the duration of each one was measured. These patterns were defined as:

"APPROACH TO THE BEACH".- From the moment when the turtle is seen in the surf until it reaches the tide line.

"ASCENT OF THE BEACH".- The turtle's crawling through the beach slope until it reaches the platform.

"WANDERING OVER THE BEACH".- From the moment the turtle starts searching until it starts to remove the superficial sand with the flippers.

"MAKING THE BODY PIT".- The turtle removes sand alternating fore and hindflippers.

"DIGGING THE EGG CHAMBER".- The turtle digs the nest with the hindflippers.

"EGG LAYING".- Oviposition.

"FILLING AND PACKING THE EGG CHAMBER".- The female covers the nest with sand using the hindflippers, some species also use the whole body.

"COVERING THE BODY PIT".- The turtle removes sand with strong movements of the flippers, covering the site of the nest.

"RETURN TO THE SURF".- From the moment the female heads back to the sea until it reaches the tide line.

"DEPART FROM THE BEACH".- The turtle returns to the sea, until it is no longer seen in the surf.

The orientation of the female during nesting was registered marking on a circle the position of the turtle's head with respect to the sea horizon. The distance between the nest and the tide line, and the nest and the vegetation limit was measured. The shape of the track left by the female during its movement throughout the beach and the impressions on the track were drawn. The cases in which the female digged a nest but did not lay eggs were registered as nesting failures; for estimating the nesting success, "half moons" were not considered.

RESULTS

We observed olive ridleys nesting in all the Pacific beaches visited, the application of ANOVA to the patterns of this species in each beach yielded no significant differences ($p>0.05$), so we included olive ridleys from all these rookeries together in the results.

Table 1 shows the hour at which the first and last females were located, and the most frequent hour of nesting for each species. It can be noticed that, except the leatherback, most of the nocturnal nesting turtles were observed between the 21:00 and the 01:00 hrs. The leatherback tended to nest later in the night (between 02:00 and 04:00), almost before sunrise.

For the duration of each behavioral pattern, only the activities observed from the start were included in the analysis. Table 2 shows the average duration of each pattern for the species considered; note that both the black turtle and the leatherback spent longer time in all the patterns analyzed. ANOVAs were applied to the duration time of patterns, these revealed some differences among species in patterns such as digging the body pit, laying the eggs, filling the nest, covering the body pit and return to the sea.

Between 72% and 94% of kemp's ridley, loggerhead, black turtle and olive ridley females nested orienting their heads towards the vegetation; 9% to 15% of olive ridleys, blacks and leatherbacks nested oriented parallel to the shoreline, and 6% to 46% of all the species nested oriented toward the sea. As shown in the Table 3, the majority of the turtles nested at 20 to 30 meters of distance from the tideline, except for the greens and loggerheads which nested at 10 meters from it, and blacks that nested at 72.5 meters in average.

The shape of the tracks observed in the beaches were compared with those reported by Pritchard et al. (1983); it was found that kemp's ridley, olive ridley, and loggerhead tracks are typical, with a minimum wandering (searching) and "V" shaped, with the nest located in the apex. Green and black turtle tracks have extended searching, being possible to find several body pits in a single track. Leatherback tracks are ondulated and "S" shaped, and it is common to find a circle made very near the nest. Kemp's ridleys, olive ridleys and loggerheads leave alternate oblique impressions in their tracks, while leatherbacks, greens and blacks leave symmetrical marks.

Table 4 shows nesting success percentages for each species, loggerhead and black turtle females showed the lowest nesting success of all the species studied.

DISCUSSION

This study shows that sea turtle species have a basic nesting behavior as Hendrickson (1981) has pointed, the slight differences observed reflect some of the particular habits of each species and the way environment influences this basic pattern. For instance, most nocturnal turtles nest around the same hour (21:00-01:00), this can be correlated with the darkest hours of the night, when the moon has not raised yet or it has already set; as the moon influences the tides it would be recomendable to do this kind of observations during a whole moon cycle in order to observe if this behavior is the same along it. The kemp's ridley is the only sea turtle species that nests during the day (besides olive ridley during the "arribadas"), the factors which cause this unique behavior are not well understood and deserve further investigation.

The time spent in each behavioral pattern and the differences revealed by the ANOVAs can be explained by anatomical factors, particular habits and, in some cases, by the characteristics of the beaches.

The species that lasts more time on the beach is the black turtle followed by the leatherback (Table 2), in the case of the black turtle this could be explained by several factors such as the slope of the beach, the various body pits digged by each female, the deep body pits characteristic of this species, the long camouflaging efforts of the turtle and the long distances they walk on the beach (Table 3). The time spent by the leatherback may be explained by their huge size and weight, and also by their deep body pits. All the species (except both ridleys) last significative different time digging the eggs chamber, this is mainly attributed to the nest depth that is directly related to the hindflippers length which vary according to the typical size of each species.

The most frequent zone of nesting is in the middle of the beach width, the black turtle walks a larger distance because its nesting beach is very wide, while loggerhead and green turtle nest near the vegetation, probably because their nesting beaches are narrow.

The loggerhead showed the lowest nesting success, followed by the black turtle, the former probably because of the characteristics of the sand and the latter because of its susceptibility to perturbance (Hailman and Elowson, 1992).

In the course of our research we had the chance to observe olive ridleys nesting in beaches with physical characteristics completely different (Escobilla, Colola and Mexiquillo), they all showed the same patterns of nesting behavior including nesting success, time spent per behavioral pattern and shape of tracks in the three beaches. Species of a single genus, like both ridleys, share all the same nesting behavior, except the hour (nocturnal and diurnal) despite they nest in different kind of beaches. We also observed some species that share a single rookery, as in the case of black turtles and olive ridleys in Colola or leatherbacks and olive ridleys in Mexiquillo. In these cases both species showed differences in some behavioral patterns, in spite of receiving the influence of the same environmental factors. We point out through this study the need of further research regarding these aspects of behavior of sea turtles, since this information can provide valuable findings for the understanding of the effect of environment in the nesting process.

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TABLE 1. NESTING HOURS FOR EACH SPECIES STUDIED

SPECIES	HOUR OF FIRST NESTING	HOUR OF LAST NESTING	HOUR WITH MORE NUMBER OF NESTINGS	SAMPLING DURATION (DAYS)	N
L. kempii	10:15	16:45	13-14	5	32
L. olivacea	20:30	03:20	22-01	8	143
C. caretta	21:00	02:12	21-22	9	22
C. m. agassizi	20:26	02:52	21-22	8	45
D. coriacea	22:45	05:10	02-04	37	16

TABLE 2. AVERAGE DURATION OF EACH BEHAVIORAL PATTERN FOR THE SPECIES CONSIDERED

PATTERN	KEMP'S RIDLEY	OLIVE RIDLEY	LOGGERHEAD	BLACK	LEATHERBACK
WANDERING		2.6 (12)	18.3 (4)	2.6 (7)	2.6 (3)
DIGGING BODY PIT	2.1 (5)	3.2 (29)	11.0 (4)	25.6 (12)	12.8 (5)
DIGGING THE CHAMBER	10.9 (7)	12.1 (40)	19.6 (5)	26.6 (19)	22.1 (8)
LAYING THE EGGS	12.5 (17)	12.2 (67)	10.0 (5)	15.5 (24)	12.0 (10)
FILLING THE CHAMBER	4.0 (21)	5.3 (102)	6.1 (7)	7.3 (32)	9.9 (12)
COVERING THE BODY PIT	3.0 (23)	5.8 (106)	7.7 (8)	54.5 (32)	28 (12)
RETURN TO THE SURF	3.4 (25)	4.2 (117)	3.3 (15)	26.7 (32)	8.0 (13)
TOTAL	35.8 (32)	49.3 (145)	76.7 (22)	174.2 (46)	102.4 (16)

( )= N

All the times are in minutes

TABLE 3. AVERAGE DISTANCE OF NESTINGS FROM SHORELINE AND VEGETATION

SPECIES	SEA (meters)	VEGETATION (meters)
L. kempii	22.X	5.8
L. olivacea (Escobilla)	23.0	9.7
L. olivacea (Colola)	31.0	80.8
L. olivacea (Mexiquillo)	20.0	16.2
C. caretta	9.2	2.5
D. coriacea	25.0	21.6
C. mydas mydas	7.5	0.5
C. mydas agassizi	72.5	69.4

TABLE 4 NESTING SUCCESS FOR EACH SPECIES

SPECIES	KEMP'S RIDLEY	OLIVE RIDLEY	LOGGERHEAD	BLACK	LEATHERBACK
%	94	96	70	73	94
N	32	145	22	46	16

CHEMICAL AND PHYSICAL CHARACTERISTICS OF MAJOR NESTING BEACHES IN MEXICO.

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INTRODUCTION

The characterization of a beach is very important for the study of sea turtle biology because nesting, embryo development, hatching success and hatchling frenzy have place at these sites.

Some authors have mentioned that few attention has been paid to physical parameters of a nesting beach, emphasizing that the sand is a very important feature that probably has a relation with beach selection and eggs survivorship (Hendrickson and Balasingam, 1966; Mortimer, 1981). There are studies regarding beach characteristics such as physical factors (grain size of the sand, beach topography, etc.) and physicochemical factors (pH, oxygen, organic material, carbonats, etc.), these studies have shown that there is not a relation between these characteristics and selection of the nesting beach (Stancyk and Ross, 1978).

In Mexico, studies of physical and physicochemical characteristics of the nesting beaches have only been done in a few places. This study is a comparative work including all the major nesting beaches in Mexico for six species of sea turtle.

The species and the beaches considered were:

Rancho Nuevo, Tamaulipas for *Lepidochelys kempii*; Tankah, Quintana Roo for *Caretta caretta* and *Chelonia mydas*; Escobilla, Oaxaca for *Lepidochelys olivacea*; Colola, Michoacán for *Chelonia mydas agassizi* and Mexiquillo, Michoacán for *Dermochelys coriacea*.

The objective is to know width and slope of the mentioned beaches; granulometric characteristics and average values of pH, salinity, organic and magnetic material of the sand, making a comparison among them.

METHODS

The data collection was made during the nesting season of the different species considered in their major nesting beach, according to the following schedule:

Rancho Nuevo, Tams.	May 25 to 29, 1993
Tankah, Q. Roo	July 6 to 14, 1993
Escobilla, Oax.	September 6 to 13, 1993
Colola, Mich.	November 6 to 13, 1993
Mexiquillo, Mich.	January 7 to 15, 1994

Three to five transects perpendicular to the shoreline were made in each beach. Width and slope were measured in each one, and sand samples were obtained for the necessary analysis. Width was measured from the high tide mark to the vegetation limit with a 25 m string marked each meter, and the slope was evaluated with a clinometer.

The granulometric analysis was made according to Folk (1969); organic material, salinity, and pH were obtained following Jackson's protocol (1982); and magnetic mineral was obtained applying a magnet to ten grams of sand, the recollected material was weighed and values taken to percentages.

RESULTS

In general terms, the beaches of the Gulf of Mexico and the Mexican Caribbean Sea presented less amplitude compared to the beaches of the Pacific, nevertheless, this relation can be affected by the tide, as in the case of Escobilla in which the tide was high during our visit. The beach with the highest slope was Colola where the black turtles walk big distances to nest, sometimes they nest on dunes and in some cases they may go back of them. Table 1 shows the physiognomical characteristics of the visited beaches.

Regarding granulometry (sorting and skewness) it can be observed that Eastern beaches (Tankah and Rancho Nuevó) are skewed to fine sizes and poorly sorted, while Western beaches (Escobilla, Colola and Mexiquillo) are skewed to coarse sizes and, in general, moderately sorted. An analysis of variance for ph, salinity, magnetic and organic material showed significant differences ($P<0.05$) between the visited beaches.

Table 2 shows sorting and skewness of the sand as well as the average values obtained for pH, salinity, organic and magnetic material present in the different beaches.

DISCUSSION

Most of these parameters are related to the geologic origin processes of the beaches and the sediments transported by rivers to the ocean that deposit along the shores; granulometry parameters such as sorting and skewness of the sand influence nesting success, as sometimes it is difficult for turtles to dig a chamber under certain sand conditions, these parameters also influence important incubation factors like humidity and gas exchange (Prange and Ackerman, 1974; Mortimer, 1990). Although we obtained significant differences for pH and magnetic material, the values are very close to 7 and 6% respectivelly. This is not the case of salinity in which the values ranged from 1.9% for Escobilla to 15.8% for Colola. The low value for Escobilla can be related to the rainy season in which the samples were collected (September). During this time it rained every day heavyly diluting the salts present in the sand even when the tide was high; probably the high values of salinity for Colola are due to the high tides observed at the time of collection.

The accumulation of organic material product of the "arribada" phenomenon may account for the high percentage of this parameter in Escobilla (34.4%).

It's evident that there are several differences regarding physical and chemical characteristics among the beaches studied, and that this group of combined features makes each beach suitable for the nesting of certain sea turtle species. Nevertheless we can't affirm that the values obtained for the parameters studied are the factor determining beach selection, or nesting and hatching success, taking account on the fact that the relation between these characteristics and such phases of the life cycle of sea turtles is unknown; we also must consider that these parameters fluctuate along the whole nesting season in each site, and that biotic factors such as predation and competition are important too.

It's important to note that the olive ridley nests in beaches with physicochemical characteristics as different as are Escobilla and Colola, which make us think that this species has a broad spectrum of tolerance for diverse factors that allows it to distribute in a wide range. More studies on sea turtle physiology and ecology are necessary to confirm this assumption.

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TABLE I. PHYSICAL CHARACTERISTICS OF ALL THE BEACHES VISITED.

	Rancho Nuevo	Tankah	Escobilla	Colola	Mexiquillo
length (Km)*	14.4	4	5	4.8	7
average width	28	5	18	190	46.5
slope	up to 30°		up to 19°	up to 31°	up to 16°
berm	undistinguishable	slightly pronunced	more than 2 m high	more than 1.5 m high	up to 2 m

* Length of the studied zone of the whole beach.

TABLE 2. PHYSICOCHEMICAL CHARACTERISTICS OF THE DIFFERENT BEACHES STUDIED.

BEACH	SORTING	SKEWNESS	pH	MAGNETIC MATERIAL (%)	SALINITY (%)	ORGANIC MATERIAL (%)
Rancho Nuevo	poorly sorted		6.92			
Tankah	poorly sorted	very skewed to fine sizes	8.65		3.5	22.4
Escobilla	moderately well sorted	skewed to coarse sizes	8.87	4.16	1.9	34.4
Colola	moderately sorted	near skewed	6.23	5.20	15.8	14.1
Mexiquillo	moderately well sorted	very skewed to coarse sizes	8.07	8.97	2.3	12.0

PRESENCE AND RELATIVE ABUNDANCE OF DEBRIS ON MEXICAN NESTING BEACHES

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INTRODUCTION

The presence of debris in seashore waters and their effects on marine organisms has been widely documented. Debris are generally produced by fishing boats, oil ships, turistical boats, etc. or are thrown to the sea by rivers that carry all kinds of material; debris may be ingested by fishes, birds, turtles or sea mammals, causing their death in most cases. Acumulation of these debris on beaches may have negative effects, specially on sea turtles, as they may serve as physical barriers during female nesting or hatchling emergence and journey to the sea. Tar, pesticides and other industrial debris may affect embrionary development and hatchlings, as they are susceptible to absorb them (Frazier, 1980; Witham, 1981).

Up to date the big problem of pollution in mexican beaches has not been studied and its effects on sea turtles are still unknown.

During the course of the field biology project "Biological and reproductive aspects of sea turtle that nest in Mexico" on 1993-94 season, some of the principal nesting beaches for the different species of sea turtles that nest in our country were visited. In our stay at these places, we observed on the beaches a big quantity and variety of debris so it seemed interesting to evaluate the sort and relative abundance of these debris.

OBJECTIVES

To evaluate the relative abundance and kind of organic and inorganic debris and the presence of non-anthropogenic debris on the principal mexican nesting beaches for kemp's ridley (Lepidochelys kempii), olive ridley (L. olivacea), green turtle (Chelonia mydas), black turtle (C. m. agassizi), loggerhead (Caretta caretta) and leatherback (Dermochelys coriacea) in order to know the degree of physical pollution of each one; and to analize their possible effects on nesting female and neonates.

METHODS

Six hundred meters of beach randomly chosen were surveyed, counting each piece of debris and taking notes on their material of manufacture and trademark if it had one and if it was visible. For data analysis, anthropogenic debris were classified in organic (cardboards and carton) and inorganic (plastic, glass, metal, styrofoam and foam). Observations were made on the presence of tar and non-anthropogenic debris like sargassum, sea grass, driftwood, rocks, coconuts and beds of shell pieces, but they were not quantified. Although non-anthropogenic debris are not produced by man, they may have certain nocive effects on sea turtle populations.

RESULTS

Among anthropogenic debris, inorganic were the most numerous in all beaches, representing as much as 90% of the total amount; plastics were the most abundant. Gulf of Mexico and Caribbean Sea beaches showed the highest presence of anthropogenic debris in relation to Pacific beaches, being Rancho Nuevo the most polluted. Table 1 shows the number of pieces present in each beach by category.

La Escobilla was the one with the greatest quantity of non-anthropogenic debris like large logs and coconuts. It is important to point out that nesting season coincides with rain season and it is possible to find open the mouths of rivers, this causes the accumulation of this kind of material on the beach. In this place we also found a large quantity of turtle egg shells, evident result of arribadas.

DISCUSSION

Rancho Nuevo and TanKah showed the largest quantity of anthropogenic debris, possibly caused by the great industrial and turistical development of this zone. The big majority of anthropogenic debris present on Gulf of Mexico and Caribbean Sea beaches are of foreign procedence, which make us think that these debris are part of the garbage that some touristic cruises and boats usually throw to the sea. Principally observed on East beaches, tar may be originated by oil spills from oil ships that travel in the area, carried by currents towards the beaches.

In general, debris may cause different kinds of damage on sea turtles individually, in the sea as well as in the nesting beaches. Such damages may be from physical obstructions during nesting and journey of females and hatchlings on the beach (Frazier, 1980), to even death by asphyxia by ingestion of plastics (Stanley et al., 1988; Eckert and Luginbuhl, 1988). This, joined to deterioration of the breeding habitat, would bring as consecuence, in long term, the diminishing of sea turtle populations.

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LIST OF SOME OF THE ANTHROPOGENIC DEBRIS FOUND ON THE NESTING BEACHES VISITED, WITH NOTES ON THEIR TRADEMARK, PROCEDENCE AND MATERIAL OF MANUFACTURE.

GULF OF MEXICO AND CARIBBEAN SEA

light bulbs from different procedence (glass)
bottle of whisky Johnny Walker (glass)
bottle of Bacardi (glass)
glass bottles from U.S.A. and France
oil can from Brasil
beer cans from Mexico, Brasil and U.S.A.
sprays from Venezuela and England (metal)
a fridge door
container of a extremely flammable material from U.S.A. (highly dangerous) (metal)
metal bottles from U.S.A.
pieces of foam
pieces of styrofoam
blocks of styrofoam
milk packs from Mexico (carton)
pieces of cardboard
bottles of oil Exxon from Mexico (plastic)
bottle of oil Roshfrans from Mexico (plastic)
deodoratnt from Colombia (plastic)

bottles of chlorine Clorox from Mexico (plastic)

bottles of plastic from Rusia, U.S.A., Indonesia, Germany, Puerto Rico, Maracaibo, Jamaica and Venezuela

PACIFIC

bottles of chlorine from Mexico (plastic)
bottles of Head & Shoulders (plastic)
shoe soles (plastic)
sandals (plastic)
batteries (metal)
glass bottles
caton boxes
pieces of styrofoam
beer cans from Mexico
pieces of foam

TABLE 1. ANTHROPOGENIC DEBRIS FOUND IN THE NESTING BEACHES STUDIED. Number of pieces per category.

beach/ category	Rancho Nuevo Tams.	Tankah Q. Roo.	Escobilla Oax.	Colola Mich.	Mexiquillo Mich.
plastic	0	992	62	75	148
glass	154	205	0	9	0
metal	45	65	0	26	16
styrofoam	55	98	5	1	1
foam	26	0	0	0	1
carton	14	0	1	23	0
total	**1,992**	**1,360**	**69**	**114**	**166**

DYNAMIC HEAT TRANSFER MODEL FOR BODY TEMPERATURE OF LOGGERHEAD TURTLES DURING INTERNESTING PERIODS

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The purpose of this work is to make an observation on body temperature and water temperature of the loggerhead turtle, Caretta caretta, under natural condition. Then, we tried to verify the mechanism of body temperature response to water temperature fluctuation using dynamic heat transfer model. The point of analysis is whether they regulated their body temperature by physiological means or not. Metabolic heat production rates were estimated for each turtles. Effect of body size on homeothermy was also investigated by numerical simulation.

Methods

Field experiment were held on the Senri-coast at Wakayama Prefecture, Japan from 1990 through 1994. Recorders were attached on the carapace and into the stomach of a turtle after nesting to record body temperature, water temperature, depth, and light intensity. The recorder is designed to record each parameter with 1 min interval. We patroled the nesting beach everynight on foot to find the next nesting of the recorder equipped turtles. The recorders were retrieved from the turtles after next nestings on the beach. Body temperature and water temperature during internesting periods were simultaneously obtained from 16 loggerhead turtles. These data were used in analysis and numerical simulation.

Results and Discussion

Body temperatures of loggerhead turtles were kept higher than water temperatures throughout their internesting periods. Mean thermal differences between body and water were significantly different among 16 individuals. Larger turtle had significantly larger mean thermal difference. Vertical movements of turtle caused suddenly change in water temperature, but body temperature indicated no reaction to such short-term (< 90 min) fluctuations. Body temperature responded to long-term (> 24 h) water temperature fluctuations with a time lag of 2 - 3 h.

