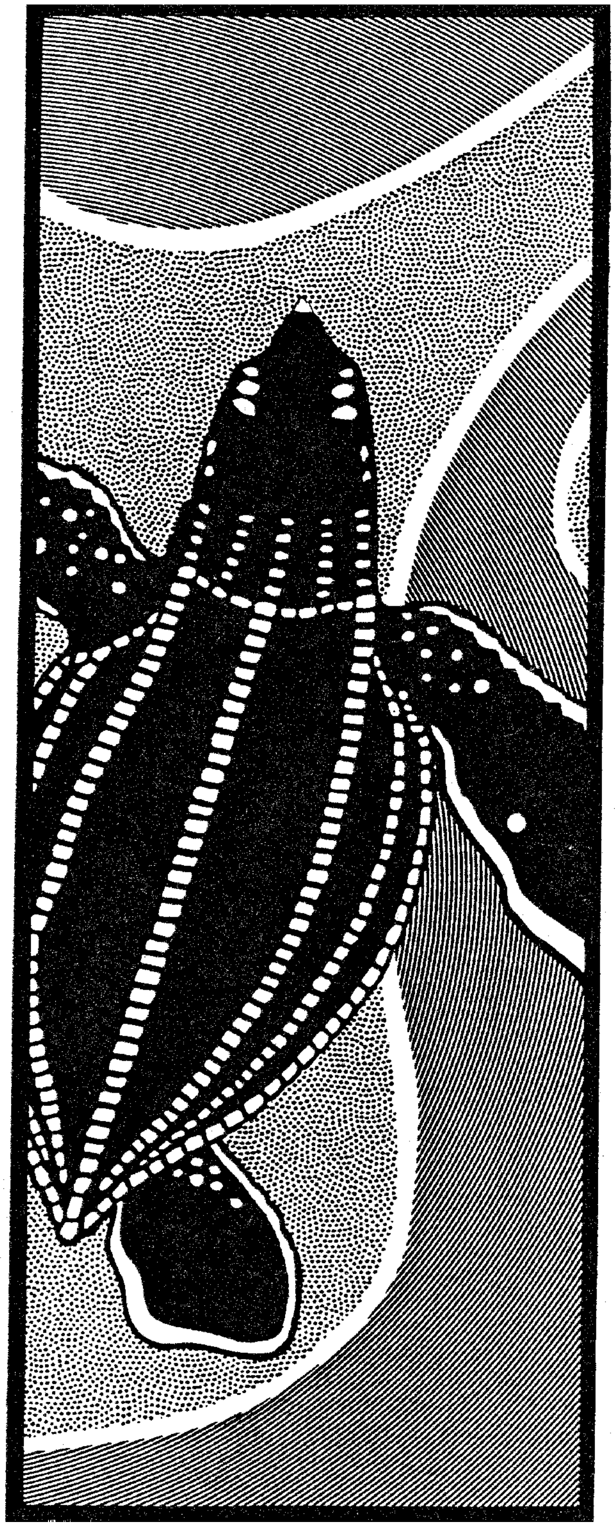
NOAA Technical Memorandum NMFS-SEFSC-415



PROCEEDINGS OF THE SEVENTEENTH ANNUAL SEA TURTLE SYMPOSIUM

4-8 March 1997
Orlando, Florida, U.S.A.

Compilers:
Sheryan P. Epperly
Joanne Braun

December 1998

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

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

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
D. James Baker, Administrator

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

December 1998

NOTICE

Correct citation of this report is:

Epperly, S.P. and J. Braun, compilers. 1998. Proceedings of the Seventeenth Annual Sea Turtle Symposium. U.S. Dep. Commer. NOAA Tech. Memo. NMFS-SEFSC-415, 294 pp.

Technical Editor: W.N. Witzell

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PREFACE

The 17th Annual Sea Turtle Symposium was held at the Delta Orlando Resort in Orlando, Florida U.S.A. from March 4-8, 1997. The symposium was hosted by Florida Atlantic University, Mote Marine Laboratory, University of Central Florida, University of Florida, Florida Atlantic University and the Comité Nacional para la Conservación y Protección de las Totugas Marinas. The 17th was the largest symposium to date. A total of 720 participants registered, including sea turtle biologists, students, regulatory personnel, managers, and volunteers representing 38 countries. In addition to the United States, participants represented Australia, Austria, the Bahamas, Bonaire, Bermuda, Brazil, Canada, Colombia, Costa Rica, Croatia, Cuba, Cyprus, Dominican Republic, Ecuador, England, Guatemala, Greece, Honduras, India, Italy, Japan, Madagascar, Malaysia, Mexico, The Netherlands, Nicaragua, Peru, Philippines, Republic of Seychelles, Scotland, Spain, Sri Lanka, Switzerland, Taiwan, Turkey, Uruguay, and Venezuela. In addition to the 79 oral, 2 video, and 120 poster presentations, 3 workshops were offered: Selina Heppell (Duke University Marine Laboratory) provided "Population Modeling," Mike Walsh and Sam Dover (Sea World-Orlando) conducted "Marine Turtle Veterinary Medicine" and "Conservation on Nesting Beaches" was offered by Blair Witherington and David Arnold (Florida Department of Environmental Protection). On the first evening, P.C.H. Pritchard delivered a thoughtful retrospect on Archie Carr that showed many sides of a complex man who studied and wrote about sea turtles. It was a presentation that none of us will forget. The members considered a number of resolutions at the Thursday business meeting and passed six. Five of these resolutions are presented in the Commentaries and Reviews section of *Chelonian Conservation and Biology* 2(3):442-444 (1997).