Using dynamic heat transfer model, the body temperature response to water temperature fluctuations could be explained as heat conduction within a body under constant thermal diffusivity and heat production rate. Loggerhead turtles seemed not to regulate their body temperatures by physiological means, thermal diffusivities and heat production rates seemed to be constant during internesting period. Estimated heat production rates for each 16 turtles resembled resting metabolic rates of lizards and green turtles (Paladino et al. 1990, Prange and Jackson 1976), were not so high as resting metabolic rate of mammals or birds (Schmidt-Nielsen 1990). A degree of homeotherm would be caused by their large body mass and large heat capacity.

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POPULATION VIABILITY ANALYSIS OF THE KEMP'S RIDLEY TURTLE

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INTRODUCTION

The Kemp's ridley turtle, Lepidochelys kempii, has undergone major demographic changes due to human impacts on its various life history stages. Since the late 40's, the nesting population has decreased from 40,000 nestings in a single day to less than 700 during the entire season (Ross et al., 1989). Decades of heavy exploitation of the eggs prior to protection of the nesting beach at Rancho Nuevo, Mexico, resulted in virtually no recruitment to the aging adult population. Incidental capture of subadults and adults in commercial fisheries also contributed to the decline in numbers (Magnuson et al., 1990). Protection of the nesting beach has significantly increased hatchling survivorship over the past 28 years and, as might be expected, an increasing number of subadult Kemp's ridleys have been observed in coastal foraging grounds (Ogren, 1989). Furthermore, the annual rate of decrease of the nesting population has lessened in recent years (Márquez M., 1994).

Population Viability Analysis (PVA) is an assessment of the demographic, environmental, and genetic factors that place populations at risk of extinction. The purpose of the PVA is not to estimate exact extinction probabilities but to identify the relative importance of the various risk factors and to evaluate the effect of management actions (Lacy and Kreeger, 1992). Computer models have been developed to simulate populations over time and to estimate the likelihood of extinction given the effects of different life history, environmental, and catastrophic factors. VORTEX is one of the most widely used PVA simulation programs and has been used to develop conservation strategies for a number of endangered species (Lacy, 1992). The purpose of this presentation was to examine the demographic changes in a hypothetical population of Kemp's ridley turtles using VORTEX. The mortality rates of the different life history stages were manipulated to model the effects of exploitation, incidental capture, and subsequent conservation measures.

MATERIALS AND METHODS

The VORTEX program, version 5.0 (Lacy and Kreeger, 1992), was used to simulate a history of demographic effects. The following parameters were applied to each input file:

1) One population was simulated over a period of 100 years. A population size of 500 turtles was used due to the program's carrying capacity limit of 9,999 animals.

2) Reproduction was assumed to be density independent with no inbreeding depression. The effects of environmental variability were included in the simulations.

3) Two types of catastrophes were included in the model; one simulating an event at the nesting beach (ex. hurricane) where reproduction is reduced and another simulating an event at foraging grounds (ex. cold-stunning, oil spill) where survival and reproduction are reduced. Both catastrophes were given a probability of occurrence of 0.01.

4) Breeding was presumed to be polygynous with an equal sex ratio at birth (1:1). All adult males were included in the breeding pool.

5) A maximum clutch size of 160 eggs and clutch size distribution were obtained from Pritchard and Márquez M. (1973). VORTEX requires the percent of breeding females producing each clutch size. Therefore, percentages of each clutch size range were divided by 10 and then assigned to each of the clutch sizes within a given range.

6) Growth curves from skeletochronological age estimates of Kemp's ridleys on the Atlantic coast suggest that sexual maturity is not attained in less than 10 years (Zug, 1990). Growth data for subadults foraging on Florida's west coast correspond with this estimate (Schmid, unpubl. data).

7) Life history stages for the Kemp's ridley were based on age estimates (Zug, 1990) and field data (Pritchard and Márquez M., 1973; Schmid, unpubl. data): eggs and hatchling (0 years), pelagic juvenile (1-2 years), subadult (3-9 years), and adult (10+ years).

8) There are no estimates available on the age of senescence for Kemp's ridleys. Tagging studies at Rancho Nuevo indicate that females return to the nesting beach up to 10.7 years after initial nesting (Márquez M., 1994). Therefore, twenty years age of senescence was selected for the analysis.

Each simulation was repeated for 100 runs, except one that resulted in memory overflow and was repeated for 10 runs. Output from each simulation included: population size at 10 year intervals, probability of extinction, mean time to first extinction, mean final population size for successful cases, and mean population growth rate. Standard errors are given in parentheses.

RESULTS AND DISCUSSION

Scenario 1 was designed to simulate the effects of increasing protection of eggs and hatchlings with moderate mortality in the subadult and adult age classes. Extreme egg and hatchling mortality resulted in extinction in less than 70 years. Reducing egg and hatchling mortality to 70% significantly decreased the probability of extinction and resulted in an increase in population size despite a negative growth rate. Further reducing egg and hatchling mortality to 50% resulted in the model population reaching the carrying capacity of the program.

Scenario 2 was designed to simulate the effects of reducing subadult and adult mortality in the absence of nesting beach protection. Reducing subadult and adult mortality from 30% to 20% resulted in a doubling of the population size by the end of 100 years. However, the runs of this simulation were extremely variable and often resulted in memory overload at which time the program would abort. The number of runs was decreased to 10 in order to successfully complete the simulation. Runs for unsuccessful simulations ranged from extinction in 45 years to the computer prompt "too many animals" (i.e. memory overload). Further reducing subadult and adult mortality to 10% resulted in memory overload during the first run.

Scenario 3 was designed to simulate the effects of nesting beach protection and to determine how subadult and adult age classes respond to different mortalities. Decreasing the mortality of the early age classes allowed the population to tolerate a higher level of subadult and adult mortality before extinction. Decreasing the mortality of only the subadults resulted in a population that increased to the carrying capacity, while decreasing only the adult mortality resulted in population extinction in less than 80 years. This suggests that the model's subadult stage is more sensitive to changes in mortality and may be indicative of the importance of reducing subadult mortality resulting from incidental capture in commercial fisheries. Crouse et al. (1987) reported that juvenile and subadult loggerhead stages were the most responsive to changes in mortality for their stage class matrix model.

The applicability of VORTEX to the actual Kemp's ridley population is constrained by a number of limitations with both the program and the available data. The main limitation with the program is the artificially low population size that must be used as a result of the four-digit carrying capacity. Improvements to the VORTEX software and technological advances with computer hardware will allow an increase in the program's carrying capacity. The program is also limited to an annual reproductive cycle. The lack of specific data on sex ratios in the wild and information on the age structure of the Kemp's ridley turtle further reduces the applicability of the program. The available data for this species is more suited to a stage-based model such as that of Crouse et al. (1987). In order to evaluate the future of the Kemp's ridley, long-term censusing studies are needed to monitor trends in abundance for both the nesting females and the in-water stages.

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Scenario 1) Varied egg and hatchling mortality, 50% juvenile mortality, and 30% subadult and adult mortality.

Simulation	Probability of extinction	Mean time to extinction	Mean final population	Mean growth rate
90% egg &	1.00	35.29	-	-0.1600
hatchling	(0.00)	(1.05)		(0.0097)
70% egg &	0.20	76.70	890.42	-0.0133
hatchling	(0.04)	(3.33)	(109.67)	(0.0037)
[illegible]0% egg &	0.00	-	8148.69	0.0426
hatchling	(0.00)		(190.64)	(0.0026)

Scenario 2) 90% egg/hatchling mortality, 50% juvenile mortality, and varied subadult and adult mortality.

Simulation	Probability of extinction	Mean time to extinction	Mean final population	Mean growth rate
30% subadult & adult	1.00 (0.00)	37.07 (1.24)	-	-0.1562 (0.0094)
20% subadult & adult	0.00 (0.00)	-	1084.20 (249.27)	0.0034 (0.0167)

Scenario 3) 50% egg/hatchling mortality, 50% juvenile mortality, and varied subadult and adult mortality.

Simulation	Probability of extinction	Mean time to extinction	Mean final population	Mean growth rate
30% subadult & adult	0.01 (0.01)	50.00 (0.00)	7977.22 (196.98)	0.0424 (0.0026)
40% subadult & adult	1.00 (0.00)	34.13 (0.87)	-	-0.1671 (0.0102)
30% subadult & 40% adult	0.04 (0.02)	57.25 (12.40)	5636.15 (294.99)	0.0216 (0.0030)
30% subadult & 40% adult	1.00 (0.00)	43.53 (1.09)	-	-0.1325 (0.0085)

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POST-NESTING MOVEMENTS OF FLORIDA GREEN TURTLES: PRELIMINARY RESULTS FROM SATELLITE TELEMETRY

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Studies of the green turtle population that nests in Florida have focused almost exclusively on aspects involving nests and hatchlings, including basic reproductive parameters such as remigration intervals, nest site fidelity, and the number of clutches per female per season. Only a few hundred nesting Florida green turtles have been tagged using traditional flipper tags. No recaptures away from the Florida nesting beaches have ever been reported. The principal objective of our study was to collect information on the migratory pathways and resident foraging habitats of the adult Florida green turtle population. This information is critical to identifying and protecting marine habitats that are essential for the recovery of this species.

Telonics ST-3, back-pack designed transmitters linked to the Argos satellite system were used. Transmitters were attached to three Florida green turtles nesting at the Archie Carr National Wildlife Refuge in southern Brevard County, Florida, during July 1994. Two of the three transmitters yielded data that provided insight into post-nesting movements. After departing the vicinity of the nesting beach, both turtles made very similar and directed movements southward along the east Florida coastline, turning westward as they approached the Florida Keys, and continuing along the Keys to the west. One individual remained for at least 50 days just offshore the lower Florida Keys, until the last transmission was received in late October. The second turtle continued west stopping near the Marquesas Keys, approximately 40km west of Key West. She remained in this area for at least 10 days after which no further location data were received. There was no evidence that either turtle made any stopovers as they travelled from the nesting area to the Florida Keys. We offer a working hypothesis that Florida green turtles make use of the extensive seagrass meadows and coral reefs in the Florida Keys as resident foraging habitat. We plan to continue this research and augment our sample size during the 1995 nesting season.

HATCHING SUCCESS OF THE LEATHERBACK TURTLE (DERMOCHELYS CORIACEA) IN NATURAL NESTS AT PLAYA GRANDE, COSTA RICA.

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During the 1993-1994 nesting season we studied leatherback turtle (Dermochelys coriacea) nesting ecology on Playa Grande, Costa Rica, one of the most important nesting beaches for this species in the Pacific. We examined the effects of poaching and predation on nests, fate of eggs in natural nests, and relationships between hatching success and various biotic and abiotic factors. Most (82.9%) of the study nests remained undisturbed and survived until hatching. Tidal effects accounted for the majority of nest loss, destroying 2.4 % of the study clutches by frequent inundation and 8.6 % by washing them away. Poaching and predation, which caused the death of 1.3% and 2.4 % of nests, respectively, were much less prominent on Playa Grande than on other nesting beaches, due to extensive patrolling of the beach at night. An additional 2.4 % of the study nests failed to hatch although they remained undisturbed by tides and predators. Of the study nests that survived to hatching, 14.6 % were oviposited below the high tide line. Due to tidal effects, significantly fewer of these nests survived to hatching than those oviposited in the open beach area or within the vegetation. The mean emergence success for successful clutches was 53.8 %; most of the eggs that failed to hatch failed to undergo any visible development. Hatching success was negatively related to the number of yolked eggs in the clutch and positively related to the number of smaller, yolkless eggs deposited on top of the clutch. Nests located 0-5 m from the vegetation had a significantly lower emergence success than those located 5-10 m from it, and contained more maggot-infested eggs. Repeated nesting by 10 individual turtles indicated that ultimate hatching success may be related to the reproductive condition of the parent turtles. Some turtles consistently produced nests with high hatching success and other consistently produced nests with low hatching success.

RECORD NUMBERS OF SEA TURTLE STRANDINGS ALONG THE TEXAS COAST DURING 1994

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The Sea Turtle Stranding and Salvage Network (STSSN) was established in 1980 to document strandings of marine turtles on United States beaches located along the Gulf of Mexico, Atlantic Ocean, and

Caribbean Sea (Schroeder, 1988). Despite on-going research and conservation efforts, strandings of sea turtles along the Texas coast reached unprecedented levels during 1994. This study was undertaken to examine stranding patterns for sea turtles found along the Texas coast during 1994 and to determine possible causative factors for the strandings.

METHODS

Stranded sea turtles were located by network participants in response to information provided by beach visitors and during systematic patrols conducted in various areas of the state. For each stranded turtle, information was collected on species, size, injuries, condition, and final disposition of the animal. Information was recorded on standardized forms that were forwarded to the state and subsequently the national STSSN coordinators.

The Texas STSSN database was queried for records of turtles found stranded during 1994. Head-started and incidentally captured individuals were excluded from further analyses (Teas, 1993). Each stranding was categorized as occurring either offshore (beaches or waters of the Gulf of Mexico) or inshore (beaches or waters of the bays, passes, or lagoons). Possible stranding causes were obtained from information provided on the individual stranding forms.

Live stranded turtles were taken to rehabilitation facilities. All of the turtles that died during rehabilitation efforts, and many of the dead stranded turtles that were not highly decomposed, were salvaged for necropsy and study. General necropsies, similar to those described by Wolke and George (1981), were performed by a limited number of STSSN participants and veterinarians.

RESULTS AND DISCUSSION

Five hundred and twenty-six turtles were located stranded, more than during any previous year on record for the Texas STSSN and nearly as many as during the previous three years combined (534). Previous yearly totals ranged from 77 in 1980 to 355 in 1990. Of the 526 turtles found stranded during 1994, 489 were located dead and 37 alive. Species composition of the 526 stranded turtles included 193 <u>Caretta caretta</u>, 254 <u>Lepidochelys kempii</u>, 48 <u>Chelonia mydas</u>, 14 <u>Eretmochelys imbricata</u>, three <u>Dermochelys coriacea</u>, and 14 unknown species turtles. Four hundred and sixty-two of the 526 stranded in offshore and 64 in inshore areas.

Comments listed on STSSN forms revealed possible causes for strandings of 47 turtles, including boat propeller injuries (24), debris entanglement (13), hook and line ingestion (4), entanglement in abandoned illegal gill netting (2), and being lodged in rocks (4). Twelve turtles had been bitten by sharks and 20 had straight-edged cuts at the bases of missing appendages, typical of human-inflicted mutilation (Heinly et al., 1988). In most cases it was impossible for the STSSN participant to determine whether the bites and mutilation occurred before or after death.

Due to the large number of turtles found stranded and salvaged during 1994, necropsies have not been completed for all individuals. Of those necropsies that have been completed, tissue deterioration prohibited conclusive determination of cause of death in most instances. However, based upon necropsies performed to date, illness and marine debris ingestion probably caused relatively few of the 526 turtles to strand. Several other possible causes for the strandings have been suggested, investigated, and dismissed because of a lack of supportive evidence. Among the unlikely contributing factors proposed were: seismic exploration, oil and gas platform removal, menhaden fishing, low water oxygen, pollutants, toxic wastes, dinoflagellate blooms, and ingestion of fish killed by any of the preceding factors (Zimmerman, personal communication).

There is circumstantial evidence that a large percentage of the strandings during 1994 resulted from incidental capture in shrimp trawls. Temporal and spatial distributions of the strandings closely coincided with nearshore shrimping effort. Strandings increased dramatically during early April and continued at high levels through mid-May (Figure 1). Strandings at that time were concentrated in the Galveston, Mustang, and North Padre Island areas, where nearshore shrimping effort was high. Strandings abruptly decreased and remained at relatively low levels from 13 May to 7 July, when Gulf of Mexico waters were closed to shrimping activities out to 322 km (termed Texas closure). When shrimping resumed in Gulf waters, large numbers of turtles were again found stranded. Strandings at that time were concentrated in the Galveston, Matagorda, and Mustang Island areas, where nearshore shrimping effort was high. In the latter portion of July, when intensive turtle excluder device (TED) enforcement and education activities occurred, strandings decreased. However, strandings again increased during late August, when TED enforcement activities decreased, and subsequently decreased when TED enforcement activities resumed.

Correlations have previously been found between shrimping effort and strandings of sea turtles in Texas (Whistler, 1989; Magnuson et al., 1990; Caillouet et al., 1991; Sis et al., 1993). In an attempt to reduce trawl-related mortality, TEDs have been phased into mandatory usage since 1990. Most of the shrimp vessels inspected by the National Marine Fisheries Service and U.S. Coast Guard in Texas during 1994 had TEDs present in their nets. However, TED installation and operational problems, that might have caused turtles to be retained in the nets, were noted in numerous instances (Zimmerman, personal communication).

Continued strandings of Kemp's ridley turtles at levels similar to those recorded in Texas during 1994 could diminish the effectiveness of conservation programs undertaken on behalf of this critically endangered species. The STSSN should continue to document stranded turtles and investigate possible sources of mortality so that sources related to human activities can be identified and reduced. TED education, enforcement, and research/development activities must be continued.

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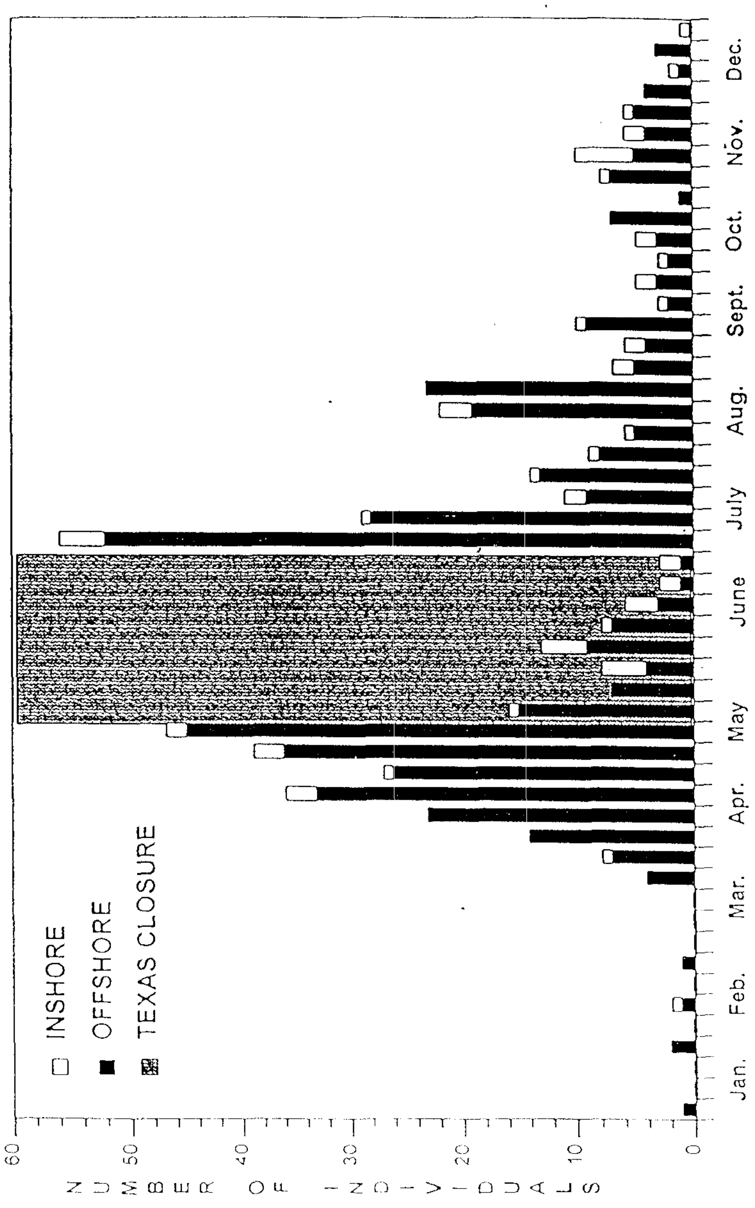

Figure 1. Weekly number of sea turtles found stranded on the Texas coast during 1994.

COMPROMISES THAT KILL: THE CONTINUING SEA TURTLE SLAUGHTER AND NEW APPROACHES TOWARD A SOLUTION

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This past year we necropsied our 1300th dead sea turtle on the 17 mile beach of Cumberland Island, Georgia. The number of dead sea turtle strandings on Cumberland Island has varied from 30 to 89 over the past 14 years, and in 1994 we had more strandings than in any year since 1980 (Fig. 1). These data also show an increase in number of strandings from 1981 to 1994. Most of the dead turtles were loggerheads, but ridleys, greens and leatherbacks were also represented. More Kemps ridleys stranded on Cumberland last year then ever recorded in a single year.

The results demonstrate that all efforts to reduce or stop the killings have been insufficient and have not resulted in protection of sea turtles. A similar situation holds for much of the Gulf and Atlantic coasts, and there is little doubt that most of the mortality is related to interactions with towed and fixed gear commercial fisheries, mainly trawl fisheries. The governmental compromises with the fishing industries during past decades have resulted in the continued killing of sea turtles rather than protection. New approaches to the problem are needed if sea turtles are to be a part of the marine ecosystems they have so importantly influenced in the past.

Possible reasons for the mortality we have observed are presented in Table 1. We believe that in some cases a combination of causes may have resulted in the mortality. Some of the proposed causes are unlikely but of the possible reasons provided, what regulatory responses would protect sea turtles and stop the killings? We present two possible responses to the various causes of mortality and judge the effectiveness of those responses in Table 2. Note that the governmental response used in the past, increased enforcement, is effective only for cheaters who do not use properly installed turtle excluder devices (TEDs) in their nets. Closure of a fishery zone is effective protection in all cases but disease.

The effective response of closing fishing zones, regardless of the cause of the mortality, seems obvious. But there is a bureaucratic problem with this obvious solution. The criteria for closure of a fishery zone issued 14 November 1994 in the NMFS Biological Opinion and Incidental Take Statement, include the caveat that the cause of the strandings must be conclusively identified before any emergency response can be initiated. (The emergency response plan is not due until 14 March 1995). Determining the cause of death in any animal is difficult, but in reptiles it is further complicated by the slowed physiological responses associated with ectothermy. In fact, definition of turtle death is difficult because the heart can be started hours after it has stopped beating. In short, the likelihood of determining the precise factor causing death, especially in a bloated turtle, is almost zero. Consequently, the present policy can result in no effective action. This epitomizes the NMFS responses of the past 15 years. This agency repeatedly delayed any actions until crises passed, then addressed issues, held meetings, funded development of TEDs, set up TED rules, mobilized the Coast Guard to help in enforcement, and took over volunteer stranding networks to document turtle strandings. What are the results? Has the magnitude of the problem decreased?

The November 1994 NMFS Biological opinion also states that previous stranding levels will be used to determine the allowable mortality quota before protective action is taken. Are previous stranding rates really acceptable? Is "twice the previous three year weekly average per zone" acceptable? Another potential for compromise is the statement that stranding data judged as anomalous by the NMFS will be excluded from the calculations! Furthermore, the action the NMFS proposes if the entire United States quota is reached is to "reinitiate (sic) consultation." They then refer to implementing the emergency response plan, which as noted above, has yet to be released. Time is critical when turtles are being killed. Delay is another compromise resulting in continued slaughter until the shrimp are gone or dispersed. Is sea turtle protection really the issue? The continued acceptance of the killings as unavoidable is absurd. Are fisheries being protected or are sea turtles? To date, it has not been sea turtles.

But criticism of the NMFS will not solve the problem. We all share the blame for allowing this to go on for so many years. How do we stop it? What approaches will really help?

First, immediate closures of fishing zones by NMFS when two or more turtles strand in a one-week period is a reasonable and effective response. But while temporary closures and unambiguous criteria for closures will work and should be used, they are actually temporary "band aids" that do not address the problem of why sea turtles are dying in fishing gear.

Second, we need to recognize that 100% compliance with TED regulations may not solve the problem and that TED-excluded turtles may still die. The studies of Malia Schwartz in the Turks and Caicos Islands this past summer suggest that the effects of anoxia may not contribute to the lethal situation, and that complications of anoxia are not the cause of death of green sea turtles trapped beneath the surface for less than an hour at 28 C. The turtles recover from the anoxic effects but collapse and die many hours later from what appears to be shock. Whether this shock is irreversible is not yet known. In other words, turtles temporarily restrained in trawl nets and eventually released by TEDs may be lethally damaged. Research on the behavior and physiology-of sea turtles in trawl nets is long overdue. The agency responsible for issuing permits should support legitimate requests to stress sea turtles. We regularly allow thousands of sea turtles to be killed by exploitive fisheries, but permit no stress or mortality in research designed to help understand the problem.

Third, additional modifications of gear and fishing techniques should be developed. If commercial fishing is to continue in sea turtle habitats, it is the exclusion of sea turtles from towed and fixed gear that will avoid the problem. Sea turtles must be kept entirely out of trawl nets, not just out-of the small bag end. Deterrents, new fishing techniques, and gear modifications should continue to be priority research areas.

Meanwhile, the public sector can reduce the problem by supporting the use of pond-reared shrimp and shrimp obtained in those turtle-safe fisheries lacking bycatch, such as the North Atlantic near-Arctic trawl fishery and cast-net fisheries.

The scientific community can increase its efforts in research on sea turtle behavior and physiology, especially as related to stress induced by entrapment. Studies on improved resuscitation techniques are also needed.

Table 1. Possible causes of recent sea turtle mortality.

1. Turtles are killed by cheaters not using properly installed turtle excluder devices (TEDs) in their nets.
2. The dead turtles are those 3% that the National Marine Fisheries Service (NMFS) says are not excluded from trawl nets with TEDs, perhaps including increased numbers of turtles claimed by fishermen.
3. The turtles were caught in try nets (used for monitoring shrimp catch rate) and died as a result.
4. The dead turtles are the small or large turtles that are not excluded by TEDs.
5. Dead turtles are the result of multiple, sequential temporary captures which do not allow total recovery from accumulated effects of anoxia.
6. TEDs are not really 97% effective.
7. Other fisheries are responsible for the dead turtles.
8. Commercial fishing effort (nets and boats) is increasing.
9. Deliberate killings have increased.
10. Sea turtle collisions with boats have increased.
11. Sea turtles in trawl nets suffer lethal effects even if excluded by TEDS.
12. More sea turtles are sick, diseased, and dying.

Table 2. Reasons for mortality and effectiveness of possible responses. (x = effective in stopping mortality)

REASONS	RESPONSES	
	increased enforcement	closure of zone to all commercial fishing
1. cheaters	x	x
2. 3% not excluded (more turtles)		x
3. try nets		x
4. small and large sizes		x
5. multiple captures		x
6. TEDs not 97% efficient		x
7. another fishery		x
8. increased effort		x
9. deliberate killings		x
10. boat/turtle collisions		?
11. TED-excluded turtles die		x
12. more sick animals		

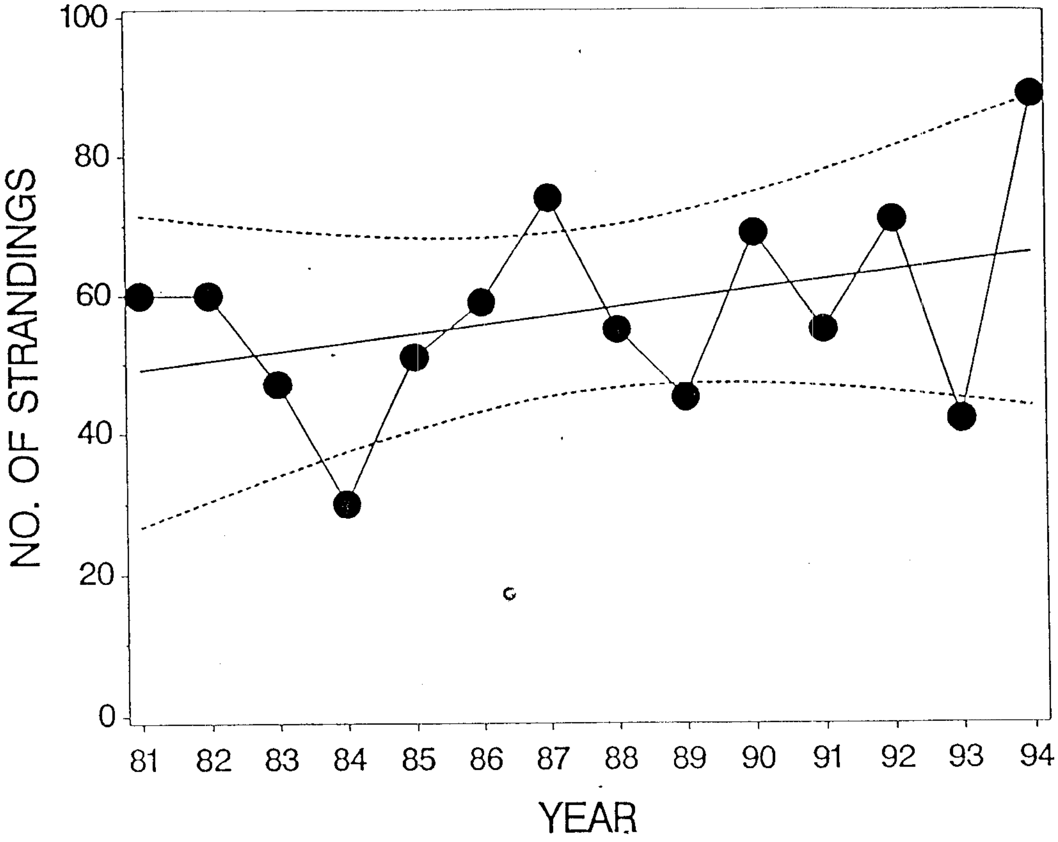

Figure 1. Number of dead sea turtles stranded on Cumberland Island, Georgia, 1981 through 1994. The 95% confidence level of the regression line is represented by the dotted lines. The slope of the regression line is not statistically significant.

THE ENDANGERED SPECIES ACT: ENDANGERED IN THE 104th CONGRESS

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THE THREATS

The Endangered Species Act (ESA) is under attack in the 104th Congress. If bills and amendments proposed are allowed to pass into law, programs protecting sea turtles will be drastically different. The new leadership in Congress has made clear their intent to reduce regulations on business and industry, a move that will potentially roll back twenty years of environmental, public health and safety protections.

Attempts to weaken the ESA are veiled in a variety of forms. Besides the direct attacks to the law itself, moratoriums on species listings and critical habitat designation, rescissions of appropriated funds, excessive cost-benefit analyses and risk assessments, and onerous landowner compensation requirements are part of ESA opponents' agenda. All combined, these bureaucratic delays and compensation requirements aim to make environmental laws unaffordable, and therefore unenforceable. Hearings have been held, bills have been passed -- all of which chip away existing protections for sea turtles and other endangered species. Now more than ever, these threats are very real; now more than ever, the need for action is urgent.

ENDANGERED SPECIES NEED YOUR VOICE

As scientists, your voice is powerful and unique. Congress needs to hear from scientists the need for biodiversity and the reasons to keep endangered species protections strong. To reach your Representatives in Congress, start locally and build support from the ground up. Request meetings when Members are in the districts, write opinion-editorials to your local newspapers, stand up for species protection at regional hearings and meetings. Remind representatives that as a scientist and as a voter, your opinions should influence how they vote on legislation aimed at weakening the Endangered Species Act.

For more information on how to become involved, please contact me directly.

RECENT ACTIONS BY THE MEXICAN INTERMINISTERIAL COMMISSION FOR MARINE TURTLE PROTECTION AND CONSERVATION

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The presence of numerous coastal habitats suitable for the life cycle of sea turtles has bolstered the existence in Mexico of one of the largest collections of nesting beaches in a single country- more than 180 have been catalogued, spread along Pacific, Gulf of Mexico and Caribbean coasts (Briseño-Dueñas and Abreu-Grobois, this volume). The country also boasts one of highest levels of species diversity (seven out of the eight extant species nest in Mexican coasts) and rookeries of critical or unique sizes for five out of these seven species: the black, leatherback and olive ridley turtle in the Pacific coast; the Kemp's ridley and the hawksbill in the Gulf of Mexico.

A large number of organizations in Mexico have developed strong interests in marine turtle research and conservation. Their roles and main attention, though, have changed over the years as the utilization of these species changed from an originally artesanal exploitation to an important industrial fishery, particularly in the Pacific, up and into the 1960's. The subsequent collapse of the fishery and particularly the demise of formerly *arribada* olive ridley colonies (for example, at Mismaloya, Jalisco and Tlacoyunque, Guerrero) shifted concern towards marine turtles conservation. Some of the first sea turtle conservation programs were set up in 1966 by the government and around the mid-70's by Mexican universities. Further, in 1984 the universities initiated yearly national symposia on sea turtle biology and conservation and established the Interuniversity Commission on Sea Turtle Conservation to coordinate the quickly proliferating sea turtle research and conservation actions in the country. There are currently 11 government agencies, more than 16 volunteer and non-government organizations, and 22 universities and research institutions working to conserve marine turtles in Mexico. Furthermore, around 40 conservation camps are set up seasonally to sustain these activities. As a whole, the work force involved constitutes one of the world's largest research and conservation ventures focused on a single topic.

Government backing for conservation reached important landmarks in the early 90's when new environmental protection legislation was drawn, an environmental protection agency was established (Procuraduría para la Protección del Ambiente- PROFEPA- equivalent of the US's EPA), and the National Commission for the Study and Use of Biodiversity (CONABIO) was set up in keeping with Agenda 21 of the UN Conference on Environment and Development. Significant steps leading towards better protection of sea turtles in Mexico also happened around this time- a total and permanent ban on marine turtle capture and commercialization of its products and sub-products was implemented in 1990; Mexico signed the CITES convention in 1992, and official implementation of TED technology in the Gulf of Mexico began in 1993.

In spite of the National Institute of Fisheries' more than 30 years experience in sea turtle conservation and very visible advances, having a broad variety of government and non-government organizations involved in marine turtle conservation has, in fact, hindered the optimization of already limited resources earmarked for this purpose. Partly, this has been so because of inherent difficulties in organizing and coordinating such a heterogeneous work force. But also because, as has occurred in many other countries, the fragmentation of official duties related to marine turtles among various government agencies has derived in overlapping or diffusely defined legal jurisdictions. The creation of the "Interministerial Commission for the Protection and Conservation of Marine Turtles" in 1994 attempted to solve this situation by bringing together all government agencies involved in sea turtle protection, research, conservation and restoration in Mexico, within a single overseeing body in charge of promoting, coordinating, and in some instances, funding national programs. It encompasses the Fisheries, Ecology, Tourism, Education, Navy, General Attorney and Transport agencies and thus serves as a direct channel to the executive branches of government which deal with specific matters directly or indirectly affecting the management of these organisms. The Presidency and the Secretariat of the Commission are taken up, respectively, by the representatives from the Fishery and Ecology branches of government (now fused into a new single ministry that includes Ecology, Natural Resources and Fisheries: Secretaría de Medio Ambiente, Recursos Naturales y Pesca - SEMARNAP).

Without going into details on the Interministerial Commission, unnecessary within the present context, we wish to point out major features which constitute distinct advances in sea turtle conservation practices in Mexico.

Functionally, the Commission constituted a technical advisory body with characteristics derived from extensive consultation with local turtle biologists and conservationists. This body, the "National Committee for the Protection and Conservation of Marine Turtles", is composed of representatives drawn from universities, research institutions, ngo's, and local communities involved with sea turtles in Mexico as well as government officials. This Committee is of major importance because, <u>for the first time</u>, institutes and organizations outside of government now have a direct influence on the development of national sea turtle conservation policies and their execution. It is also in charge of

A. promoting and prioritizing research and conservation project in sea turtles reproduction, foraging and development areas in Mexican habitats,

B. encouraging programs leading to the sustainable management of sea turtles,

C. promoting vigilance programs in coastal habitats and in market places to reduce sea turtle mortality and the commerce of organisms or their products, and

D. promoting alternative income sources for coastal communities particularly for those which traditionally exploited sea turtles.

While representatives from Fisheries and Ecology government agencies hold the two secretariats in the National Committee, this cabinet is chaired by a President, who must be a representative from an academic institution. The final four elements of the board of directors are taken up by the chairpersons from the subcommittees which coordinate and oversee the implementation of Commission-sponsored projects in focal areas to be developed nationwide.

The mandate for these four subcommittees and the scope of current programs financed with Commission's resources support novel or previously under-funded but, nonetheless, priority projects, a particularly urgent step for many coastal university marine turtle programs.

The Databases and Information Analysis subcommittee is in charge of developing uniform nationwide databases and information systems which will support conservation and research activities. The subcommittee is composed by representatives from organizations already associated with marine turtle information management in Mexico (including BITMAR, the National Fisheries Institute, and CONABIO). Fresh financial aid is being channeled towards the consolidation of BITMAR's capacity to monitor sea turtle conservation results, develop analytic tools and communication among work groups.

The subcommittee on Research (including Nesting Beach Conservation) is composed by representatives from all university and institutes doing research on marine turtles in Mexico. It will develop, coordinate and promote research programs addressing deficiencies in current knowledge of marine turtle biology and ecology. It will also promote training in marine turtle-related areas at all academic and technical levels, and target resources towards critical nesting beach conservation projects deprived of sufficient economic support. Among the current research projects already underway with Interministerial Commission's funding: a study of trogid beetle scavenging of olive ridley's nestings at Playa La Escobilla, Oaxaca; a conservation genetics study of leatherback and olive ridley populations in the Mexican Pacific coast; a study of the black turtle mating system. Additionally, funding has been extended to university and research institutes conservation programs in critical nesting beaches not already under official government support (Rancho Nuevo, for example, which already receives extensive endowment was thus excluded) and included programs on leatherbacks (in Tierra Colorada, Guerrero; Barra de la Cruz, Oaxaca; Mexiquillo, Michoacán), black turtles (in Maruata and Colola, Michoacán), olive ridleys (in Ceuta, Sinaloa and Playón de Mismaloya, Jalisco), besides green and loggerheads (in X'Cacel, Quintana Roo).

The subcommittee for Community Affairs (encompassing Environmental Education, Community Participation and Alternative Commercial Projects) is composed of representatives from the social development, education and tourism agencies in government, and from universities, ngo's and community organizations. It is in charge of identifying and promoting productive schemes providing alternative economic resources to coastal communities where marine turtle nest (ecotourism, agriculture, forestry, fisheries and aquaculture). It will also promote local environmental education programs not only in the nesting beaches regions but also in towns and cities, thus stimulating an interest in matters related to marine turtle conservation in Mexico as a whole. Already, seed money has been channeled to arts and crafts factories and ecotourism programs in Michoacán, and alternative commercial enterprises (village bakeries, and family horticulture) in Oaxaca. A video based on coastal children´s creations in local communities, depicting clear concern over the marine turtle´s plight and the excesses of human beings has already been produced and is being utilized as a useful tool in environmental education programs nationwide.

In order to promote the implementation of efficient protection of marine turtle reproduction and development areas within Mexican jurisdiction and the law-enforcement of legislation prohibiting commerce of marine turtle and their products, the last subcommittee, on Legislation, Inspection and Vigilance, was set up. This subcommittee is composed by representatives from ministries and agencies in the area of Transport, environmental protection, highway patrol and the Navy. It will also encourage training in environment protection and an increased public and official awareness of current conservation legislature. Official funding for these branches of local, state, and federal government is already in effect. Nevertheless, significant improvements in communication between Committee members have facilitated and accelerated denunciations and punishment.

Recent economic hardship in Mexico will probably cause that priorities be displaced towards social development programs causing limitations in the availability of financial resources for the conservation of biological resources (marine turtles included). There will, therefore, be an ever greater need to optimize federal budgets. Thus, foremost among the near future tasks of the National Committee will be the drafting of a <u>single</u> long-term national strategy for marine turtle conservation and yearly action plans. This undertaking will involve, for the first time, coordinated planning of the work to be performed by all organizations in Mexico involved in sea turtle conservation.

STATUS OF THE OLIVE RIDLEY NESTING POPULATION IN PLAYON DE MISMALOYA, MEXICO: 13 YEARS OF DATA

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Olive ridley (Lepidochelys olivacea) is the most abundant of marine turtles of the world. In Eastern Pacific is distributed from Baja California, Mexico until Chile Republic. In this region are there two of the most important nesting population of the world: Nancite beach in Costa Rica and La Escobilla beach in Mexico, and it have feeding zones like the region between Panama and Ecuador (Marquez-Millan, 1990).

In accord with Casas-Andreu (1978) and Center for Environmental Education (1982), in Playon de Mismaloya beach were registred during 60's and 70's several large mass nestings (arribadas) of 20, 30 or 50 thousand organisms in one nesting season. Playon de Mismaloya was considerated one of the most important beaches of the world for nesting of olive ridley.

The Universidad de Guadalajara since 1982 has carried out protection and research activities of marine turtles in this beach. this have done possible to obtain information of the olive ridley population tendency and history-life traits.

METHODS

Playon de Mismaloya beach is located in Mexican Central Pacific, State of Jalisco, it has an extension of 45 km and 120 m wide. The clime is subhumid with annual rain precipitation of 700-800 mm, average annual temperature of 26-28°c, being the most warm months June, July and August (Casas-Andreu, 1978).

Nesting season of olive ridley is June-December. Three camps are installed for protection and research of marine turtles: Playon, La Gloria and Majahuas. Walk and motorcycle daily nocturnal patrollings are carried out for collected and hatch eggs, and daybreak patrolling to do census of traces. The hatchlings of hatcheries are released in the sand of the beach.

RESULTS AND DISCUSSION

In accord with census of traces (1985-1994) is there annual average of 4,500 tracks of olive ridley sea turtle. The clutch frecuency is unknown for this population, but if we considerate that olive ridley lay two nests for year (Van Buskirk and Crowder, 1994) and there is no mortality among one clutch and the other one, then we can estimate a annual average of 2,250 adult female olive ridley sea turtles. If the sex ratio of population is 1:1, then we have a overall population of 4,500 adult olive ridley in this beach.

In accord with historic information about of the size population, the present data shown that population of olive ridley in Playon de Mismaloya beach is seriously decremented and is threated of extinction, on account of overexploitation of adult and eggs, principally. At present day the maximum recorded arribada is of 100 organisms. other pression on nesting population of olive ridley is the modification of the use of soil neighboring to beach, several tourist developments are building.

By other hand, the census of traces shown that turtles in 81.44%

prefer nesting in the platform zone of the beach or "zone b" (area between maximum level tide -"zone a"- and dune zone -"zone c"-), followed by zone a (12.25%) and zone c (6.02%). The zone b apparently have the suitable conditions of temperature and moisture for incubation of the eggs.

Study of the traits of life-history is an important component of evolutionary and ecological research (Harvey and Pagel, 1991), and the life-history comparisons among population or species may support predictions about population dynamics, provide insight into responses to evolution and can be used for determining appropriate conservation measures for marine turtles (Van Buskirk and Crowder, 1994). Thus, we have been recorded this information in nesting population olive ridley of Playon de Mismaloya. The results are showed in the Table 1.

By other hand, the results of protection of eggs and adults are shown in the Table 2. Is possible observe that the number of protected nests, eggs and hatchlings are increasing year by year, however the increment is on account of both major and best beach patrolling activities. Since 1982 until 1994 we have protected close 15,000 nests and 900,000 hatchlings, but we don't know if it have repercussion on size population or if because it the population keeps in the present level observed. The 100% of the annual nests in this beach could be pillaged by men if there is no protection activities. At present day pillage by men is near of 65% of the annual nests. Also, if we considerate annual average of hatchling yielded (70,000) and overall annual abundance of eggs (near of 450,000), we are protecting just near of 15% of the possible yield of hatchlings. Embrionary mortality (35%) is affecting during incubation of the eggs.