The symposium was fortunate to have many fine presentations competing for the Archie Carr Best Student Presentations awards. The best oral presentation award went to Amanda Southwood (University of British Columbia) for "Heart rates and dive behavior of the leatherback sea turtle during the internesting interval." The two runners-up were Richard Reina (Australian National University) for "Regulation of salt gland activity in *Chelonia mydas*" and Singo Minamikawa (Kyoto University) for "The influence that artificial specific gravity change gives to diving behavior of loggerhead turtles". The winner of this year's best poster competition was Mark Roberts (University of South Florida) for his poster entitled "Global population structure of green sea Turtles (*Chelonia mydas*) using microsatellite analysis of male mediated gene flow." The two runners-up were Larisa Avens (University of North Carolina-Chapel Hill) for "Equilibrium responses to rotational displacements by hatchling sea turtles: maintaining a migratory heading in a turbulent ocean" and Annette Broderick (University of Glasgow) for "Female size, not length, is a correlate of reproductive output." The symposium was very fortunate to receive a matching monetary and subscription gift from Anders J. G. Rhodin of the Chelonian Research Foundation. These enabled us to more adequately reward the fine work of students. The winners of the best paper and best poster awards received $400 plus a subscription to *Chelonian Conservation and Biology*. Each runner up received $100.

The symposium owes a great debt to countless volunteers who helped make the meeting a success. Those volunteers include: Jamie Serino, Alan Bolton, and Karen Bjorndal, along with the UF students provided audio visual help, John Keinath chaired the student awards committee, Mike Salmon chaired the Program Commiteee, Sheryan Epperly and Joanne Braun compiled the Proceedings, Edwin Drane served as treasurer and provided much logistical help, Jane Provancha coordinated volunteers, Thelma Richardson conducted registration, Vicki Wiese coordinated food and beverage services, Jamie Serino and Erik Marin coordinated entertainment, Kenneth Dodd oversaw student travel awards, Traci Guynup, Tina Brown, Jerris Foote, Dan Hamilton, Richie Moretti, and Vicki Wiese served on the time and place committee, Blair Witherington created the trivia quiz, Tom McFarland donated the symposium logo, Deborah Crouse chaired the resolutions committee, Pamela Plotkin chaired the nominations committee, Sally Krebs, Susan Schenk, and Larry Wood conducted the silent auction, and Beverly and Tom McFarland coordinated all 26 vendors. Many individuals from outside the United States were able to attend the 17th Annual Sea Turtle Symposium thanks to the tireless work of Karen Eckert, Marydele Donnelly, and Jack Frazier in soliciting travel assistance for a number of international participants. We are indebted to those donating money to the internationals' housing fund (Flo Vetter Memorial Fund, Marinelife Center of Juno Beach, Roger Mellgren, and Jane Provancha). We raise much of our money for international travel from the auction; thanks go to auctioneer Bob Shoop, who kept our auction fast-paced and entertaining, and made sure the bidding was high.

The Annual Sea Turtle Symposium is unequaled in its emphasis on international participation. Through international participation we all learn a great deal more about the biology of sea turtles and the conservation issues that sea turtles face in distant waters. Additionally, those attending the symposium come away with a tremendous wealth of knowledge, professional contacts, and new friendships. The Annual Sea Turtle Symposium is a meeting in which pretenses are dropped, good science is presented, and friendly, open communication is the rule. The camaraderie that typifies these meetings ultimately translates into understanding and cooperation. These aspects, combined, have gone and will go a long way toward helping to protect marine turtles and toward aiding their recovery on a global scale.

Jeanette Wyneken, Ph.D.
1997 Symposium Coordinator and President

Jeannie Fulford and Beverly Harvey imported files and typed abstracts as necessary. Art Schwarzschild provided assistance in reading MacIntosh files. Jack Frazier helped with translation. We are grateful for their contributions.

Sheryan P. Epperly and Joanne Braun
1997 Symposium Proceedings Compilers

SEVENTEENTH ANNUAL SEA TURTLE SYMPOSIUM

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PART I. ORAL AND VIDEO PRESENTATIONS

MEAGER STRUCTURING OF mtDNA D-LOOP SEQUENCES AMONG EASTERN PACIFIC OLIVE RIDLEY ROOKERIES: EVIDENCE OF SIGNIFICANT INTER-ROOKERY GENETIC EXCHANGE?

[1]F. Alberto Abreu-Grobois, [1]Raquel Briseño-Dueñas, [2]René Márquez-Millán, [3]Anny Chávez, and [4]Brian Bowen

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The population structure of the olive ridley (*Lepidochelys olivacea*) sea turtle in the Eastern Pacific (EP) was analyzed from mtDNA d-loop sequences of Mexican, Costa Rican and Australian rookeries. Whereas mtDNA studies in other sea turtles have found highly structured distributions of molecular markers among nesting populations (indicative of demographic independence), the scanty genetic differentiation found between EP olive ridley rookeries (>98% of the genetic variance occurs within populations, fixation index= 0.014) coupled with genetic diversity levels similar to other species (h= 0.465-0.684) can best be explained by the existence of significant genetic exchange between rookeries. This hypothesis is corroborated by reciprocal tag returns from nesters between rookeries within Mexicó and between Mexicó and other EP countries.