For the local conservation and management of the population of olive ridley in Playon de Mismaloya, must are considerated other aspects in addition to nests and hatchlings protection, like development of basic biological and ecological studies (for example, embrionary development, sex ratios, structure and dynamic of population), environmental education activities in coastal communities and economic alternatives for it, and other ones.

ACKNOWLEDGMENTS

We thanks overall researchers of Universidad de Guadalajara and volunteers that have participated in recorded of information during 13-years. We have been supported by Universidad de Guadalajara, Urban Development and Ecology Ministry, Public Education Ministry, Fish Ministry, National Committee for Protection and Conservation of Marine Turtles, Fish National Institute, State of Jalisco Government, and Ricardo J. Zevada Fundation.

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TABLE 1. Olive ridley life-history data collected from females and hatchlings on Playon de Mismaloya beach. Mexico

	MEAN	STD ERR	RANGE	n
CARAPACE LENGTH * (cm)	67.81	4.8	55.7 - 82.6	1590
CARAPACE WIDTH * (cm)	71.72	. 0.1575	60.6 - 84.4	577
CLUTCH SIZE (eggs)	96.8	0.7794	28 - 145	3940
EGGS SURVIVAL (%)	0.67	--	0 - 1	5179
INCUBATION PERIOD (days)	47	--	44 - 60	5179
HATCHLING CARAPACE ** LENGTH (mm)	38.44	0.004	2.0 - 4.9	+ 2406
HATCHLING WEIGHT (g)	13.35	0.042	8.4 - 19.8	+ 2406

* curve

**straight

\+ from Godinez-Dominguez (1989).

TABLE 2. Protection of nests, eggs and hatchlings, olive ridley sea turtles on Playon of Mismaloya beach, Mexico. 1982-1994 period.

YEAR	NESTS PROTECTED	EGGS	HATCHLINGS FREEDOM
1982	690	60000	40000
1983	295	29000	18668
1984	65	6565	4534
1985	722	66874	46190
1986	503	48016	30502
1987	1044	91855	39844
1988	518	47885	35800
1989	1253	94442	47667
1990	2000	192289	154205
1991	1800	162476	117782
1992	1500	138240	92374
1993	2500	238310	160308
1994	2000	185112	76628
TOTAL	14890	1361064	864502

NEW LAWS IN BELIZE PROTECTING SEA TURTLES

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Special Development Areas (SDAS) have been created in Belize to stipulate the type of development that will be permitted within those areas. They are zoning plans which can be reviewed and altered in time, but experience has shown that it is better to have some plan in place than no form of guidence at all. Each SDA is·intended to cover an area which has a discrete local socioeconomic basis. The means of plan implementation is through subdivision density control.

Two SDAs in Belize, Manatee and Monkey River, include sea turtle nesting beaches. In both areas, special sea turtle nesting reserves have been created. Both areas are subject to the most thorough form of zonation applied in an SDA. Because these areas were identified as prime nesting ground for the hawksbill turtle, the following array of restrictions has been attached to any future development:

a) a density of a minimum of four acres per parcel;

b) a minimum beach frontage per parcel of 1,000 feet;

C) a construction set-back of 200 feet from the low water mark;

d) the requirement that a maximum of only 20% of beach vegetation is cleared;

e) the prohibition of all external electric lights;

f) the requirement of the strict control of all domestic animals;

g) all piers or jetties require a minimum interval of 1,000 feet between them;

h) a total restriction on sea wall construction;

i) and a total restriction on any form of dredging.

SYNCHRONOUS INTERSEASON REMIGRATION INTERVALS IN GREEN TURTLES (CHELONIA MYDAS) FROM AVES ISLAND

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Since 1979, FUDENA has been monitoring the green turtle (*Chelonia mydas*) nesting population of Aves Island (Venezuela, 15 40' 30'' N, 63 36' 26'' W). Turtles are tagged with Monel tags as they arrive to nest.

The objective of this study was to determine if the date of the first nesting of a specific turtle within a season, is similar to the first nesting date of the past season.

Registering of appearance of each turtle allows us to estimate the time between emergences in consecutive nesting seasons or Interseason Remigration Interval (IRI). A total of 857 IRI were registered since 1979, with appearance dates between February and November. Most common IRI periods were 2 years (49.24 %) and 3 years (36.06 %) (Table 1 and Fig. 1). Difference between dates of first nesting in successive seasons range from 0 days to 195 days (fig. 2), with a mean of 24.18 days (sd:

23.82); 50.53 % of the returns (first nesting dates) occurred with a difference of ± 18 days compared with the first nesting date of the past season, and 72.81 % with a difference of ± 30 days (figs. 3 and 4).

Results showed that arrival of turtles each nesting season is predictable.

The synchrony in date of first nesting in a particular time of the year, could be related with the biological clock of each reproductive female, and water temperature or photoperiodicity could be the controlling factors.

The high degree of synchrony in IRI dates allows to optimize efforts when monitoring individuals for specific studies such as disease control or recovering telemetry devices, and gives a major understanding of the reproductive ecology of C. mydas, essential for restoring and management of this reptile in danger of extinction.

Table 1. Interseason Remigration Intervals
in reproductive females of Chelonia mydas
from Aves Island

YEARS	CASES	%
0	10	1,17
1	17	1,98
2	422	49,24
3	309	36,06
4	53	6,18
5	21	2,45
6	13	1,52
7	4	0,47
8	2	0,23
9	3	0,35
10	2	0,23
11	1	0,12

Fig. 1. Interseason Remigration Intervals in reproductive females of Chelonia mydas from Aves Island

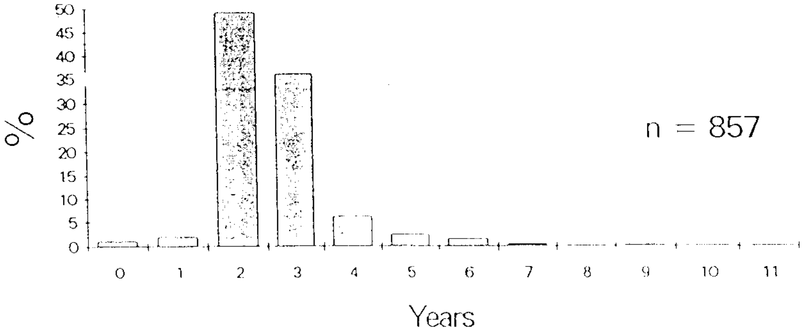


Fig. 2. Difference between Interseason Remigration dates in reproductive females of Chelonia mydas from Aves Island

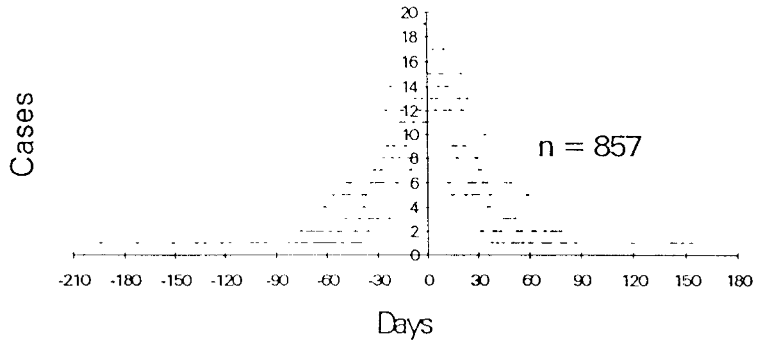
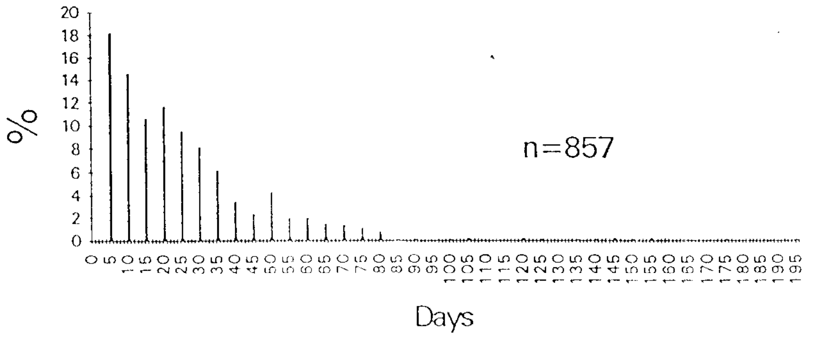


Fig. 3. Difference between Interseason Remigration dates in reproductive females of Chelonia mydas from Aves Island (grouped in five days periods)



POPULATION CYCLES OR POPULATION DECLINE: ARE LEATHERBACK TURTLES GOING EXTINCT?

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Leatherback turtle (Dermochelys coriacea) numbers appear to be declining worldwide. Leatherbacks no longer nest in India. In the 1950's thousands nested in Sri Lanka, today only 20. In 1980, 6000 leatherbacks nested in French Guiana, in 1992 only 2500. In 1980, 3,000 nested at Tierra Colorada, Mexico, in 1992-93 only 1500. In 1980, 2000 nested at Chacahua, Mexico, in 1992-93 only 900. In 1980, 4000 nested at Mexiquillo, Mexico, in 1992-93 only 400, and in 1993-94 only 14. At Terengganu, Malaysia, 6000 nested in 1970, 1500 in 1980 , 25 in 1990, and 2 in 1992. At Las Baulas de Guanacaste, Costa Rica over 1500 nested in 1988-89 and 1989-90, 800 In 1990-91 and 1991-92, but in 1993-94 only 193. Only the Suriname colony has increased- from 400 in 1975, to 2000 in 1993. In 1981, Ross estimated world population as 30,000 to 50,000 females. In 1982, Pritchard reported new nesting populations along Pacific Mexico and revised the world estimate to 115,000. He still considered leatherbacks endangered because of heavy exploitation. Nesting colonies are in rapid decline and we now estimate world population as 20,000 to 30,000. At this rate of decline leatherbacks will be extirpated in 18 years.

Is this extrapolation accurate? We have to be careful of extrapolating information from regression lines based on 2 points. However, the recent loss of leatherbacks from several nesting colonies, the heavy poaching of eggs on many leatherback beaches for the last 50 years, the continued capture of leatherbacks in the long line fishery in the Pacific, and the effects of the now banned high seas drift net fishery may be drastic indeed. If the declining numbers of leatherbacks nesting in Pacific Mexico and Costa Rica represent a real decline in population size, then the Pacific leatherbacks, at least, are in danger of extirpation. If they represent population fluctuations, then we need to examine the instances of population fluctuations in other vertebrate populations which have often been warning signs of impending crashes. While sea turtle biologists may have become accustomed to population fluctuations in sea turtle populations, they should remember that such fluctuations also preceded the collapse of fisheries in the U. S. Great Lakes, the North Sea herring fishery, and the recent collapse of the Grand Banks fishery in the North Atlantic.

THE CORRELATIONS BETWEEN THE CLUTCH SIZE AND HATCHING SUCCESS AS WELL AS THE NUMBER OF HATCHLINGS AND THE EMERGENCE SUCCESS OF ATLANTIC LOGGERHEAD SEA TURTLES (CARETTA CARETTA CARETTA)

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INTRODUCTION

This study was done on Cape Island in the Cape Romain National Wildlife Refuge in Awendaw, South Carolina. The primary purpose was to determine if there was a correlation between the hatching success and the emergence success. A correlation between the number of hatchlings and the emergence success was also studied. This was studied by using whole nests in beach hatcheries.

BACKGROUND

On Cape Island a very successful recovery program is taking place. Eggs of about 80% of the nests on the island are relocated into hatcheries to prevent predation by ghost crabs (Ocypode quadrata) and raccoons, (Procyon lotor), as well as protection from erosion and high tides.

The hatching success is determined each year by excavating the nests after they have hatched. In 1993, the hatching success was an average of 79.1% among the relocated nests, while only 44% in the control nests. In 1992, the hatching success was 83.8% in the relocated nests, versus 17% in the control nests (Unpublished report 1994).

The purpose of this research and experimentation is to determine whether there is a correlation between the clutch size and the hatching success, and if there is a correlation between the number of hatchlings and the emergence success of Atlantic loggerhead sea turtles.

In Malaysia, researchers split clutches of leatherback (Dermochelys coriacea) and hawksbill (Eretmochelys imbricata) turtle eggs into groups of 40 to 60 eggs per hole in beach hatcheries. The results demonstrated that split clutches had a better hatching success and a better emergence success. The hatching success differences were 10.3% and 5.7% in the leatherback and hawksbill nests, respectively. There were no dead hatchlings found in the leatherback nests, whereas in the hawksbill nests, the number was significantly lower than the whole nests (Motimer, et. al. 1993).

Dawsey (pers. comm.) suggests that a greater number of hatchlings in a nest would correlate to a better emergence success due to the contribution of energy from each hatchling. This will produce more total work and therefore make the process easier for each individual.

PROCEDURE

Nests are collected daily in the morning and are transferred to beach hatcheries on the same island. Once every two weeks, control nests are marked on the beach. The condition of the control nests is checked each day for five days, and once a week after that.

At the end of the nesting season, 25% of the nests are excavated. The reason for this is to determine the hatching success and the emergence success. Twenty-five percent of the nests in each hatchery are chosen at random and excavated. The number of unhatched eggs is recorded as "bad eggs" and the number of dead turtles found is recorded.

RESULTS

The results in this study proved to have no statistical correlation, but they do slant toward the hypothesis. In Figure 1, the hatching success is graphed in relation to the clutch size. It appears as though the clutch size is slightly inversely related to the emergence success. In a regression analysis, the R squared value is (-)0.0152 which means there is almost no correlation, but the relationship is slightly inverse, as expected.

Figure 2 shows the hatching success plotted against the emergence success. It shows that if there is a hatching success greater than about 70%, there is a greater chance for an emergence success less than 100%. The R squared value for it is (-)0.008 which also means there is a slight but not statistically significant correlation.

Figures 3 and 4 are both graphs which examine different possible correlations between hatching success and emergence success. The first is a plot of the number of hatchlings produced versus the emergence success. The main idea that Figure 3 points out is that a nest usually doesn't have an emergence success lower than 100% if the number of hatchlings produced is less than about 80 turtles. Figure 4 relays the same basic message, except in a percent. It also shows minimum hatching successes for the possibility of dead turtles. In this study, if a nest had a hatching success of greater than about 65%, then there was a greater probability for one turtle to die in the nest. If the success was greater than about 75%, 1 or even 2 turtles were likely to die, if any. If it was greater than about 80%, 1, 2, or 3; if it was greater than about 85%, 1, 2, 3, or 4 had a chance of dying in the nest. There were no nests that had more than four dead turtles in them. In other words, the greater the hatching success, the more likelihood for a hatching success of less that 100%.

CONCLUSIONS

The number of eggs had an inverse relationship on the hatching success and the emergence success was thought to be true at the start of this study. The results of this experimentation prove this hypothesis insignificant. The hypothesis was proven correct, but the correlation that was found was not statistically significant. Therefore, I recommend that further research and experimentation be executed on this subject, especially with split clutches. However, the depth of the sand must be carefully measured so that the temperature does not alter the sex ratio.

ACKNOWLEDGMENTS

First and foremost, I would like to thank my mentor, Larry Davis, my advisor, Murray Eicher, and two of my co-workers, Sarah Dawsey and Barry Stieglitz. Also, I would like to thank some other people that collected data and worked very hard during the summer: Larisa Avens, Tammy Gross, George Gaskins, and F. B. Del Porto, as well as some other volunteers.

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Figure 1

Clutch Size Vs. Hatching Success

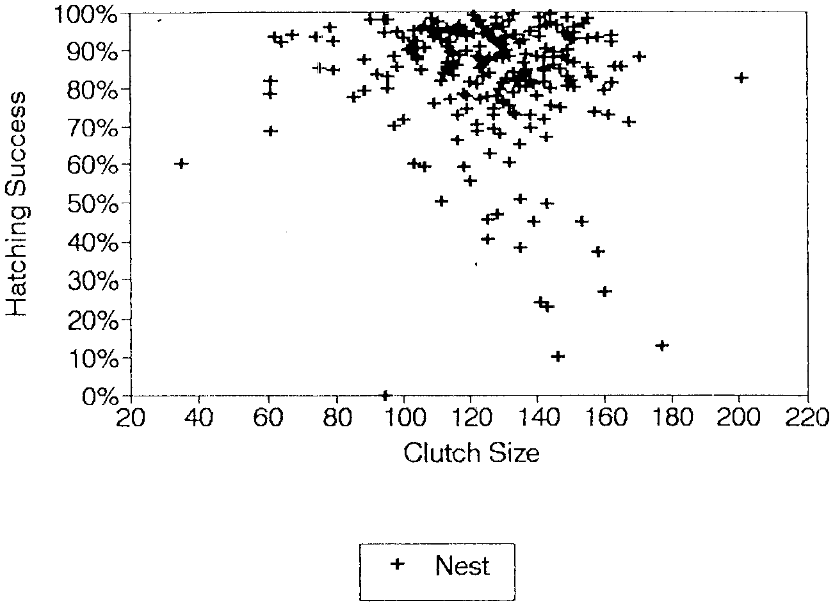


Figure 2

Hatching Success Vs. Emergence Success

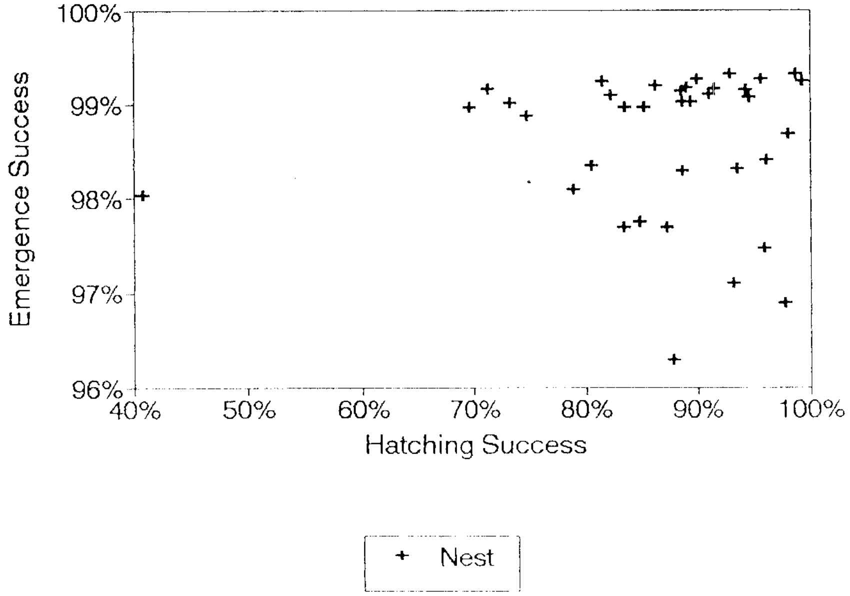


Figure 3

No. Hatchlings Vs. Emergence Success

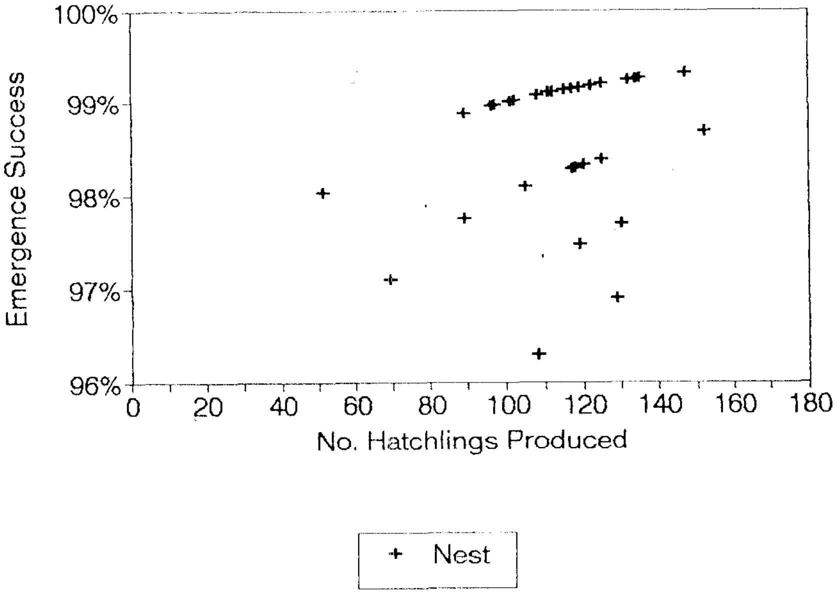
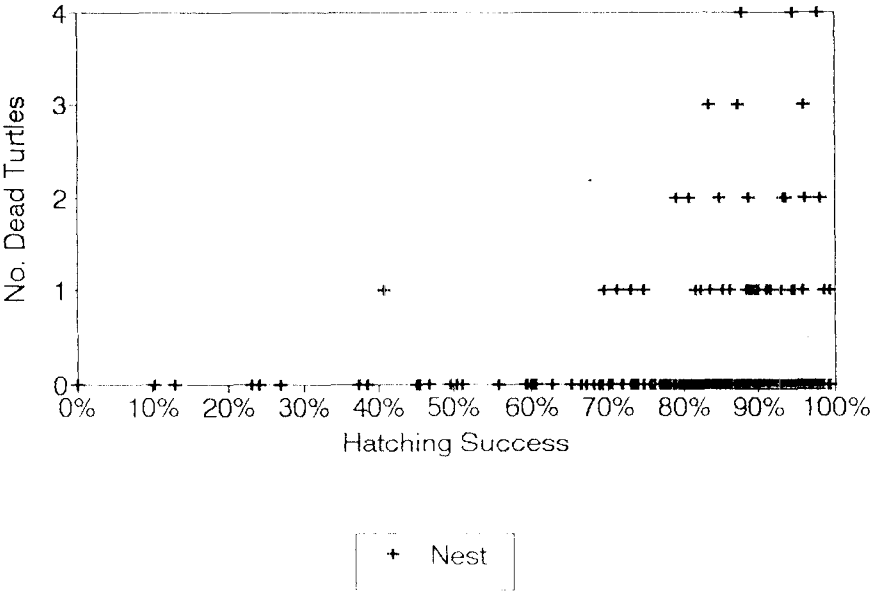


Figure 4

Hatching Success Vs. No. Dead Turtles



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DETERMINATION OF PRIMARY CUES USED FOR FOOD RECOGNITION IN LOGGERHEAD SEA TURTLE (CARETTA CARETTA)

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This study analyses visual and olfactory cues in food recognition of Loggerhead (Caretta caretta) sea turtles. It focusses on which sense is predominately used in sea turtles when determining whether or not an item is food stuff. A series of stimuli were presented to the turtle and reaction time noted. These stimuli include fish, items that look like fish, items of different colors, sizes and shapes, and I examined whether color, shape, size or smell of the stimuli elicited an attempt at ingestion. Also, the role of proximity of an item in olfactory and/or visual cues was tested by varying the stimuli distance. Stimuli with and without olfactory cues were examined to study the significance of scent. This study provides information about recognition of food stuff and whether or not attempts at ingestion are limited to certain cues. These data will help us determine the likelihood of certain pollutants being ingested and why they are mistaken for food stuff.

METHODS

1) Reaction time was calculated by placing food stuff at varying distances directly in front of the turtle, anterior and within the visual field. Distances used were 2.54, 12.7, and 35 cm. The size of food was also varied by using 10 and 18 cm food stuff. Food stuff tested included squid and smelt.

2A). Nine synthetic fish (with no odor) with a similar look to the fish normally used in feeding (squid, smelt, herring) were presented, at a distance of 35 cm, and reaction times noted. These times were compared with reaction times using real fish to determine the role of olfactory cues.

2B). A scent stimuli made from a mixture of blended fish was presented with the synthetic fish such that the olfactory stimuli was now present. Reaction times were compared to part A.

3) To determine the role of olfactory cues without visual stimuli of any kind, fish extract was circulated in the water with the turtles and reactions were noted.

RESULTS AND DISCUSSION

Reactions of the turtles varied according to distance of placement . Reaction time to synthetic fish without odor varied widely between individuals for each of the different synthetic fish. The turtles showed more reactions occurring towards synthetic fish with smell than without. Significant behavioral reactions were recorded when fish extract without any visual stimuli (no actual fish) was presented. The turtles swam with open mouth, biting at tank pipes, and they showed an increased general activity level in response to the olfactory stimuli. These findings indicate that loggerhead sea turtles use their sense of smell for their search for food and that visual stimuli are important in the choice of food stuff. This could be one possible explanation for why certain pollutants are mistaken for food stuff.

SUBSISTENCE HUNTING OF LEATHERBACKS IN THE KEI ISLANDS, INDONESIA

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The Kei Islands are located southwest of New Guinea in the Maluku province of Indonesia (5°43'S, 132°50'E). Historically renowned for its natural diversity and beauty (Wallace 1989), this archipelago has been subjected to intensive timber harvest during the last several decades. Local inhabitants subsist primarily on agriculture and marine resources, including turtles. Of the five species of sea turtles found in Kei waters the olive ridley (<u>Lepidochelys olivacea</u>) and loggerhead (<u>Caretta caretta</u>) are encountered least often. Green (<u>Chelonia mydas</u>) and hawksbill (<u>Eretmochelys imbricata</u>) turtles nest within the archipelago, but their numbers have been severely reduced due to the poaching of nesting females, incidental capture in gill nets, take by skin-divers using treble hooks, and the collection of eggs. Leatherbacks (<u>Dermochelys coriacea</u>) do not nest on the islands, but frequent the waters (90-3,300 m depth) off the southwestern coast of Kei Kecil throughout the year. The nearest leatherback nesting area is on the north coast of Irian Jaya, some 1,000 km away by sea (Bhaskar 1987).

Peoples of Kei hunt leatherbacks in the open sea using traditional harpoons and dugout sailboats. This traditional leatherback fishery has been part of Kei culture for centuries (Compost 1980) and encompasses many traditional rituals and beliefs locally known as "adat".

Objectives of our study were to: identify villages which hunt leatherbacks and estimate the number of leatherbacks taken seasonally; determine methods, season and location of leatherback capture; describe traditional beliefs and rituals associated with hunting; and to initiate an environmental education program to introduce the peoples of Kei to marine resource conservation.

METHODS

In an effort to describe the leatherback fishery we interviewed hunters, village chiefs and elders in ten villages on Kei Kecil and the adjacent islands of Ur, Warbal and Tanimbar during 2 October-13 November 1994. Hunting methods and traditional rituals were studied further by accompanying hunting boats out to sea. Carcasses brought into the villages were measured and their sex and reproductive condition noted. Information on the take of other turtle species was also collected.

During meetings and discussions with village chiefs and hunters from eight villages, we shared sea turtle research techniques and exchanged information about turtles, such as, the potential causes for the area's decline in turtle numbers. We hired a chief and hunter in each of the eight villages to collect data (e.g., number, species, size, method of capture) on the turtles harvested by their village throughout 1995.

An environmental education program established for the children of Ohoidertutu village was conducted opportunistically on the beaches when turtles were brought to the village and during weekly workshops on marine ecology in the local school.

RESULTS

We observed leatherbacks feeding on abundant surface scyphomedusae between Kei Kecil and Tanimbar Islands, the area in which they are hunted (Figure 1). Six necropsies conducted during our study suggest these to be their main prey item in this area.

Approximately 200 leatherbacks are harpooned southwest of Kei Kecil (Figure 1) during October-April, the local oceanic calm period. Eight villages participate in the hunt, five villages (Ohoidertutu, Matwaer, Ohoidertom, Somlain, Ohoiren) are located on the southwestern coast of Kei Kecil; the others (Warbal, Ur, Tanimbar) are on offshore islands. Adat calls for village elders to make an offering of a 100 Rupiah coin, areca palm nuts and rice liquor to the Gods prior to the hunt. Eight to ten men then sail a dugout boat 5-10 km offshore and perform a ceremonial chant believed to attract the turtles to the boat. The chant continues until a leatherback is sighted, at which time the sails are dropped and all men on board row towards it. A man on the bow harpoons the turtle through the carapace or neck, sometimes several times. The turtle is then pulled to the boat and clubbed over the head. Several men jump into the water to push the turtle over the gunnel of the boat. If it is a large leatherback, the boat is often submerged to ease pulling the turtle over the gunnel.

Interview data suggest that both adult males and females are taken. During our study we witnessed six adult females taken by Ohoidertutu village in two weeks, all carried undeveloped eggs approximately 3 cm in diameter. Average curved carapace length and width was 154 cm (range 145-164 cm) and 107 cm (range 103-113 cm), respectively. As many as 13 leatherbacks have been harpooned in one day by Ohoidertutu villagers (P. Teniwut, Chief of Ohoidertutu, pers. comm., 1994).

DISCUSSION

The waters of Kei are a potentially important feeding area for the leatherback in this area. Leatherbacks which frequent these waters are possibly migrating to the nesting beaches on the north coast of Irian Jaya, as suggested by the presence of undeveloped eggs in all of the females captured during our study. Timing of the occurrence of leatherbacks in this area correlates to the nesting season on Irian Jaya (May-January).

The harvest of leatherbacks in the Kei Islands is controlled by adat, which encourages villagers to hunt only for subsistence and does not allow the sale or trade of leatherback meat. Despite a changing cultural and physical landscape leatherbacks are only hunted for sustenance; the meat is not sold. Increased needs for meat, however, have changed perceptions of the traditional leatherback hunt. Leatherbacks are hunted more frequently today than in previous decades when they were hunted only for ritual purposes.

It is of concern that many of the traditional beliefs and rituals associated with the hunt have been lost, as it has undergone the transition from being only a ritual event to becoming a food source. This may be an indication of the onset of a breakdown in cultural values, a global problem shared by many indigenous communities and which has occurred in other sea turtle hunting societies which have undergone rapid change in modern times (e.g., Nietschmann 1982). What began centuries ago as a highly ritualized and perhaps sustainable practice is now an intensive harvest of this turtle, but a necessity for sustenance in the Kei Islands. This is attributed to population growth in these islands and deforestation which has resulted in the loss of forest resources such as deer, birds, and pig.

If traditional values continue to breakdown it could result in further growth of this fishery. Assuming the leatherbacks hunted in Kei waters are from the nesting stock of Irian Jaya, the combination of high nest loss on those beaches due to beach erosion, poaching and pig predation (Starbird and Suarez 1994) and increased hunting pressure in Kei waters of adult females and males would reduce a possibly already diminished population in this region.

While the hunt provides an important food source for peoples of Kei, there is great potential to reduce the number of leatherbacks harvested by these communties. Understanding local tradition is an important first step towards effective conservation of the leatherback turtle in the Kei Islands. Integrating the needs of the people and their traditional values into plans to conserve the turtles will prove the most effective conservation approach.

An effective solution may be to encourage alternative sources of meat such as pigs, goats and chickens. In Ohoidertutu village where the most leatherback turtles are harvested (70-100/yr), both the chief and sub-chief agreed that alternative sources of meat would reduce the drive to hunt leatherbacks. Some villages have a few domestic animals but have not actively bred them for food. By providing villages with animal stock and improving husbandry skills, the need to hunt leatherbacks could be reduced significantly. Conservation initiatives in this area should also foster an understanding of the ecology of the leatherback turtle among locals. Through environmental education and public awareness campaigns, the villagers will gain a better understanding of contemporary dangers facing leatherback turtles. Informed choices by the peoples of Keï will help ensure sustainability of their fishery by establishing guidelines for the take of leatherbacks and addressing the need for management of the fishery (Pritchard 1994). Through community participation and local agreement, such a conservation program will be most likely to survive and flourish in the future.

ACKNOWLEDGMENTS

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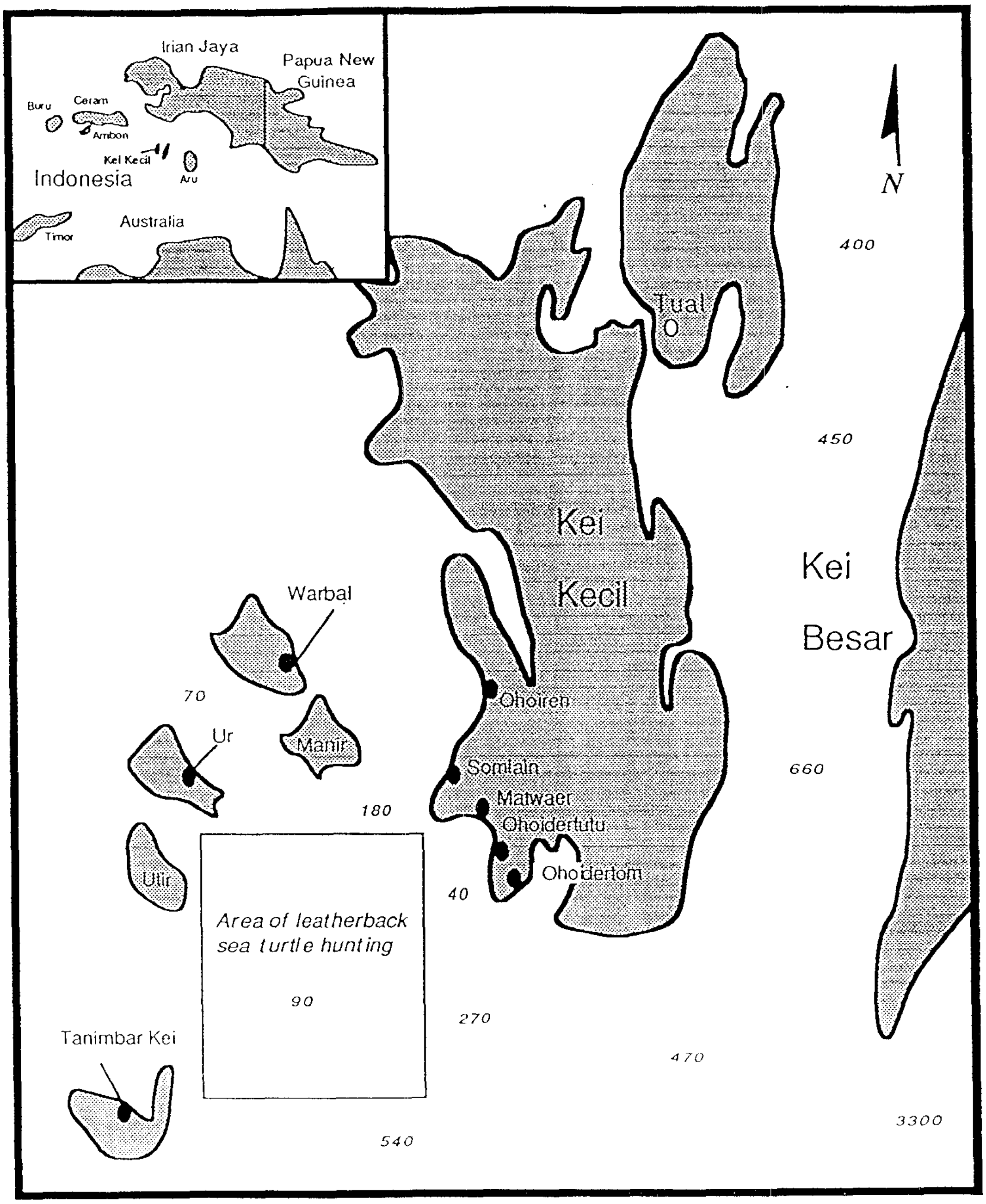

Figure 1: Location of traditional leatherback sea turtle fishery in Maluku, Indonesia (not to scale).

REPRODUCTIVE CHARACTERISTICS OF THE OGASAWARA GREEN TURTLES.

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Since 1981, the Ogasawara green turtle population has been monitored by Ogasawara Marine Center. Within the Ogasawara Islands in Japan, green turtles nest in Mukojima, Chichijima and Hahajima groups, as the most northern major breeding sites of this species in the north Pacific region. Adult turtles migrate to the islands from March, and matings occur off the coast through May. Currently, local fishermen annually spear around 100 mating adults. From the fisheries statistics in Hahajima group for 1975-1994, mean body weight of males was 99.1 kg (range=53-149, n=965) and mean body weight of females was 131.1 kg (range=49-194, n=997). Nesting occurs from May through early September, with peak nesting in June and July. Mean straight carapace length of nesting females for 1985-1994 was 95.2 cm (sd=4.5, range=82.7-107.7, n=308). Mean clutch size was 102 (sd=26.2, range=4-183, n=598). From the nesting activities by wild caught females in a pen, mean number of clutches within a season was calculated as 4.1 (74 turtles, 304 clutches, max=6). On the natural beaches, mean number of emerged hatchlings per clutch was 42.2 from the 1991 through 1994 seasons (972 clutches). Ghost crabs, *Ocypode cordimana*, completely depredated 14-23% of the study nests each season.

ATMOSPHERIC BASKING IN THE HAWAIIAN GREEN TURTLE, *CHELONIA MYDAS*: COMPARISONS OF TUMORED AND NON-TUMORED TURTLES.

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INTRODUCTION

In the Northwestern Hawaiian Islands, the green turtle, *Chelonia mydas*, demonstrates a behavior that is generally uncharacteristic of marine turtles--hauling on shore to bask, both during the day and night. For well-studied and similar species of freshwater turtles, this behavior is best explained as a means of thermoregulation. Although a nearly ubiquitous behavior among freshwater turtles, basking currently occurs in only one species of marine turtle, *C. mydas*, and in few locations in the Pacific Ocean: Australia (Bustard 1973, 1979), the Galápagos Islands (Snell and Fritts 1983), and the Northwestern Hawaiian Islands (Balazs and Ross 1974; Whittow and Balazs 1982).

Yet another characteristic of *C. mydas* in Hawaiian waters is the relatively high prevalence of green turtle fibropapillomatosis (GTFP), whose symptoms include both internal and external tumor growth. In certain foraging areas in the main Hawaiian Islands, tumored animals have been observed in 49- 92% of sampled populations (Balazs 1991). Due to the prevalence of GTFP and to the occurrence of the relatively rare basking behavior of C. mydas in Hawaiian waters, we sought to determine if a relationship between basking and GTFP disease might exist. Furthermore, we sought to determine what physiological role(s) might help explain the occurrence of basking in this population of marine turtle, the impact of GTFP on physiological processes such as metabolism, as well as abiotic factors potentially correlated with basking.

In this preliminary study with captive C. mydas, we asked the following questions:

1) Does the basking behavior of tumored and non-tumored turtles differ?

2) Does basking influence body temperature (T_b)?

3) Is basking correlated with certain abiotic factors?

4) Does basking influence metabolic rates?

5) Does presence of GTFP tumors influence metabolic rate?

METHODS

Five tumored turtles (SCL range: 47.8-58.9 cm.) and four non-tumored turtles (SCL range: 44.5-50.9 cm.) were obtained from the wild in Kaneohe Bay, Oahu (21° 30 N, 157° 50 W) on six different occasions between June 21 - Sept. 23, 1994. Turtles were measured, weighed, scored on a scale of 1-4 according to degree of tumor severity (4 being most severe) (Balazs 1991), and brought into captivity at the National Marine Fisheries Service Kewalo Research Facility in Honolulu, Hawaii. Tumored and non-tumored turtles were housed in identical, yet separate tanks, each equipped with a basking ramp (made of plywood and painted off-white with sand to provide a non-skid surface). Sea water temperature in tanks remained between 24.0-25.5°C. Average tumor score of study animals was 2.6 (range: 2-3). Turtles were fed between 6-8 a.m., and their diets consisted of a daily ration of 4 squid plus a multivitamin/individual.

1) Basking was observed either in person or using a still camera equipped with an interval shooting mechanism that was set to photograph basking ramps at set time intervals.

2) Body temperature measurements were obtained using a Yellowsprings YSI thermistor probe inserted 15 cm. cloacal depth (Determined by Mrosovsky (1980) to be an adequate placement to determine deep body temperature).

3) Abiotic factor data were of two types: A) meteorological data obtained from the National Weather Service from the Honolulu airport (within two air miles of the captive site), and B) operative environmental temperature (T_e) which is determined with the use of a hollow copper model of a C. mydas and is the measure of the true environmental temperature experienced by the animal (see Bakken and Gates 1975 for discussion).

4) Metabolic rates were determined using gas collection methods. A funnel-shaped mask made from a plastic container was taped over the animal's head to provide an airtight seal. A Y-shaped valve placed at the end of the mask served to separate inspired and expired gases. Expired gas was collected in a 20L Collins Bag, dry gas samples were analyzed using a Beckman Oxygen Analyzer or a Radiometer, and gas volume was measured with a gas meter.

PRELIMINARY RESULTS

On 47 observation days from mid-September to mid-December, a minimum of one tumored-turtle (mean=4, s.d.=1.23) was observed on the basking ramps. Non-tumored turtles were never observed basking. 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). Average body temperatures of post-basking tumored turtles was 3.3°C (s.d.=1.18) above water temperature. Because non-tumored turtles were never observed basking, no data are available for their post-basking body temperatures. Post-swimming body temperatures 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). Average body temperatures above water tempeature of tumored turtles that had been free swimming was 0.65°C (s.d.=0.31) and 0.51°C (s.d.=0.46) for non-tumored turtles.

Twenty-four hour data reveal that tumored turtles in captivity are both diurnal and nocturnal baskers, with the highest number of individuals basking mid-day (between 1100-1400 hours), and the fewest basking turtles in the early morning hours (between 0500-0700).

Data on metabolic rates suggest that the influence of basking and elevated body temperatures on metabolic rates of tumored turtles varies significantly among individuals. Only one turtle demonstrated the expected response of elevated temperatures (from basking) associated with an increase in metabolic rates. Basking data from most (3 of 4) tumored animals suggest that basking incurs less of a metabolic cost than swimming, despite elevated body temperatures. Metabolic rates for non-tumored turtles post-swimming are similar to the standard metabolic rate (0.024 L/Kg/Hr) determined for resting adult C. mydas (Prange and Jackson 1976; Jackson and Prange 1979).

Metabolic rates of post-swimming turtles with body temperatures between 24.5-26.3°C suggest that tumored turtles incur significantly higher metabolic costs (mean metabolic rate for tumored turtles=0.040 L O_2 /Kg/Hr, s.d.=0.022 compared to mean metabolic rate for non-tumored turtles=0.017 L O_2/Kg/Hr, s.d.=0.007; t=3.15, p=0.009). [Tumored turtles n=3 turtles @ 5 different temperatures, mean T_b=25.3, s.d.=1.13; non-tumored turtles n=4 turtles @ 8 different temperatures, mean T_b=25.4, s.d.=1.27].

DISCUSSION

Our study on the physiological role(s) of basking and the potential correlation to abiotic factors yields many intriguing results, many of which require more extensive research before conclusions can be drawn. The fact that only tumored-turtles were observed basking lends support to the idea of an association between GTFP and basking, yet the nature of this relationship remains uncertain. In order to determine how UV radiation and/or heat influences tumor growth, laboratory experiments should be conducted. One potential function for diseased animals to bask would be to elevate body temperatures to attain a febrile state, which has been shown to enhance the immune response and increase survivorship in numerours vertebrate species (Kluger 1991). Although this study confirms that turtles are elevating body temperatures via basking, laboratory studies involving manipulation of turtle temperatures, close observations of the progression of GTFP, and determination of specific immune responses (i.e. increased activity of white blood cells, etc.) are necessary to confirm the theory of behavioral fever occuring in basking C. mydas.