ANALYSIS OF THE INCIDENTAL CAPTURE AND MORTALITY OF SEA TURTLES IN THE SHRIMP FLEET OF PACIFIC COSTA RICA

Randall M. Arauz[1], Roberto Vargas[2], Isabel Naranjo[2], and Carlos Gamboa[2]

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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. Henwood, Stuntz and Thompson (unpubl), provide gross estimates of turtle catch and mortality by foreign nations based on metric tons of shrimp exported, assuming turtle catch rates comparable to those in U.S. waters, although the authors recognize that it is questionable wether mortality rates in US waters can be applied to foreign nations. Verifiable estimates of present CPUE and mortality rates must be provided by each country exporting shrimp into the US in order to ascertain the level of protection provided by the regulations implemented.

The principal objective of this paper is to describe the Costa Rican shrimp fishery and provide reliable estimates of turtle catch and mortality rates in these waters.

DESCRIPTION OF THE SHRIMP FLEET OF PACIFIC COSTA RICA

Fifty five vessels operate along the Pacific coast of Costa Rica. Wooden or steel hull Florida type vessels are used, with an average hull length of 60 to 85 ft. A single flat or two seam balloon net with a headrope length from 65 to 80 ft is pulled from each outrigger. Target species include white shrimp (*Peneaus occidentalis*, *P. stylirostris, P. vanamei*) and small shrimp (*Trachypenaeus* sp. and *Xiphopeneaus* sp.) in shallow waters (9 to 40 m), pink (*P. brevirostris*) and brown (*P. californiensis*) in deep waters (65 to 85 m), and fidel and camello (*Solenosera* sp and *Heterocarpus* sp.) in the deepest waters (100 to 300 m). Seventeen of the fifty five vessels are licensed to fish only for fidel and camello shrimp.

METHODOLOGY

An observer program was implemented during four separate projects (Arauz, R.M., 1994; Arauz *et al.*, 1997a; Arauz *et al*., 1997b; Gamboa, 1993), including a research thesis by Rice, R.E. (1973). During each project, the dates, location, number of tows, hours of fishing, headrope length of the nets and number of turtles captured was recorded. Each turtle captured was identified, and the general condition recorded (alive or dead). The CPUE for each zone was estimated by dividing the number of turtles captured by the amount of hours fishing. Because the turtle catch per unit of effort (CPUE) is a direct function of net size and length of tow, all CPUEs were normalized to a 30.5m (100ft) headrope length and one hour tows. Furthermore, turtle catch and mortality rates were maintained in separate blocks, according to the fishing zone (geographic area, target species and depth):

1) Gulf of Nicoya white shrimp fishery. Average depth from 9 to 27 meters.
2) South Pacific white shrimp fishery. Average depth from 9 to 40 meters.
3) Golfo Dulce white shrimp fishery. Average depth from 9 to 15 meters.
4) North Pacific pink shrimp fishery. Average depth from 65 to 85 meters.
5) South Pacific pink shrimp fishery. Average depth from 65 to 85 meters.
6) Deep fidel and camello shrimp fishery. Average depth from 100 to 300 meters.

<u>Assumptions</u>:

1) The 17 vessels with exclusive fidel licenses do not catch turtles (zone 6).
2) Of the other 38 vessels, 19 fish white shrimp and 19 fish pink shrimp.
3) The 19 white shrimp vessels are equally distributed in the white shrimp fishing grounds, thus 6.33 vessels operate in each fishing zone (zones 1 to 3).
4) The 19 pink shrimp vessels are equally distributed in the pink shrimp fishing grounds, thus 9.5 vessels operate in each pink shrimp fishing zone (zones 4 and 5).
5) In Costa Rica the average headrope length of each trawl net is 80 feet.
6) White shrimpers do 4 drags a day (4 hours/drag).
7) Pink shrimpers do 2 drags a day (5.5 hours/drag).
8) All shrimp vessels work an average 21 days of the month, year round.
9) CPUE rates do not vary seasonally.

The average CPUE for Costa Rica is estimated by dividing estimated turtle captures for each fishing zone by effort (using the assumptions listed above).

RESULTS

Two hundred eighty one turtles were captured after 2556.5 hours of observation during the four projects. The vast majority are olive ridleys (90.04%), followed by the green turtle (9.6%) and the hawksbill (0.4%). Mortality among olive ridleys is estimated to be 37.55%, and 50% for greens. The only hawksbill captured was alive. Average CPUE sea turtles in the Pacific coast of Costa Rica is estimated to be 0.1019. The annual catch of sea turtles using the assumptions listed earlier result in an estimated 15,631.2 along the Pacific coast of Costa Rica.

Costa Rica has the highest yet recorded average CPUE rate for sea turtles in the world. The olive ridley nests in massive "arribada" fashion in six locations of the tropical eastern Pacific, thus these high rates may be the rule in these waters. The countries of the eastern tropical Pacific must adopt the use of Turtle Excluder Devices (TEDs) in their shrimp fleets if adequate long term protection is to be provided to these populations of threatened sea turtles.