Data on abiotic factors and basking behavior indicate that basking frequency is greatest during mid-day when ambient temperatures are highest. Although T_e was not found to be a good predictor of basking using simple linear regression analysis, these data as well as other abiotic factor data (ambient temperature, cloud cover, substrate temperature, etc.) will undergo statistical scrutiny to determine if any associations between basking and abiotic factors exist.

Despite changes in body temperatures, metabolic rates of basking and non-basking tumored turtles indicate that for the majority (75%) of the turtles studied (n=4), basking incurs less metabolic cost than swimming. Perhaps this explains the reported incidences of tumored turtles observed stranded ashore (basking?) at various locations throughout the main Hawaiian Islands (G. Balazs, unpublished data).

Increased metabolic rates for tumored turtles at similar temperatures as non-tumored turtles suggest that GTFP likely affects physiological processes. Further studies on the physiological effects of GTFP on C. mydas are necessary in order to determine the impact of the disease at both the individual and population level.

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AN OVERVIEW OF 1994 MARINE TURTLE STRANDINGS

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Data for this summary were collected by the National Marine Fisheries Service (NMFS) Sea Turtle Stranding and Salvage Network (STSSN) during calendar year 1994. The STSSN was established in 1980 to document strandings of marine turtles along the U.S. Gulf of Mexico and Atlantic coasts. The network includes the eighteen coastal states from Texas through Maine and includes Puerto Rico and the U.S. Virgin Islands in the Caribbean. Data are compiled through the efforts of network participants, mostly volunteers, who document marine turtle strandings in their respective areas and contribute those data to the centralized stranding database maintained at the NMFS Miami Laboratory. A stranding is defined as a turtle which washes ashore dead or alive or is found floating dead or alive, generally in a weakened condition. When a stranded turtle is encountered, a stranding report is completed to document the species, location, condition, measurements, and remarks the observer has about the stranding, including injuries, disease, evidence of entanglement or other potentially relevant comments.

During 1994, a minimum of 2,425 marine turtle strandings were documented by Sea Turtle Stranding and Salvage Network (STSSN) participants. Of the 2,425 total, there were 1,292 loggerheads (Caretta caretta), 362 green turtles (Chelonia mydas), 66 leatherbacks (Dermochelys coriacea), 39 hawksbills (Eretmochelys imbricata), 573 Kemp's ridleys (Lepidochelys kempii) and 93 turtles which could not be identified to species. State stranding totals are as follows: Florida, 815 (630 Atlantic coast, 185 Gulf coast); Texas, 526; North Carolina, 244; Georgia, 227; Louisiana, 181; Virginia, 145; South Carolina, 85; Massachusetts, 40; New Jersey, 33; Mississippi, 26; Delaware, 22; New York, 20; Maryland, 16; U.S. Virgin Islands, 14; Puerto Rico, 13; Rhode Island, 13; Alabama, 4; Connecticut, 1; no stranding reports were received from New Hampshire or Maine. Gulf of Mexico (Texas through Florida-Gulf) strandings totalled 922 - 47.0% Kemp's ridleys, 33.4% loggerheads, 11.3% greens, 2.4% hawksbills, <1% leatherbacks, 5.2% unidentified. Southeast U.S. (Florida-Atlantic through North Carolina) strandings totalled 1,186 - 66.3% loggerheads, 19.5% greens, 7.8% Kemp's ridleys, 3.0% leatherbacks, <1% hawksbills, 2.6% unidentified. Northeast U.S. (Virginia through Maine) strandings totalled 290 - 68.3% loggerheads, 16.6% Kemp's ridleys, 7.9% leatherbacks, 2.4% greens, 4.8% unidentified. U.S. Caribbean (Puerto Rico and U.S. Virgin Islands) totalled 27 - 74.1% greens, 22.2% hawksbills, 3.7% leatherbacks. Thank you to all of the STSSN participants who documented marine turtle strandings during 1994.

EFFECTS OF ANTHROPOGENIC DEBRIS ON MARINE TURTLES IN THE WESTERN NORTH ATLANTIC OCEAN

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The data used in this analysis were collected by the National Marine Fisheries Service (NMFS) Sea Turtle Stranding and Salvage Network (STSSN). This network was established in 1980 to document marine turtle strandings along the U.S. Atlantic and Gulf of Mexico coasts, Puerto Rico and the U.S. Virgin Islands. Data are collected by volunteers who document strandings in their respective areas and contribute those data to a centralized database located at the NMFS Miami Laboratory.

Data collected by the STSSN are useful in documenting the impacts of anthropogenic debris on marine turtles; however, care must be taken when interpreting these data. Stranding coverage has varied both temporally and spatially and the quality of data collection has increased as observers gain experience. These data, therefore, represent a sample of sea turtles affected by marine debris.

Network participants examined 676 marine turtles affected by anthropogenic debris from 1980 through 1992 - 260 loggerheads (*Caretta caretta*), 208 greens (*Chelonia mydas*), 83 leatherbacks (*Dermochelys coriacea*), 75 hawksbills (*Eretmochelys imbricata*), 35 Kemp's ridleys (*Lepidochelys kempii*) and 15 turtles which were not identified to species. Geographically, 243 turtles were documented in the Gulf of Mexico, 332 in the southeast U.S. Atlantic, 81 in the northeast U.S. Atlantic and 20 in the U.S. Caribbean. A total of 182 turtles were entangled in monofilament fishing line, 74 were entangled in fish net material, 114 were entangled in trap lines or rope and 46 turtles were entangled in non-fishing gear debris. Non-fishing gear debris included plastic fiber "onion" sacks, burlap bags, plastic bags, plastic 6-pack yokes, packing twine, steel cable, aluminum beach chairs and various other materials. A total of 103 turtles ingested plastic piece or balloons and 94 turtles ingested monofilament line and/or fish hooks. A total of 118 turtles were affected by tar and/or oil.

THE EFFECT OF GHOST CRAB PREDATION ON THE SURVIVAL RATE OF LOGGRHEAD SEA TURTLE EGGS

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The purpose of this study is to determine whether or not the ghost crab predation on Kiawah Island, South Carolina, is significantly detrimental to the survival rates of loggerhead sea turtle eggs. There are mixed feelings about whether the ghost crab is a major or a minor predator. Some scientists believe that they are minor predators, but can cause major damage to the entire nest (Carr, 1984). Other scientists feel that ghost crabs are major predators because they are so numerous (Rudloe, 1979).

METHODS

Observations were taken on eighteen nests for about three months. Each nest was surveyed individually for ghost crab burrows around the wire screen that was placed over the top of the nest cavity. These burrows were recorded according to their size and in relation to where they were located around the screen. A sample of the vegetation population was also taken so that at least one other factor having an effect on the nests could be accounted for.

RESULTS AND DISCUSSION

From the data that was collected, it was shown that the ghost crab predation did not have a significant detrimental affect on the survival rate of the loggerhead turtle eggs. The main reason for this would be that not all of the ghost crab burrows were successful in penetrating the nest cavity and that there were other factors that also affected the nest. With the vegetation sample, it was revealed that the amount of vegetation also did not have a significant effect on the survival rate of the eggs. This could also be accredited to the fact that other factors had an effect on the eggs at the same time.

Further studies should be done with nests that have only been preyed on by ghost crabs so that a clearer conclusion can be drawn.

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ADVANCES IN TELEMETRY: IMPLICATIONS FOR THE STUDY OF SEA TURTLES

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Satellite telemetry, specifically using the ARGOS data collection and location system, became an important tool in the study of animal movements in the early 1980s. Much of the initial work, although driven by the marine mammal and sea turtle field, occurred on terrestrial mammals simply because there were fewer technical obstacles to overcome in deployment on a terrestrial species.

Although sea turtles were among the first species to be instrumented with crude satellite telemetry devices adapted from oceanographic buoy technology, the field expanded substantially with the utilization of saltwater switch technology, advanced microprocessors which offered control and data collection options, and the extreme miniaturization of satellite transmitters that occurred in the mid-1980s.

Miniaturization of the circuitry continued into the 1990s, and with advances in lower power circuit technology, satellite transmitters were developed which operated using lower terminal voltages than previously possible. This allowed a reduction in the size and weight of the battery required by satellite transmitters. Since the actual electronics for a satellite transmitter represent only a small percentage of the weight of an entire package that is deployed on the sea turtle (the majority of the weight is associated with packaging and battery systems), smaller configurations became available to scientists. As satellite transmitter packages were reduced in size, numerous options became available for deployment on turtles, including techniques that mounted the transmitter directly to the carapace, and various towed packages.

The utilization of advanced microprocessors led to the development of more sophisticated data collection techniques, and the use of various sensors. Saltwater switch technology allowed collection of dive counts and times, and interfaces to pressure transducers allowed the development of dive profiles, thus leading to the collection of more interesting and useful data in combination with positioning of the animal.

On a final front, development of unique specialized circuits, which could be fully cast solid with polymers, allowed the development of more simplified packaging which was still able to withstand extreme pressures of deep dives without the requirements for expensive high pressure housings.

The development of these technologies has opened the way to scientific investigation of many sea turtle species. Currently, researchers have a selection of various transmitter electronics, power supplies, sensing options, packaging and attachment options. Specific satellite transmitter configurations provide different sizes, power output, battery capacity and sensing options, and these factors should be considered with regard to research priorities.

NESTING LOGGERHEAD SEA TURTLE (<u>CARETTA CARETTA</u>) ACTIVITY ON HILTON HEAD ISLAND, SOUTH CAROLINA

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The loggerhead sea turtle (<u>Caretta caretta</u>) has been monitored on Hilton Head Island since 1985 by Project Turtle Watch, a program of the Museum of Hilton Head Island. The Projects's objectives are to monitor loggerhead nesting and to relocate nests that are in danger of being lost or destroyed due to erosion, high tide, predators, or human activities. Nest relocation is a preventative measure to help to reduce the number of eggs lost. According to Wyneken et al. (1988), relocating nests is an effective conservation method if the eggs are not traumatized and are moved before the membranes attach to the egg wall.

METHODS

The Project Turtle Watch Staff monitored each section of the beach daily on an all-terrain vehicle from 15 May to 15 August, 1994 and periodically thereafter until all nests were hatched and/or inventoried. The staff began monitoring the 23.4 kilometers of beach at 0500 hours to locate the nesting activity. Data recorded at the time of hatching included: the number of empty shells, the number of unhatched eggs, the number of dead hatchlings, and the number of live hatchlings. The unhatched eggs were dissected and categorized as follows: infertile, died early development, died late development, and died during hatching.

RESULTS AND DISCUSSION

There were a total of 242 emergences recorded for the 1994 season. Of these, 139 were actual nests and 103 were false crawls. Of the 139 nests, 83 were relocated, 26 were natural, 23 were stolen, and 7 were lost. The average number of eggs per nest was 114. Of the 139 nests that were recorded, 109 hatched, a 78% nest success rate. The overall hatching success rate was 71%. The 1994 hatching success for the relocated nests was 70% and the natural nests was 71%.

The hatching and nest success rates may be related to many factors that influence the loggerhead to nest on Hilton Head. Beach selection, artificial lighting, housing, sand grain size, and temperature may all be factors based on other studies done on loggerhead nesting activity (Mann 1978, Kraemer and Bell 1980, Stoneburner and Richardson 1981, Mortimer 1982, Frazer 1983, and Carr 1986). Since the hatch success rates were similar in both the relocated and natural nests, it appears that careful relocation can be a useful tool in improving overall nest success for this species. In this study, nest and hatching success for the 1994 season were analyzed based on these factors.

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STRESS IN SEA TURTLES

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Activity of the hypothalamo-pituitary-adrenal (HPA) axis is often used as an indicator of the dynamics of the stress response in vertebrates. The initiation and maintenance of the hormonal cascade that constitutes this axis is under the control of the central nervous system (CNS). The CNS is presumed to be highly sensitive to the effect of environmental homeostatic disrupters. The adaptive significance of the stress system is that it allows the reassignment of metabolic energy to activate physiological mechanisms responsible to bring the internal environment back to a homeostatic equilibrium. This redistribution of energy expenditure may take place even at the cost of the inhibition of reproductive functions. In sea turtles, the dynamics of the stress system and their relationship with the general physiology of these animals is poorly understood. The objective of this work was to study the effect of capture and handling on the activation of the HPA axis of sea turtles and its effects on gonadal androgens.

METHODOLOGY AND RESULTS

In order to study the dynamics of the stress response in sea turtles we have included in this work both sexes and five species. Individuals posess different backgrounds and represent different age classes. A variety of capture and holding conditions was examined to evaluate the basal activity of the HPA axis in response to diverse stimuli.

Immature Kemp's Ridleys: Nets were set between 0700 and 0730 hr. every morning on the Texas coast. Nets were checked every 30 to 45 min. Following this procedure, immature wild male (n=11) and female (n=22) Kemp's Ridleys were captured. On the average, blood was drawn within 10 min. of recovering the animals from the net. The animals were placed in the shade and held in tanks (1x2 mts.) with enough water to cover their bodies. Two subsequent blood samples were drawn at approximately 20 and 45 hr. after the initial blood sample was taken. Inititial corticosterone (B) levels were significantly elevated both in males and females, compared with basal levels demonstrated in unestimulated olive ridley and loggerhead nesting females. Mean B levels increased significantly over the term of the experiment in both sexes. In addition, male testosterone (T) levels showed a significant decrease whereas the mean levels of this hormone were unchanged over time.

Mature male Kemp's Ridleys: Six male Kemp's Ridleys raised in captivity were transported to the Texas coast for their reintroduction to the wild. Blood samples were taken a week before transporting the animals (April 12) and immediately after a 4 hr. drive to the coast (April 20), where individuals were placed in a large, outdoor holding pond. Approximately a month later (May 19) the ponds were drained, the turtles captured, and a third blood sample drawn. Initial mean B levels in these animals were considered normal compared to nesting, unestimulated olive ridley and loggerhead sea turtles. B levels were significantly elevated after transportation. T levels decreased significantly after transportation and reached the lowest value before releasing the animals.

Nesting loggerheads: 12 female loggerheads were captured immediately after nesting at Merritt Island, K.S.C., Florida. An initial blood sample was taken upon capture. The animals were then turned on their carapaces and maintained in this position for six hours. Subsequent blood samples were drawn at 20, 40, 60, 120, 240, and 360 min. after the initial blood sample. We found no significant difference in basal B levels between these female nesting loggerheads and the olive ridleys captured in Costa Rica. B showed a statistically identical initial increase over time as that seen in nesting solitary olive ridleys. By six hr. B levels were significantly elevated in olive ridleys.

Adult male green turtles: Nets were placed in relatively shallow water off the coast of Panama at approximately 1700 hr. Two adult male green turtles were retrieved from the nets at aproximately 0800 the next morning. After recovering the males from the nets, both animals were turned on their backs and maintained in this position for up to 12 hr. Serial blood samples were collected from both males at 0 (upon retrieval from nets), and approximately 6 and 12 hr. Initial B levels were significantly elevated over basal levels measured in nesting loggerheads and olive ridleys (fig.1). After six hr. B decrease significantly and remained at approximately the same levels determined at 12 hr. On the other hand, T levels remained the same over the 12 hr. period.

Blood processing: All the blood collected under these protocols was immediately centrifuged, the serum frozen and then brought to the lab to be analyzed for Corticosterone (B) and Testostosterone (T). In the case of nesting loggerheads only B was measured.

DISCUSSION

In general, circulating B levels in all species of sea turtles included in this study were confined to a maximum of 8 ng/ml of mean B regardless of the duration and nature of the stimulus. Therefore, it appears that the scope of the stress response in sea turtles is a conserved trait and is different from other vertebrate species. We were not able to determine basal levels of B in net-captured animals, as the animals were in the nets an undetermined period of time. On the other hand, we observed no significant differences in basal B levels between nesting olive ridleys, Kemp's Ridleys raised in captivity, and loggerhead sea turtles. This suggests that basal B levels in all sea turtle species are below 1 ng/ml. Accordingly, initial B levels measured in net-captured animals were significantly elevated over basal levels, indicating that this method of capture is effective at stimulating the HPA axis.

Mature and immature Kemp's Ridleys showed a decrease in circulating T levels, presumably as a consequence of stress, as indicated by the significantly elevated B levels. Alternatively, the observed decrease in T levels in adult male Kemps may have been due to natural T cycles in these animals. Further, we did not observe this reciprocal relationship between these two steroids in immature females of the same species. We believe that males serve as a good model to study the adaptive significance of a stress response, i.e. the shutdown of the reproductive axis in order to re-route energy into overcoming the effect of homeostatic disrupters, also known as stressors.

Based on the activity of the HPA axis, adult post-nesting loggerheads appeared to be less responsive to turning stress, compared to adult post-nesting olive ridleys subjected to the same stimulus in Costa Rica. In addition, adult male green turtles showed a lessened response to net-capture stress when turned on their backs (Fig.1). Moreover, no significant decrease in mean T levels were observed in these animals. Together, these data suggest that turning stress may not constitute a major stressor to sea turtles, including olive ridleys. This last observation may help explain our findings related to olive ridleys in that we were unable to induce the activation of the HPA axis in some of these individuals after application of turning stress. Based on our observations on the stress response of Kemp's Ridleys, we suggest that net capture appears to be highly stressfull to males of this species, judging by the decreased mean circulating T levels observed in immature, and possibly, mature net-captured animals.

ACKNOWLEDGEMENTS

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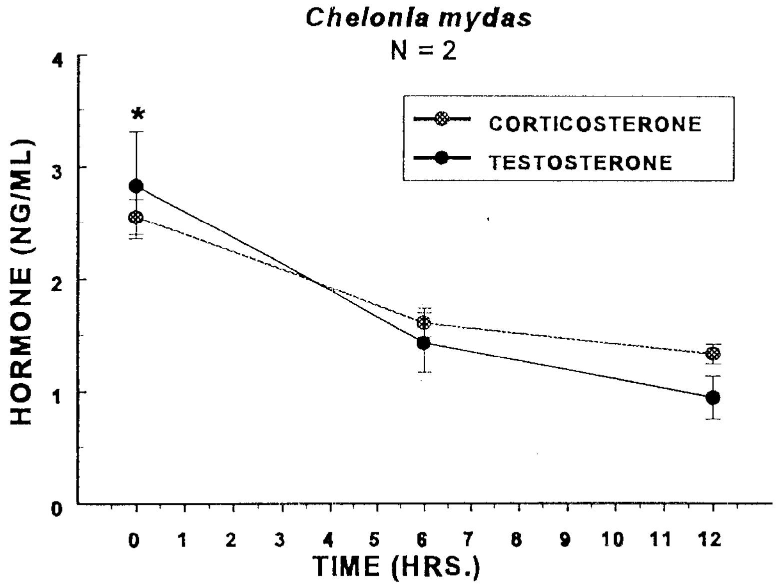

Figure 1. Circulating steroid levels in two adult male green turtles captured by net off the east coast of Panama. The asterisk indicates a significant difference for B only.

MARINE TURTLES IN EGYPT: RESULTS OF A COASTAL ASSESSMENT BY MEDASSET OF THE MEDITERRANEAN COAST BETWEEN ALEXANDRIA AND EL-SALUM (1993)

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ABSTRACT

Although the main objective of the study was an assessment of the coast for potential nesting of marine turtles, the opportunity was taken to prepare a detailed inventory of all beaches within the survey area. Information on the climate, physical structure of the coast, on human use and on nature protective value was also evaluated. The inventory may well serve as a basis for further studies on other aspects of coastal conservation, e.g. for the investigation of the Egyptian sand dune habitat. A thorough photographic documentation of the beaches was compiled and a record was kept of the fauna and flora encountered. The project, headed by M. Kasparek, was carried out by MEDASSET in conjunction with the Regional Activity Centre for Specially Protected Areas, Tunisia (UNEP/MAP) and the National Institute of Oceanography and Fisheries, Alexandria.

INTRODUCTION

MEDASSET made a complete survey of the Western Mediterranean Coastal Desert of Egypt in order to establish whether this potentially excellent habitat bears any incidence of marine turtle nesting, and to assess the ecological value of this area. 602kms of coastline totalling 63 beaches, comprising 254.8 kms, were surveyed. All flat coastal strips which consist of loose material were treated as beaches. This definition, thus includes all coasts which do not consist of rocks. All beaches even if they looked unfavourable for nesting, were surveyed. The survey period extended over 1 month. Ground patrols walked along the beach, in the day, looking for turtle tracks. Coast length, the number of beaches, the total and mean beach length and the mean beach width for each region were calculated. The suitability of the beaches as nesting sites was assessed. Marine coastal ecosystems (sand dunes, coastal wetlands, lagoons, river deltas) were also assessed and several endangered species of birds, mammals, reptiles etc. were recorded. Although photographic documentation of the beaches was compiled. Together with the beach inventory this may provide an important basis to monitor future development of the Egyptian coast. Thus the document is not only useful for turtle students and conservationists, now and in the future, but might also be of value in the study of the ecological and socio-economic value of the coast of Egypt.

RESULTS

Marine turtles were found to nest along the coast between Alexandria and El-Salum. A total of 10 tracks from emerging female turtles were found, the tracks being more or less evenly scattered across the study area. Thus nesting takes place with random distribution, and without concentration on certain beaches. Nesting was confirmed through records of hatchlings. All tracks of emerging turtles were identified as those of the Loggerhead Turtle (Caretta carretta). It is the first time that confirmation of marine turtle nesting has been made for this coast. Several dead turtles were found washed ashore. They all, including the ones seen in fishmarkets and elsewhere, were also identified as Caretta caretta. No indication of Green Turtle (Chelonia mydas) occurrence was found in Egyptian waters.