ACKNOWLEDGMENTS

I would like to thank Alexis Gutierrez of the Puntarenas Chamber of Fishermen for his cooperation. This study was mainly financed by the National Commission for Scientific and Technological Research of Costa Rica (CONICIT) and U.S.A.ID/Costa Rica.

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Rice, R.E. 1973. A preliminary investigation of the Pacific ridley sea turtle (*Lepidochelys olivacea*): sex ratio, external dimensions, reproductive development, feeding habits, and the effect of shrimp fishing on them in Costa Rican waters. Unpublished thesis. Grinnel College. Associated Colleges of the Midwest, U.S.A.

Table 1. Catch per unit of effort of sea turtles (indiv/hr/30.5m) in the white shrimp fisheries of Pacific Costa Rica, 1997. Rice (1973), Gamboa (1993), Arauz (1994), Arauz *et al*. (1977*a*,*b*)[1,2,3,4,5].

	Vessel	month/year	Hours	# turtles	CPUE/indiv/hr/30.5m
Fishing Zone 1					
	Edjorka [2]	Sep-92	66.5	0	0
	Ana Lourdes [2]	Dec-92	49.75	6	0.0804
	Pta Guiones [2]	Mar-93	58.25	0	0
	Ana Lourdes [2]	Mar/Apr-93	39.4	0	0
	Nautilius [4]	Aug-95	87.81	28	0.236
	Don Beto [4]	Feb-96	68.05	0	0
	Don Manolo [4]	Mar-96	82.1	0	0
	Andi [4]	Apr-96	22.5	1	0.0317
	Ana Lourdes [5]	Sep-96	101.55	12	0.1819
	Capt.Lostalo [5]	Oct-96	24.08	0	0
	Karla G [5]	Nov-96	42.84	1	0.0231
	Total		**642.83**	**48**	**0.0684**
Fishing Zone 2					
	Edjorka [2]	Apr-93	75.08	13	0.1154
	Edjorka [2]	Jun-92	54.75	1	0.0122
	Maria Pia [4]	Jun-95	29	4	0.1623
	Picaroto [4]	Jul-95	40.5	3	0.0707
	Nautilius [4]	Aug-95	128.6	41	0.1989
	Edjorka [4]	Oct-95	186.3	8	0.0264
	Rio Grande [4]	Nov-95	164.34	6	0.0243
	Maria Aurelia [4]	Jan-96	134.82	7	0.0344
	Andi [4]	Apr-96	41.75	2	0.0342
	Edjorka [5]	Oct-96	69.41	3	0.1201
	Edjorka [5]	Sep-96	116.5	4	0.0312
	Monarca [5]	Sep-96	54.03	0	0
	Capt.Lostalo [5]	Oct-96	44.56	1	0.032
	Karla G [5]	Nov-96	17.41	2	0.1435
	Edjorka [5]	Nov-96	69.49	0	0
	Total		**1226.54**	**95**	**0.0598**
Fishing Zone 3					
	Joshua [4]	May-96	31.6	1	0.0487
	Edjorka [5]	Set-96	83.5	1	0.0074

Total	**115.1**	**2**	**0.0188**

TABLE 2. Catch per unit of effort (indiv/hr/30.5m) of sea turtles in the pink and fidel shrimp fishery of Costa Rica, 1997.

Vessel	month/year	Hours	# turtles	CPUE/indiv/hr/30.5m
Fishing Zone 4				
Rice[1]	Sep-73	43.2	34	0.5247
Edjorka[2]	Sep-92	12	0	0
Karla G[2]	Jan-93	81.7	19	0.155
Andi[4]	Apr-96	29.5	3	0.1453
Total		**166.4**	**56**	**0.2381**
Fishing Zone 5				
Edjorka[2]	Jun-92	27.7	4	0.0963
Edjorka[3]	Aug-94	69.3	15	0.1443
Karla G[4]	May-95	127	13	0.09284
Maria Pia[4]	Jun-95	15.43	2	0.0977
Joshua[4]	Apr-96	52.75	0	0
Joshua[4]	May-96	2	0	0
Edjorka[5]	01/09/1996	19	4	0.13167
Karla G[5]	Nov-96	22.5	1	0.05
Total		**335.68**	**39**	**0.0881**
Fishing Zone 6				
Joshua[4]	Apr-96	36.95	0	0
Joshua[4]	May-96	33	0	0
Total		**69.95**	**0**	**0**

TABLE 3. Analysis of 281 sea turtles captured off the Pacific coast of Costa Rica after 2556.5 hours of commercial shrimp fishing, 1997.

Species	Total	%	Alive	Dead	Unknown	% Mortality
Lepidochelys olivacea	253	90.04	153	92	8	37.55
Chelonia mydas	27	9.6	11	11	5	50
Eretmochelys imbricata	1	0.4	1	-	-	0

POPULATION GENETICS OF THE LEATHERBACK TURTLE IN THE MEXICAN PACIFIC

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INTRODUCTION

The nesting populations of the leatherback *(Dermochelys coriacea*) in the eastern Pacific, particularly those found along the Pacific coast of México, are among the most important for this species worldwide. However, there is now great concern over the dramatic decline in the numbers of females nesting at these rookeries in recent years (Sarti *et al*., 1996), which has highlighted the need to better understand population structure. A previous global genetic survey of leatherbacks (Dutton, 1996) did not include the Mexican rookeries. This study is the first genetic evaluation of the nesting colonies in the Mexican Pacific, and provides insight into the placement of these colonies relative to the global scheme of population genetics for this species.

SUMMARY OF PRELIMINARY RESULTS

We analyzed allele frequency data for multiple microsatellite loci from samples obtained from four major rookeries in the Mexican Pacific; Mexiquillo, Chacahua, Tierra Colorada, and Barra de la Cruz in order to 1) determine the degree of genetic variability within and among nesting colonies in the Mexican Pacific; 2) to determine the degree of gene flow among the Mexican rookeries, and 3) to evaluate population structure. We compared findings within México with other nesting populations in the world.

Preliminary results for 2 loci (DC99 and N32; see Dutton 1996), show relatively high levels of heterozygosity (H=0.70) in the Mexican nesting colonies, which are comparable to levels reported for other rookeries (Dutton 1995). The genotype frequencies are in Hardy-Weinberg equilibrium, and a Fst value of 0.018 was obtained, indicating that the Mexican leatherback rookeries are most likely all part of a single, random-mating population. Furthermore, a high level of gene flow was found (Nm>4) between rookeries in México and Pacific Costa Rica, suggesting interchange between females nesting in these two countries, although alternative explanations, such as recent shared ancestry cannot be ruled out until additional markers and larger sample sizes are analyzed. Based on phylogenetic analysis of the results so far, two distinct clades can be recognized: one containing the rookeries in Malaysia and South Africa, and a second one containing populations from the Caribbean and eastern Pacific.

Work is ongoing to sample additional populations and analyze additional microsatellite loci in combination with mitochondrial DNA sequences.

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MIXED STOCK COMPOSITION OF THE MISKITU CAYS GREEN TURTLE FISHERY BASED ON mtDNA MARKERS

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The seagrass beds of the Caribbean coastal waters of Nicaragua support the largest foraging population of green sea turtles, (*Chelonia mydas*), in the Western Hemisphere. For over 400 years, Miskitu Indians have harvested green turtles from this foraging ground for subsistence. Where are these turtles coming from? Rookery specific mtDNA control region polymorphisms (and related haplotype frequency shifts) can be used to identify the origin of the turtles on the foraging ground. Information on the relative contribution of nesting colonies to this feeding ground is necessary for assessing the impact of the green turtle fishery on the greater Caribbean population.

GTFP ON THE WORLD WIDE WEB

Peter A. Bennett and Ursula Keuper-Bennett

24 Reid Drive #3, Mississauga ON, L5M 2A6, Canada

George Balazs: "No fibropapilloma in Tahiti. But of course, they also have nearly no turtles. I'm trying to decide which is worse."

Good evening. My wife and I spend each July and August at Honokowai, West Maui, Hawaii. Two or three times a day, we dive with sea turtles. While this might sound like fun, it's not. Nearly all of these turtles have green turtle fibropapilloma tumours--GTFP for short. We're turtle-watchers, and we've put the story of the Honokowai turtles and their GTFP on the World Wide Web. Tonight I'll tell you a little about what we've done and why we've done it. We put GTFP on the Internet because we made a promise to Clothahump, the first sea turtle we ever met. She swam into our lives one day in 1988, and we saw her almost daily each summer until 1993. That year, we saw her just once. The sight of her eyes and neck burdened with tumours was profoundly painful. After that dive, we tried to come to grips with our emotions. We did what hurt people do when they're angry: we laid blame. We blamed Maui County. We blamed the developers and the pineapple companies. We even blamed the GTFP researchers for failing this turtle. We blamed everyone, including ourselves.

Forrest Gump: "A promise is a promise, Lt. Dan."

Then came the promise. Ursula's exact words were: "We're gonna blab Clothahump's story to the whole world." Not an eloquent vow, but by speaking here tonight, we're keeping that promise. We've always told Clothahump's story to anyone who would listen, but it took a while to discover how to do this most effectively.

Ernest Hemingway: "Never mistake motion for action."

Never underestimate motion, either, even if you're going nowhere. Sometimes, if you move around randomly for enough time, you find your path just because you've been moving. In our case, we happened upon the World Wide Web. Many of you are familiar with the Web. If you're not, think of the Web as a vast collection of online documents that you can search for any word or phrase that you like. These can be linked so that clicking your mouse on a key phrase can fetch the whole document that is being referenced. This makes the Web an important new medium for the distribution of information. The Web differs from other media in many ways, but one stands out: anyone can place information on the Web. It's a way to communicate your ideas to the world. Fools and philosophers have equal access to this new medium--your audience decides which category to put you in. By luck, the Web blossomed just when we needed it. At first it was so new that a search for "sea turtle" found fewer than 200 references. Today you'd find almost 30,000. There were no pages devoted to marine turtles. When we searched for fibropapilloma, we found nothing at all. We decided to change that. We began work on Turtle Trax--our Web document. We could see the potential of the Internet, but what we hadn't grasped was just how to use it--until we saw the World Wide Web. We knew then we'd found our vehicle, but we also needed wisdom and guidance. For that, we looked to the sea turtle community.

We looked first to the Caribbean Conservation Corporation. We admire the CCC, so we decided to make our own three Cs. For us, these came to represent three requirements for success at anything, not just keeping Web pages online.