DISCUSSION

Although evidence of nesting was found, the number of nests was extremely low compared with other areas in the Eastern Mediterranean (Turkey and Greece). Possible reasons for this are as follows:

a) In contrast to all other known marine turtle beaches in the Mediterranean the sand of the Western Egyptian beaches is composed of white, calcareous rather than siliceous grains. The subsurface temperature of the calcareous sands may be too low for successful breeding of turtle eggs due to the increased reflectivity and decreased absorbance of the white grains.

b) The 10m isobathe (the line of equal sea depth) indicated a lack of significant areas of shallow sea in front of the coastline. Sea grass agglomerations on the shore were found on only 8 out of 63 beaches indicating the lack of sea grass beds of the coast. This is without doubt the reason that the herbivorous Green Turtles does not occur in this part of the Mediterranean.

c) During periods of high tide, in particular, the strong predominantly inshore winds contribute to very strong wave action over many beaches and this may help destroy buried turtle clutches.

THE COASTAL HABITAT

The area between Alexandria and El-Salum holds large, almost unspoilt coastal ecosystems with beautiful, white primary sand dunes and limestone cliffs unique in the Mediterranean. The limestone cliffs are part of a series of 3 ridges, running parallel to the sea, which form the whole coast. The intervening area between the ridges and the next inland is occupied in some places by salt lagoons and marshes. These are thought to be an important breeding, resting and wintering ground for migratory birds.

CLIMATE, PLANTS AND WILDLIFE

Climate: The study area has a typical Mediterranean climate, characterised by a long, fairly warm season and a short, slightly rainy temperate winter favourable for a therophytic biological spectrum. Precipitation falls mainly during the colder season from autumn to spring with a mean annual of about 1500 mm, but this may vary from one year to another. The average temperature is around 20 degrees centigrade.

Plants: The study area has a unique vegetation. Annuals form the highest percentage of the total flora, followed by evergreen non-succulent perennial subshrubs and the perennial herbs. Apart from some cultivated olives and figs, trees are completely absent from the Western Coastal Desert. The vegetation of the sand dunes was found to suffer a great deal from human influence, in particular from grazing by sheep, goats and camels.

Wildlife: The sand dunes and limestone formations were found to support a rich and fascinating wildlife, detailed in full in the report.

Birds: All water birds seen along the shore were recorded systematically. 10 species were identified, the most surprising result being the presence of the Greater Sand Plover. This summer visitor to the Western Egyptian Mediterranean coast, may breed in the coastal wetlands. If so, this would be the westernmost and only African point on the distribution area of this rare species.

Mammals: A relatively high number of mammals occur in the coastal belt between Alexandria and El-Salum. (Osborn and Helmy, 1980, in Kasparek, 1993) listed records of 27 species. The study area does not provide suitable habitat for the Monk Seal (Monachus monachus). All rocks are rather flat and no coastal caves were seen. No seal tracks were found and none of the local people interviewed knew of their occurrence in Egyptian waters. The subspecies Crocidura suaveolens matruhensi was found at Marsa Matruh. This subspecies is endemic to the Western Egyptian coast. Marsa Matruh is so far the only locality in which it has been found.

Reptiles: 36 species of reptiles were found including Testudo kleinmani, the only land tortoise living in Egypt.

HUMAN DEVELOPMENT

The coast between Alexandria and El-Salum was divided into five regions: The Arabs Gulf, The Gulf of Hekma, Abu Hashafa Bay, Marsa Matruh West and The Gulf of Salum. The beach inventory helped highlight precisely the level of human development in each of the 5 regions.

The Arab Gulf: The Arab Gulf, close to Alexandria, boasts beaches covering 91.6km of it's 170km coastline. Large scale construction sites, holiday resorts, hotels and summer houses crowd the beaches. The usual building material for houses, walls etc. is limestone. As a consequence of the great demand for building materials, the ease of access to the limestone ridge and it's ease of cutting the coastal ridges have been exploited. In many areas they have been levelled completely.

The Gulf of Hekma: Local people come to the beaches in this region to swim. One out of the seven beaches in this region exhibited signs of heavy human development. One beach was used for the deposition of waste from a quarry. Sand and grit covered the beach over an area of some 800m forming a 2m high wall against the sea. A small lagoon, rich in bird life, was found at the tip of Ras El Daba.

Abu Hashafa Bay: Over half of the beaches in the bay exhibited development in the form of hotel complexes and bungalows. As tourist development increases military restrictions limiting access to certain areas are reduced, further threatening the coastal dunes.

Marsa Matruh West: Most of the beaches in this region are still, as yet, unspoilt. A large lagoon is situated here. It is, however, completely developed, the town of Marsa Matrub covering much of it's shores. The area between Marsa Matruh and El-Salum is the largest continuous unspoilt coastal ecosystem in Western Egypt and one of the largest in the Mediterranean.

The Gulf of Salum: Only 2 out of the 10 beaches in the Gulf of Salum showed signs of human development, the majority were unspoilt. Houses extended onto one beach, this beach being owned by El-Salum. Another beach was used by the Navy. It should be noted that none of the 63 beaches surveyed along the length of the coastline were protected.

POLLUTION

The Egyptian coast was found to be badly polluted with crude oil and plastic rubbish washed ashore. Terns were observed which were heavily coated with oil. From the inscriptions on the plastic bags and wrappings it was understood that the majority of the rubbish came from Egypt, Italy and Greece. There was no beach, or beach section, without tar balls along the shore.

RECOMMENDATIONS TO THE EGYPTIAN GOVERNMENT

1) The conservation and protection by law of the unique sand dunes, limestone ridges and wetlands.

2) The declaration of a Coastal National Park ("Sidi Barrani National Park") between "Marsa Matruh West and El-Salum.

3) Immediate steps, nationally and internationally, against pollution of the sea and beaches with crude oil and plastic litter. International bodies, such as UNEP/MAP, are asked to support the Egyptian Government in it's efforts against pollution of the Mediterranean Sea.

4) The Egyptian Authorities should make sure the legislation forbidding commercial turtle trade is properly enforced. Marine turtles caught accidentally by fishermen were sold for consumption in the fishermarket of Alexandria.

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ACKNOWLEDGEMENTS

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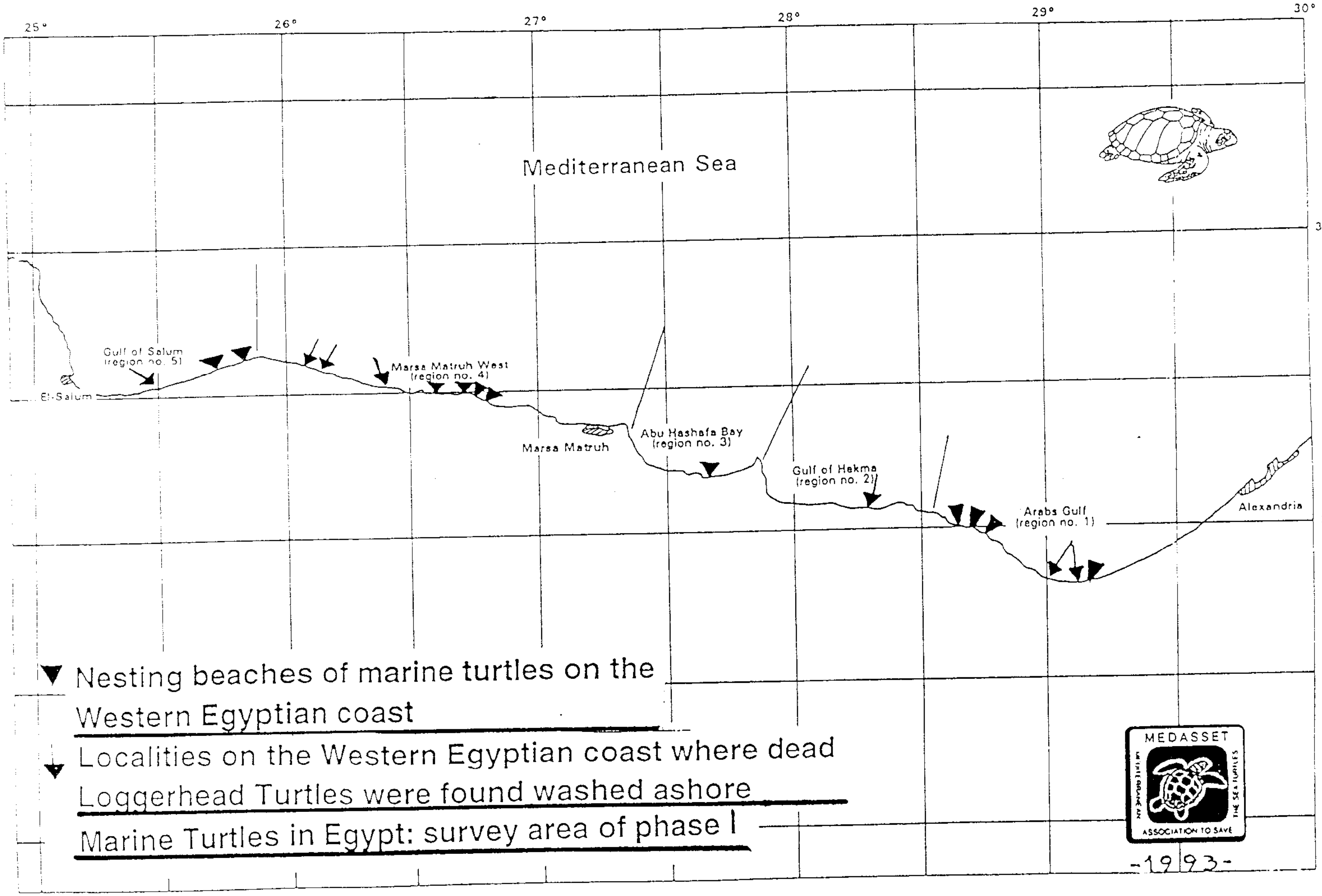
thank the local people and the fishermen who so willingly provided them with information concerning the occurrence of marine turtles. We wish to extend our thanks to the Herpetofauna Conservation International (HCI, U.K.) for their support. We wish also to thank zoologist Mark Prescott for having helped us compile the data collected in this paper.



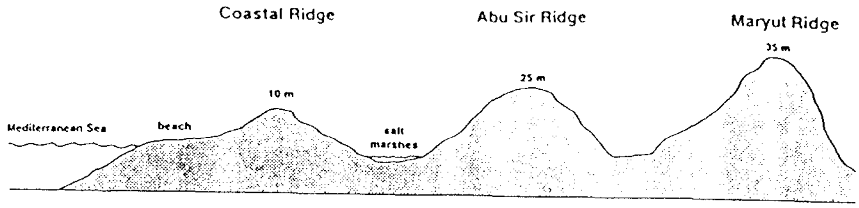


Fig. 1. Schematic cross section of the coastal region of Western Egypt. Three limestone ridges run parallel to the coast.

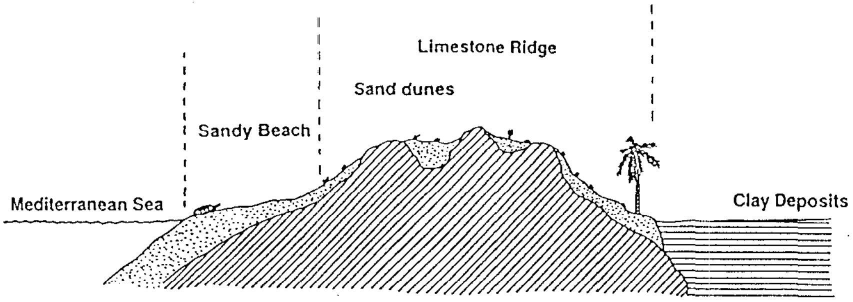


Fig. 2. Typical cross section of the Mediterranean coast of Western Egypt. The sand dunes cover a limestone ridge.

Tab. 5. The status of development of the Mediterranean coast between Alexandria and El-Salum in 1993. Development is divided into three groups (no development, modest development and heavy development) and the table gives the number of beaches and their total length by region.

region	none		modest		heavy	
	no.	km	no.	km	no.	km
1	2	23.5	14	42.6	9	45.5
2	6	21.0	0	0	1	5.0
3	2	6.0	1	20.0	2	5.6
4	14	48.3	3	8.8	1	2.5
5	8	39.0	1	6.0	1	0.5
sum	32	137.8	19	77.4	14	59.1
%	49	50.1	29	28.3	22	21.6

SEA TURTLE CONSERVATION AT EL BANQUITO BEACH, MIRANDA STATE, VENEZUELA.

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In 1992 a conservation program was initiated of the sea turtle nesting at El Banquito beach (Miranda State, Venezuela). The program had participation from sea turtle conservacionists and local people specially trained. The results confirmed the nesting of three sea turtle species in the beach, Dermochelys coriacea, Caretta caretta and Eretmochelys imbricata. That year, several nests were translocated to a closed area in the beach (Guada et al., 1993; Vernet, 1992).

In 1993 and 1994, The monitoring and protection program, near a dozen of small beaches were incorporated adjacent to El Banquito beach (Playa Grande, Maspano, Acantilado, Hamaca, Punta Diente, between them). In El Banquito are located the facilities for the translocated nests (Vernet, 1994a; 1994, in evaluation). Moreover, the nesting of the green turtle, Chelonia mydas was confirmed.

This private program has released a few thousands sea turtle hatchlings to the beach. Moreover, the presence in the area permitted to get valuable information on the incidental catch of sea turtles in the artisanal fisheries and the sea turtle strandings (Vernet, 1994b) and, to establish a new predator not reported previously in the country (Conepatus semistriatus) for sea turtle eggs (Vernet, 1994a)

The area under study has proved the advantages of private efforts in the conservation of sea turtles, although, unfortunately, the robbing of the nests continues in the area.

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THE STATUS AND CONSERVATION OF SEA TURTLES IN KENYA

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[2]Baobab Farm Ltd., P.O. Box 81995, Mombasa, Kenya.

Five species of sea turtles have been recorded to be found in the Eastern African region; namely; green hawksbill, loggerhead, olive ridley and the giant leatherback (Frazier, 1975; Howell 1988, Olendo 1993, Unpubl.). Neither the loggerhead, nor leatherback turtles is known to nest in the area.

Traditionally sea turtles have been exploited along the Kenya Coast for many years. They have been hunted for both subsistence and commercial trade. Over-exploitation now threatens their survival as the population has reduced drastically over the years. Interviews with the local people reveal a rapid and drastic decline in turtle numbers and nests in the past two decades. They are primarily hunted for food, oil and for economically valuable products such as shells and leather. Nesting females are predictable defenceless targets and hence are easier to capture than pelagic turtles. The effects of removing most females from a population may not be noticed for many years. By the time it is obvious that a population is crushing, it may be too late to stop the decline. Also, the majority of turtle eggs laid each year are poached.

Indeed the local people have used these animals sustainable despite the fact that their life histories makes them highly vulnerable. But today's exploiters are far more numerous, their technologies are much more sophisticated and the cultural inhibitions that prevented people from over-exploiting have largely been eliminated (Norse, 1993).

THREATS

It is clear that the dominant threat to sea turtle survival is human activity. These include: killing of adult turtles, poaching of eggs, incidental capture in fishing gear, loss of nesting beaches to coastal developments and tourism, accelerated beach erosion, predators and pollution.

(a) Killing of adult turtles

Adult green and hawksbill turtles are hunted for food (meat and oil) and shell respectively. Nesting females are the easy targets. In some areas of the Lamu Archipelago, the sucker fish or Remora is used to capture pelagic turtles. One remora is not strong enough to raise the turtle, but they are used to anchor or hold it so that it cannot escape. It is then caught by other methods.

(b) Poaching of eggs

The majority of turtle eggs laid each year are poached by the local people who consider it a delicacy.

(c) Incidental capture in fishing gear

Some types of nets used by small scale fishermen have been identified as serious threats to sea turtles in Kenyan waters. These include drift nets, gill nets, shark nets (majerife) and purse seines. Also, there is conclusive evidence of threats caused by trawling by commercial trawlers. Most of the trawlers are active in Ungwana Bay which is home to some of Kenya's most important sea turtle and dugong populations.

Trawlers are known to catch everything in their path - sharks, turtles and fish. But as trawl lasts several hours, turtles caught in these nets usually drown and are usually dumped overboard as "trash". Thus trawlers pose the greatest threat to the survival of Kenya's sea turtle population.

(d)Loss of nesting beaches to coastal developments and tourism

Loss of nesting habitats to beach front developments as a result of the well established tourism industry in Kenya is another serious threat to sea turtles. Turtles are known to come back to nest where they hatched. Destruction of such habitats disrupts the nesting patterns of the turtles. Also some of these developments instal powerful beach security lights which disorientate both the female nesting turtles as well as the emerging hatchlings thus increasing their mortality from natural and anthropogenic sources.

(e)Accelerated beach erosion

Sand removal from the beach as well as construction of beach walls by many of the hoteliers and other private owners have tended to accelerate beach erosion in low energy beaches some of which have been the only remaining nesting beaches. This exposes the nests to flooding with eggs getting washed ashore.

(f)Predators

Sea turtles have generally a wide range of predators. Those that we may have control over are the depredation of nests by feral dogs and foxes. This appears a critical problem in certain parts particularly Watamu area and the remote beaches in Kipini and Kiunga.

(g)Pollution

Recent marine aerial survey (Wamukoya et al 1994 in prep)has revealed that Kenya's waters is highly polluted with floating plastics. The extent to which debris on the beach affects nesting and hatchlings is not known. Adults and hatchlings may be harmed or obstructed as they cross the beach. In addition to the potential effects of plastics on sea turtles, the debris is unaesthetic and potentially dangerous to both the local people and tourists using the beach as well as the pelagic marine organisms.

CONSERVATION EFFORTS

(a)Legislation

Sea turtles are fully and officially protected in Kenya by several local and international laws such as:

- i) The Fisheries Amendment Act (1989)
- ii) The Wildlife Conservation and Management Act (1989) and;
- iii) CITES

There are gaps in legislation in Kenya particularly as it relates to "The Convention on the Conservation of Migratory Species of Wild Animals" (1979). Sea turtles are protected under this Convention. However, Kenya has not ratified the convention. All the same, despite the extensive legislation with stiff penalties poaching of adult sea turtles and egg collection is still rampant.

(b)Turtle Conservation Project

This project was started in November 1989 by Kenya Wildlife Service in collaboration with Baobab Farm Ltd. Initially, the project involved egg collection for artificial incubation at Baobab Farm and systematic relocation of sea turtle nests. By 1992, it was realized that headstart and nest relocation would not necessarily promote long term survival of the species, thus nest "insitu" protection was encouraged. Some of the factors that mitigated against nest relocation were handling and transportation of turtle eggs which apparently reduced hatching success.

A multisectoral Turtle Conservation Committee was formed to oversee future conservation in Kenya. The committee emphasises integration of the local community in Turtle Conservation. To enhance this approach, "Save the Turtle Fund" has been established to provide an incentive to the local people for nest reporting and protection.

The incentive varies from one area to the other with the highest in the urban areas. It ranges from 250-500 Kenya Shillings for nest reporting and protection and 2 Kenya Shillings for each egg from which a hatchling successfully emerged. Since the inception of the incentive scheme and intensive public awareness campaign, through the posters - talks and turtle walk, there is an increase in reports received from the local people (Table 1).

PLANNED CONSERVATION STRATEGIES AND PRIORITIES

With the population estimate and distributional data for sea turtles now available (Wamukoya et al 1994 in prep), the Turtle Conservation Committee looks forward to improve on the present conservation status of sea turtles in Kenya by:

1. Maximising the number of protected nests everywhere and the hatch rate for each nest by fully integrating the local people through the incentive scheme. We hope more people and organizations will support us by donations to the "Save the Turtle Fund".

2. Providing long term protection to important nesting beaches (like Ras Tenewi and Shella) and foraging habitats (such as Mpungutis and Takaungu).

3. Implement effective lighting mitigation measures on coastal developments located on nesting beaches.

4. Encourage the trawlers to use Turtle Excluder Devices thus reducing mortality from commercial fisheries.

5. Reduce threat from marine pollution.

6. Determine of inter-regional seasonal movements of sea turtles by an elaborate tagging programme in collaboration with neighbouring countries particularly Somalia, Tanzania, Mozambique, South Africa and Seychelles.

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Table 1. Summary of Turtle Eggs, Hatchlings, & Payment

Year	No. of Turtle Nests	No. of Turtle Eggs	No. of Turtle Hatchlings	Payments to Fishermen - Kshs.	Remarks
1989	1	128	37	-	
1990	1	153	0	-	
1991	8	932	430	1200.=	
1992	3	375	276	400.=	
1993	12	1381	691	4762.=	
1994	22	2962	1850	10219.=	
TOTAL	47	5931	3284	16581.=	Increase in nest reporting by the local people

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POPULATION ECOLOGY, NESTING AND SUCCESS OF LEATHERBACK TURTLES, DERMOCHELYS CORIACEA, AT LAS BAULAS DE GUANACASTE NATIONAL PARK, COSTA RICA

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Las Baulas de Guanacaste Park located near Tamarindo, in Guanacaste Province, Costa Rica, contains two important nesting beaches for Pacific leatherback turtles. Playa Grande is 4 km long and historically supported about 1300 nesting leatherbacks annually. Playa Langosta is 1.3 km long and supported about 200 leatherbacks annually. We have studied the nesting ecology of leatherbacks on these beaches from 1991 to 1995. In 1991-92, 229 leatherbacks nested on Playa Langosta and in 1993-94, 158 females nested on Playa Grande and about 35 nested on Playa Langosta. Nesting peaked in December and January. Mean internesting interval was 9 days and clutch size was 64 on Playa Grande and 65 on Playa Langosta. Nests were distributed evenly on undeveloped Playa Langosta, but were concentrated away from developed areas on Playa Grande.