Richie Moretti: "These poor babies keep dying in our arms and they can't yell and scream so we've decided to do the yelling and screaming for them."

Our first C is for Compassion. We think that you have to care deeply. Only then do you stand a chance of getting someone else to care. For us, the Hidden Harbor Turtle Hospital symbolizes that kind of compassion.

Dr. Archie Carr: "[The CCC's] most important attributes are a single-minded resistance to any distraction... and a determination to make [the Tortuguero colony] the most thoroughly studied sea turtle population in the world."

Our second C is for Commitment. No commitment, no completion. Dr. Carr's description says it best: "...single-minded resistance to any distraction..."

Mimi Carr: "...he was a man who lived to write and he worked hard to refine and craft his words so that they were true for him."

Our third C is for Communication. We never had the privilege of meeting Dr. Archie Carr, but we've read his words. He was the best: a Master Communicator. We couldn't help but to love, respect, and even envy him for his gift. The fact is, you can feel powerfully about something and be focused and committed, but if you can't communicate that, the message plops down around your feet and refuses to go anywhere. Communication implies not just that noises are being made and received, but they that are understood. Through his writing, Dr. Carr taught us that and more.

He taught us that anyone is a potential friend of sea turtles, so we designed Turtle Trax to be useful to a wide audience. That's why we keep Turtle Trax simple--no animation, no bells, no whistles. Although we use lots of pictures of turtles with tumours, we try to make the text useful even without images. We also try to appeal to a wide range of educational backgrounds. For us, kids are the most important. For them, we include poems, sea turtle photos, colouring pages, the writing and art of other kids, and inspiring stories like Jean Beasley's account of Huffy, the turtle that wouldn't give up. The first thing on the kids' page, though, is our essay, "Why Howzit Is Dying." It's a grim introduction, but it's effective. It's one of our most requested pages. At the other end of the spectrum, we wanted to provide a resource for people conducting research into GTFP. For this, we developed The Sickbay. Here we include examples of GTFP in various stages of development. We thought that images showing GTFP on turtles in their native habitat, turtles that we've seen and documented over several years, would be of interest. Again, the reaction has been positive and encouraging. It's satisfying to know that our images have more than just shock value. We're greedy. We want to reach everybody, so we use "hooks" to get people interested in our information. Lots of people want to learn about sea turtles but have no idea that a disease as horrible as GTFP exists. We therefore provide general information about sea turtles to bring people in, and when they show up, we try to teach them about GTFP. That gets those who are already interested in sea turtles, but we don't stop there.

Bob Alexander: "The first thing they go for is the stupid stuff."

Bob Alexander is an Internet consultant on Maui, and he was commenting upon the typical reaction of people new to the Web. In recognition of that, we made sure Turtle Trax had some "stupid stuff"--the Awesomely Way Cool BogusCam(TM), for example. People like to be entertained, so we created a weekly sea turtle comic strip. The idea is to provide material that brings in people who ordinarily wouldn't be interested in sea turtles--and to keep them coming back. Once in a while, someone decides to poke around a bit more, and we've hooked another one. People don't want just disease, sadness and death--that's like watching Senate debates all day. Turtle Trax might be a vehicle for GTFP education, but we can't just wallow in disease and tragedy. We must celebrate that we still have sea turtles, and make an affirmation to help them. We've experienced a full range of emotions underwater, and we want our audience to experience that too. While the fate of GTFP is in the hands of scientists and a few administrators, funding and support must come from the many, so we try to get our message to the masses in any way possible.

George Balazs: "The usual outcome for most affected turtles in Hawaii is debilitation over a protracted period, followed by death."

That is the message. We deliver this message in a way that isn't scientific at all. We try to make people care about the effect GTFP has on individuals. Although GTFP threatens green turtles everywhere, the impact is on individuals. Suffering and dying happens one turtle at a time. The biographies we've placed on the Web introduce people to individual animals. We show how the disease affects them, year by year. When Tutu, our grand dame, showed regression, we rejoiced, and people visiting Turtle Trax rejoiced with us. When we suffered the loss of Howzit, the epitome of Honokowai juveniles, people on the Internet suffered with us, and yes, they wept too.

Howzit's story is actually more tragic than the loss of a single turtle. Howzit was a juvenile in 1992. He--we called Howzit "he" because somehow he seemed male--he was curious and not at all bashful, and he behaved as though he owned the place. We knew that Howzit had GTFP, but we hoped that he'd be one of the lucky ones. It was not to be. In 1995, Howzit was emaciated. Although he wasn't covered with tumours like some, we knew he wouldn't survive. Howzit wasn't in his usual place in 1996. We think Howzit is dead. The importance of Howzit's story is this: he is typical of the juveniles at Honokowai. They all have tumours. They arrive at Honokowai, they get tumours, they disappear--all of them. No exceptions. We can't produce bodies, but given the site fidelity of Hawaiian green turtles, we don't think they've just wandered away. We're certain that they die. The effect of the loss of youth on a long-lived, slow-breeding species is easy to see. If Howzit is really a typical juvenile Hawaiian green turtle, the species is in grave danger.

Howzit's story, and the stories of the turtles he lived with, are the stories we're telling the world through the Web. Turtle Trax is more successful than we dared to imagine, and we have pretty good imaginations. It won't amount to much, however, if we can't turn this into increased funding and direct improvement in the health and lives of these turtles. A few years ago, a Ph.D. from Hawaii referred to us as "hysterical environmentalists." Since then, we've tried to temper our words with the help of science, but we still focus what we do on basic human instinct. What is the worst thing a human can envision? Not disease, not death, but dying without anyone noticing! Had we not been at Honokowai, a lot of turtles would die from GTFP and no one would notice. Well, we noticed and that is what Turtle Trax is: 24 hour, 7 day a week testimony to the fact that they're gone. Mourning their loss this way has converted our mutual rage into something productive and therapeutic. Please support GTFP research. Thank you.

LOGGERHEAD SEA TURTLE CONSERVATION IN THE GULF OF NAPLES

Flegra Bentivegna

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The Stazione Zoologica "A. Dohrn" of Naples is one of the oldest and most important scientific centers in Italy, and is a focal point for marine biological research. The Aquarium Group is involved in a special program on the endangered species of sea turtles. The program of safeguarding sea turtles which started in 1980, is based on practical measures and scientific research. The practical measures consist in recovery of animals in difficulty; cure and rehabilitation; release in the wild ; and stimulate public awareness of the threat to the environment.

The Aquarium rescues all *Caretta caretta* (the most common species of marine turtle in Italian waters) that have been wounded by hooks, nets or are victims of marine traffic or pollution. The Aquarium Research Group has evolved procedures for the treatment and maintenance of these animals before releasing them in the wild. Recently the group successfully used a Video-Endoscope which is a non invasive procedure to remove a polyethylene cord and hooks from loggerhead turtles . A hyperbaric chamber was also used to save a turtle's fin which was damaged by a fishing net, a common occurrence. Without this treatment, the fin would been amputated. This approach is well in line with a conservation stance; efforts must be directed towards supporting the wild population dynamics and not simply the survival of one individual.

Public awareness is a crucial practical measure. A programme for fishermen, the local population, and tourists has been developed to help reduce the mortality rate of sea turtles and to promote the reporting of any useful information concerning them. Public awareness was also increased by television appearances, newspaper articles, displays, and by attending conferences. This includes work with school children and last year a competition was ran in collaboration with the local chief of public education. The task was to compile research on sea turtles, the prize being to join the Aquarium group on a trip to Sicily to release ten rehabilitated sea turtles. The scientific research conducted within the framework of the Aquarium's sea turtle project focus on: biology and physiology, ecology, dynamics and migration, and data collection and dissemination.

The Aquarium Group conducts studies of aspects of sea turtle biology on the specimens of *Caretta caretta* that are housed in the Aquarium prior to their release in the wild. All information on marine turtles is studied and evaluated. The information is disseminated appropriately. Data on number and size of captured sea turtles, method of capture, and type of damage suffered gives a measure of the status of the Mediterranean sea turtle population and, in general, to define the degree of danger present in the Gulf of Naples to this species. In October 1995 we began to track a loggerhead using satellite telemetry. This was the first attempt to track a loggerhead in the Mediterranean Sea.

LIMITATIONS OF SKELETOCHRONOLOGY FOR DEMOGRAPHIC STUDIES IN SEA TURTLES

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Demographic models have been limited by our inability to determine age of individual sea turtles. Skeletochronology has been used to estimate ages based on growth marks in the humerus. Body size at earlier ages can be estimated from these growth marks. We tested two assumptions: (1) growth marks in the humeri are laid down annually and (2) there is a constant proportional allometry between humerus radial growth and carapace length growth. Based on our study of a tropical population of juvenile green turtles, both assumptions were rejected. Skeletochronology should only be applied to sea turtle populations or lifestages for which the assumptions have been validated.

LOGGERHEAD TRANSATLANTIC DEVELOPMENTAL MIGRATIONS DEMONSTRATED BY mtDNA SEQUENCE ANALYSIS

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Mitochondrial DNA sequences were used to test the hypothesis that juvenile loggerhead sea turtles in pelagic habitats of the eastern Atlantic are derived from nesting populations in the western Atlantic. Samples were collected from 131 pelagic loggerheads in the waters around the Azores and Madeira. A subset of 121 samples had haplotypes which match mtDNA sequences found in nesting colonies. Maximum likelihood analyses indicate that 100% of these pelagic juveniles are from the nesting populations in the southeastern U.S. and adjacent Yucatán Peninsula, México.

GLOBAL PHYLOGEOGRAPHY OF THE RIDLEY SPP.

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To assess the biogeography of ridley turtles, mtDNA control region sequences were compared among 8 nesting locations. Within *L. olivacea*, the most common haplotype in Atlantic samples is distinguished from an Indo-Pacific haplotype by a single nucleotide substitution, and East Pacific samples are distinguished from the same Indo-Pacific haplotype by two nucleotide substitutions. This shallow separation is consistent with a biogeographic model proposed by P.C.H. Pritchard. However, these data implicate the Indo-Pacific region as the source of the most recent radiation of olive ridley lineages. Population extinction and colonization, as regulated by climate and oceanographic conditions, may explain the observed phylogeographic pattern within *L. oliveacea*.