Since 1988-89 the population at Las Baulas has declined from about 1500, to about 800 in 1990-91 and 91-92, and to 193 in 1993-94. Poaching of nests declined from 19.1 % in 1988-89 on Playa Langosta and 24.5 to 38.0 % in 1988-89 and 1989-90 on Playa Grande to < 4% in 1993-94 due to environmental education and conservation activities on the beaches. Our efforts to educate the local community included training of guides, presentations in local schools, art classes, taking school children to the beach to see the turtles, discussions with local residents, and support of school sports programs. Efforts on the beach included scientific research, patrolling by EARTHWATCH volunteers, discussions with tourists, and protection of nests. In 1994-95 the nesting population rebounded and initial estimates indicate around 600 turtles nested on Playa Grande and almost as many nested on Playa Langosta. To understand this nesting colony both major beaches will have to be monitored simultaneously in the future.

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IMPORTED FIRE ANTS (SOLEONOPSIS INVICTA): A GROWING MENACE TO SEA TURTLE NESTS IN KEY WEST NATIONAL WILDLIFE REFUGE

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Native to Brazil, the red imported fire ant (IFA), (Soleonopsis invicta), arrived in the United States in the 1940s and now occurs in 10 states where sea turtles nest. This insect is known to be a predator of certain coastal reptiles (Mount 1981), but a literature review revealed no published works on IFA predation at sea turtle nests. The aims of this paper are (1) to document a marked progressive increase in the number of instances that IFA were found in sea turtle nests in Key West National Wildlife Refuge (KWNWR); (2) to examine the possible implications of this for sea turtle management, particularly for areas where only remnant populations persist.

STUDY AREA AND METHODS

The KWNWR study area consists of 8 beaches situated some 22-37 km west of Key West, FL. The beaches vary in length from 300 m to 2.5 km. All are very narrow, low-energy sites that are inundated periodically by higher than normal tides.

Systematic weekly surveys were performed season-long between 1990-94, and an array of site characteristics was recorded (Wilmers unpubl. rep.). All nests were excavated to calculate productivity and assess possible causes of nest failure. Instances of IFA in the clutch cavities were recorded at all nests.

RESULTS

From 47-67 loggerhead (Caretta caretta) and 0-9 green (Chelonia mydas) turtle nests were found annually. IFA were observed in 25 loggerhead and 3 green turtle nests. They were found in a single loggerhead turtle nest in 1990, and were first observed in a green turtle nest in 1991 (Fig. 1). Loggerhead turtle nests containing IFA increased markedly in 1993, and the number doubled in 1994 (Fig. 1). In 1994, 50% of all loggerhead nests at Main Beach (Marquesas Keys) and 40% of those at Boca Grande Key contained IFA (Fig. 2). IFA were found in 15% of the green turtle nests on Boca Grande Key (Fig. 3).

We found live hatchlings covered with IFA at 1 green and 3 loggerhead turtle nests; ant-inflicted wounds on the hatchlings were evident. At another loggerhead nest, 40 pipped loggerhead eggs had been invaded by IFA; the eyes of each hatchling had been eaten. IFA were found on emaciated dead hatchlings at 5 other nests (4 loggerhead, 1 green).

We do not know at what stage of incubation most turtle nests were invaded by IFA, but the insects were clearly scavengers, not predators, in some instances. For example, at 1 green and 7 loggerhead turtle nests, IFA were found amidst rotten eggs in clutch cavities that had been inundated by high tides.

Sixteen (64%) loggerhead nests invaded by IFA produced nestlings (mean=48.4, range=5-100, SD=31.3). However, hatchlings may have departed from some of these nests prior to IFA invasion.

DISCUSSION

In small sea turtle rookeries, the annual loss of even a few nests to IFA predation can be consequential. In KWNWR, only a remnant population of green turtles persists, with only 3-4 breeders in the entire population (Wilmers 1994)-- at such a low level IFA predation at turtle nests could suppress recovery.

Most turtle nests in KWNWR are deposited landward of the narrow beaches (Wilmers 1994). It may be that sea turtle nests in dunes are more prone to IFA invasion because of public use. Careless picnickers and illegal campers in KWNWR disturb dune vegetation and discard food items, actions which can promote the spread of IFA (Dr. J.L. Stimac pers. comm.).

It appears that sea turtle nests are vulnerable to IFA predation from time of egg-laying to hatchling emergence. Turtle eggs in nests invaded by IFA often had characteristic breach holes. We did not witness IFA in the act of piercing turtle eggs, but they surely are capable of doing so. Mount et al. (1981) reported on IFA predation of six-lined racerunner (Cnemidophorus sexlineatus) eggs. Domestic chicken eggs, which have a hard outer shell, can be penetrated by IFA (Dr. J.L. Stimac, pers. comm.).

IFA are apparently capable of killing hatchling turtles. IFA may attack in great numbers, and their venom is potent. Hatchling sea turtles would be especially vulnerable as they emerged from the egg.

Control of IFA on nesting beaches would be problematical. Densities of 20-30 IFA mounds per acre commonly occur in some habitats (Kohler 1993). Even the more benign pesticide formulations can hazardous when used near water. Moreover, IFA mounds do not maintain their shape in sandy areas (Kohler 1993), and are virtually indiscernible. Thus, finding and treating individual IFA mounds proximal to turtle nests would be very time consuming, if not futile. Regardless, treated areas are quickly colonized by fire ants from untreated areas (Stimac and Alves 1994). Work on biological control of fire ants using a fungal isolate is ongoing (Stimac and Alves 1994).

MANAGEMENT IMPLICATIONS

That IFA invaded and spread rapidly on uninhabited, relatively remote islands in KWNWR should be of concern to all sea turtle managers. Female IFA can fly 12 or more miles (Kohler 1993), and can be inadvertently introduced to a beach by boaters. It appears that virtually any sea turtle nesting beach in the U.S. can be invaded by these insects.

Given the widespread distribution and continuing expansion of IFA in coastal areas, their impact on sea turtle nests merits greater attention. Research should not be limited to only a few study sites on similar beaches in a small geographical area: IFA populations and their effect on sea turtle nests will vary according to local conditions. States with sea turtle rookeries should establish a database to monitor and assess trends in IFA invasion of sea turtle nests.

ACKNOWLEDGMENTS

We thank Dr. Jerry Stimac for kindly sharing his knowledge and perspectives on fire ants.

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Figure 1. Number of loggerhead and green turtle nests invaded by imported fire ants in Key West National Wildlife Refuge, 1990-94.

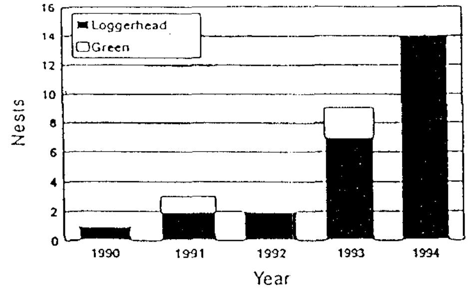


Figure 2. Percent of loggerhead turtle nests invaded by imported fire ants on selected beaches in Key West National Wildlife Refuge, 1990-94.

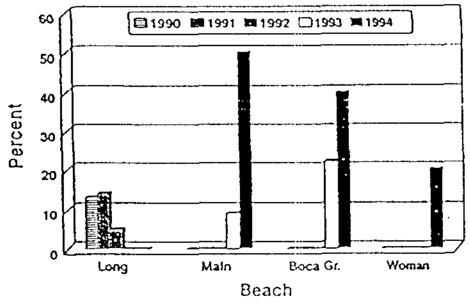
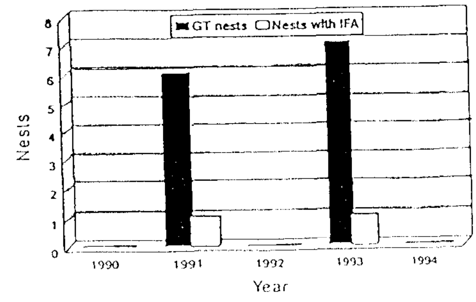


Figure 3. Green turtle (GT) nests invaded by imported fire ants (IFA) on Boca Grande Key, 1990-94.



A "HATCHLING ORIENTATION INDEX" FOR ASSESSING ORIENTATION DISRUPTION FROM ARTIFICIAL LIGHTING

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Proper orientation from nest to sea is critical for hatchling sea turtle survival. On artificially lighted beaches, this nocturnal sea-finding behavior is disrupted, resulting in increased hatchling mortality.

Here we describe a Hatchling Orientation Index (HOI) as a way to quantify the effects of artificial lighting on hatchling sea-finding. With a survey schedule that limits temporal and spatial bias, this index should provide a means to accurately monitor trends in sea-finding disruption at specific beach sites. As an example of how HOI surveys can be used, we present results of surveys conducted in Florida, USA, during 1993 and 1994.

METHODS

HOI data come from measurements of hatchling tracks at sites where hatchlings have emerged the previous night. Because hatchling tracks are short-lived and long shadows aid in track identification, it is important to conduct HOI surveys at dawn.

In 1993 and 1994, dawn HOI surveys were conducted at 23 beach sites in six Florida counties, USA (Fig. 1). During walking surveys, surveyors searched for hatchling track evidence along the upper beach zone where nesting is most common. Surveyors taking part were selected from Florida Department of Environmental Protection sea turtle permit holders and were experienced in identifying hatchling tracks.

Due to the weathering of hatchling tracks, visible track evidence found during dawn surveys was generally from the previous night's hatchling emergence activity. At each sign of a hatchling emergence event (the presence of hatchling tracks), surveyors located the point of origin (the emergence depression), and with a hand-held sighting compass, measured the following:

1) Ocean direction: The bearing of the most direct ocean route from the emergence depression.

2) Angular range: Bearings of the two most widely separated hatchling tracks, as measured from the emergence depression.

3) Range-outlier (angular range minus outlier): Angular range excluding the most remote hatchling track (the outlier).

4) Mode (modal direction): The most frequent general bearing of hatchling tracks, as estimated by the observer. Emergence event evidence having five or more tracks directed along each of two distinct bearings were considered bimodal. Where two modes were measured, the mode with the greatest number of tracks was identified and used in the analysis presented here.

5) Circlers: The number of hatchlings whose tracks have made complete circles; limited to assignments of 0, 1, 2, or >2.

In order to place boundaries on the area where tracks would be measured, a circle with 10-m radius and center at the emergence depression was drawn in the sand at each site. Bearings for angular range, range-outlier, and mode, were measured to the point where tracks intersected the 10 m circle, or where they disappeared (in vegetation, on hard wet sand, or due to predation), at whichever point tracks were longest.

Sampling

An ideal HOI survey should span the entire season of hatchling emergence activity. Uneven surveys can either favor or slight periods when hatchlings are poorly oriented (such as during the new moon cycle). For HOI surveys conducted in Florida in 1993 and 1994, systematic surveys (1-4 days per week) were attempted, but weather and scheduling of surveyors required some alteration of survey schedule.

Classifying Sea-finding Disruption

Sea-finding disruption was categorized as "moderate" or "severe" based on the deviation of modal direction from ocean direction and the angular range attributes of hatchling tracks. We classified disruption as moderate if the modal direction of hatchling tracks deviated 30°-90° from the most direct ocean path, or if the angular range of tracks was 90°-180°. We considered disruption severe if the modal direction deviated more than 90° from the most direct ocean route, or if the angular range of tracks was 180° or greater. The data allow other classification schemes to be devised.

RESULTS AND DISCUSSION

Hatchling sea-finding disruption from beach lighting remains an important conservation problem in all the counties surveyed (Fig. 2). Except in Broward and Sarasota Counties, levels of sea-finding disruption declined somewhat between 1993 and 1994. In all counties surveyed, local ordinances have been promulgated to reduce artificial lighting on nesting beaches. In Broward County, however, this ordinance applies to only a small region of the county.

Differing levels of sea-finding disruption among years demonstrates the importance of continuous monitoring. New construction, newly installed lighting, and existing lighting that may be either on or off during surveys all contribute to variation in sea-finding disruption.

Hatchlings that do not enter the water (which is often the case when sea-finding is disrupted) do not survive. Hatchlings that do eventually enter the sea may have reduced survivorship. Misorientation and disorientation in hatchlings is expected to use energy stores, cause dehydration, and increase the likelihood of predation on the beach. HOI surveys can assist in assigning a value to these effects.

Another way that hatchling orientation can be quantified is to release groups of hatchlings on the beach and measure their orientation. Some advantages of a HOI survey over hatchling release experiments are:

1) For a given number of hatchling emergence events measured, effort to conduct HOI surveys is smaller than the effort required to obtain hatchlings and release them. As a result, more beach area can be covered with a HOI.

2) HOI surveys can be conducted so that relatively large numbers of undisturbed, naturally located nests are represented.

3) HOI surveys represent hatchlings that have emerged at natural times throughout the previous night.

Disadvantages in relying on a HOI are:

1) Data from hatchling tracks are not as detailed as one would gather from direct orientation measurement of released hatchlings.

2) On beaches with frequent and heavy rain during the hatching season, or with coarse, hard sand, hatchling tracks may not be readable.

ACKNOWLEDGEMENTS

We offer thanks to the following individuals whose hard work provided data for this ongoing study. Greg Altman, Nelia Coyle, Lew Ehrhart, Jerris Foote, Kristine Hahn, M. Hensley, Angy Leach, Russ Lowers, Beth Morford, C. McMillian, Bubba-Lou Owen, Nicole Park, Jane Provancha, Cheryl Ryder, Barbara Schroeder, Jill Steinitz, Melissa Tolbert, Linh Uong, and Carolyn Yates. For their cooperation we give special thanks to Bionetics Inc., Cape Canaveral Air Force Station, Merritt Island National Wildlife Refuge, Mote Marine Laboratory, Palm Beach County Department of Environmental Resources Management, and the University of Central Florida Marine Turtle Research Group. Funding for the project was provided through grants from the Florida Game and Freshwater Fish Commission Nongame Wildlife Program and the U.S. Fish and Wildlife Service.

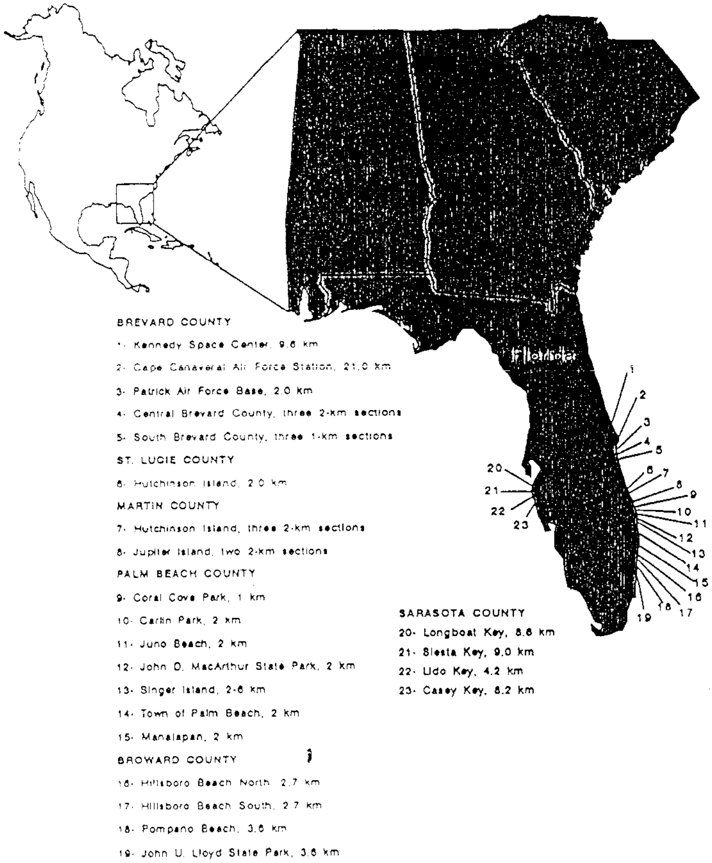

Figure 1. Location and length of study beaches surveyed as part of a Hatchling Orientation Index conducted in Florida.

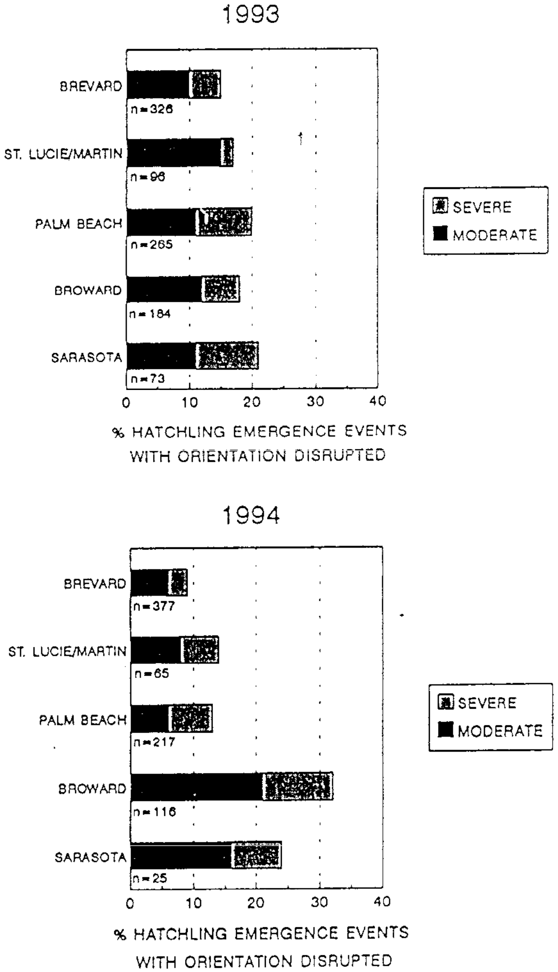

Figure 2. Level of hatchling sea-finding disruption in six Florida counties surveyed in 1993 and 1994 for a statewide Hatchling Orientation Index. Definitions of moderate and severe sea-finding disruption are in the text.

MORPHOLOGICAL DIFFERENCES IN HIND FLIPPERS OF HATCHLING GREEN TURTLES FROM THE HAWAIIAN ISLANDS AND FLORIDA, USA.

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Anecdotal observations have been made over the years suggesting that green turtles (Chelonia mydas) from the Atlantic and Pacific Ocean basins differed in a number of morphological features. Ontogenetic differences in plastron color have been documented (Balazs 1986). Other observations included the suggestion that the flippers of Hawaiian turtles in the Pacific were proportionately larger than those of Atlantic turtles. Genetic analyses showed that Atlantic and Pacific populations diverged long ago (Bowen et al. 1992). Hence, the groups have been free to follow separate evolutionary paths since their isolation from one another. We examined one morphological character, rear flipper size, in hatchling green turtles from the Pacific Ocean basin, Hawaii and the Atlantic Ocean basin, Florida.

We measured each carapace using standard straight-line and curved measurement techniques and traced the hind flippers of live hatchlings. The mean area of each hatchling's flippers was determined by digitizing the outlines and calculating an average for the pair. The data were subjected to morphometric analysis. Our results showed that the two populations differ in rear flipper size and carapace size. Hatchlings from Florida were larger than hatchlings from Hawaii. However, Hawaiian hatchlings had absolutely and proportionately larger hind limbs. Rear flipper size scales isometrically with carapace size in both populations. Linear regression of the square root (Mean Flipper Area) as a function of body size resulted in different linear models (Equations 1-2) for the two populations (with similar slopes and different y-intercepts). Both correlation coefficients were significant at $p \leq 0.01$.

Floridian population: $$y = 0.1872x + 0.7415 \qquad r = 0.5045 \tag{1}$$

Hawaiian population: $$y = 0.2755x + 0.6960 \qquad r = 0.5658 \tag{2}$$

We propose several developmental explanations for the differences. we have found. Different y-intercepts imply that the rear flippers of Florida green turtles, at hatching, have grown less during embryonic development than those of Hawaiian turtles. The similar slopes mean that the growth trajectories are the same. Because the growth trajectories are the same, there are several alternative hypotheses to explain the morphological patterns observed. (i) One explanation is that during embryonic development, Hawaiian turtles invest more cells into the forming limb than Florida turtles . This might be accomplished either by the formation of a larger limb bud in Hawaiian turtles or by the earlier formation of the limb bud. (ii) Developmental regulation of limb growth may also account for the differences in flipper size at hatching.

It is unclear if the sizes of the flippers and the carapace at hatching are related. We are faced with at least three alternative explanations. (i) Both limb buds and carapace form from the flank of the embryo. Assuming the early embryos start with roughly the same numbers of cells, then Hawaiian embryos might invest more in hind flippers and less in carapace while the reverse may be true in the Florida population. (ii) Alternatively, differences in rear flipper and carapace size may be due to heterochronic mutation in one of the populations (genetic changes that result differences in the timing of developmental events). The developmental instructions for Hawaiian green turtles may specify that hind limb bud formation starts at a slightly earlier stage and that carapace formation starts at a slightly later stage than in Florida turtles. (iii) A third alternative is that the two systems (carapace and hind limb) may be developmentally decoupled (as some experiments with snapping turtle, Chelydra serpentina, embryos suggest; Burke 1989). If so, then growth rates of limbs and carapace are free to vary independently. In other words, we may be observing both population-specific growth rates for the rear flippers, and population-specific growth rates for the carapace.

ACKNOWLEDGMENTS

We thank Larry Ogren and Archie Carr for their keen sense of observation and for calling GHB's attention to the possiblity of flipper size differences. Barbara Schroeder recognized the authors' mutual interests and put us in contact. Shawn K. Koga and personnel of the U.S. Fish and Wildlife Service at French Frigate Shoals assisted in collecting and Compiling data. The digitization and initial analyses were performed by Yvette Anderson. We thank Mike LaBarbera, Jo Ann Cameron, and Ann Burke for thoughtful discussions.

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