THE MARINE TURTLE SITUATION IN CHILE

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INTRODUCTION

Although the Chilean coast is characterized by the cold Humbolt Current, and there is a popular belief that marine turtles do not occur in this country, the first record for the region, recorded by Abbot Molina in 1782 (Donoso-Barros 1962), comes from Chile. Furthermore, there are reports from central Chile in the national press since January 1897, and preColumbian rock paintings are known from the north of the country. Of the 5 species of sea turtles recorded from the eastern Pacific, 4 are known from Chilean coasts: Leatherback turtle, *Dermochelys coriacea*; Eastern Pacific green turtle, *Chelonia mydas agassizi*; Olive ridley turtle, or Pico de Loro, *Lepidochelys olivacea*; and Loggerhead turtle, *Caretta caretta*. A review of Chilean literature on sea turtles made by Frazier and Salas (1984) as well as more recent information, indicates a regular occurrence of these animals. For example, Frazier and Brito (1990) documented 30 cases of *D. coriacea* captured or netted accidentally in central Chile, by the artisanal swordfish (*Xiphias gladius*) fishery operating out of San Antonio (33° 35' S), between January 1988 and June 1989. Their study included captures as far north as Isla Mocha (38° 22' S), and an estimated annual mortality of 250 individuals.

Given this discovery, at the end of 1989 it was decided to develop the program "Monitoring of Sea Turtles Captured In The Swordfish (‘albacora’) Fishery in Central Chile" at the Museo Municipal de Ciencias Naturales y Arqueología (MMCNA) of San Antonio. The primary goals are to document the relationship between this drift net fishery and sea turtles and to determine the frequency, areas and periods of capture. Other activities include a revision of scientific literature related to sea turtles published since 1980, and examination of specimens in private collections, universities and museums of Chile. Local fishermen were educated about these endangered species, and any new information related to sea turtles in Chilean waters was investigated. A total of 153 new records of sea turtles were obtained, 64 of which come from publications in the national popular and scientific press; the data include new geographic records, as well as data on size, morphometry, stomach contents, sex and epifauna.

RESULTS

Dermochelys coriacea, Leatherback Turtle

A total of 82 new records were obtained for Chilean waters, 26 of which come from the literature. These records indicate that this species, and not *Chelonia mydas*, as was formerly thought, is the most abundant sea turtle in Chile. Except for one individual captured in December 1992, the records come from the swordfish drift net fishery, which is active between January and July. Out of 62 specimens caught in this fishery between 1982 and 1992, at least 53 drowned. Records occur from Caldera (27° 5' S) to Ancud, Chiloe Island (41° 5' S). The southernmost distribution was formerly Valparaiso (33° S) (Frazier and Salas, 1983; 1986), so this has now been extended considerably, and according to rumours may even include the south of Isla de Chiloé. Of the specimens that were measured, 10 were adults and 4, subadults.

Four Chilean specimens of *D. coriacea* have been reported with marks: one in 1988, from near Valdivia (40° S), marked in Costa Rica (Chandler, 1991); one on 14 April 1988 from near Mocha Island (30° 30' S), marked in México (Márquez and Villanueva, 1993); one on 15 June 1992 from near San Antonio (33° 30' S) marked in México (Márquez and Villanueva, 1993); and one from Coquimbo (30° S) marked in Costa Rica. These first records of marked turtles in Chile, indicate that Chilean Leatherback turtles come from Central America and México.

Chelonia mydas agassizi, Eastern Pacific Green Turtle, Tortuga Negra.

Formerly thought to be the most common sea turtle in Chilean waters, this species is now regarded to be second in abundance to *D. coriacea*. A total of 49 new records of this species were obtained, of which 35 are from local newspapers, magazines and scientific publications. Of 22 measured specimens, 14 were juveniles, 4 were subadults and 4 were adults.

Although this species is considered to be omnivorous, eating various invertebrates (Cornelius, 1986), stomach contents from Chile have shown that it feeds mainly on algae such as *Macrocystis piryfera* (Formas, 1976), *Durvillaea antartica*, *Glossophora kunthii*, *Gymnogongrus furcellatus* and *Plocamiun violaceum* (Troncoso, 1988). Stomach contents of an individual examined during this study revealed the algae *Ulva* sp., *Lessonia* sp. and *Porphyra columbina*, semi-digested annelids and a piece of plastic. At least 6 specimens were captured purposely by fishers, 4 were caught incidentally in fishing activities and 1 was found stranded live.

Records occur from Arica (17° 31' S), in the north to Isla Desolación (52° S) and Isla Navarino (55° S), in the south, as well as Easter Island. Most records are from the austral summer, but there are also records during spring and winter, which shows that they can occur during the most of the year. No marked *C. mydas* is known from Chile.

Lepidochelys olivacea, Olive Ridley Turtle ("Parrot beak").

This species is the most numerous of all sea turtles in the Eastern Pacific and rest of the world (Frazier and Salas, 1986). The few earlier records of *L. olivacea* from Chile ranged from Arica to Quintero (32° 46' S); the species was formerly thought to be abundant in the extreme north where a limited fishery on it had been reported. However, there is no recent evidence to support this claim; and apparently Chilean fishermen mistake *Lepidochelys* for *Chelonia*.

Of 21 new records of *Lepidochelys* from the Chilean coast, 4 are from national scientific literature; of these, 19 are adults and 2 subadults. The reports are from between January and September and occurred between Arica (17° 30'

S) and Punta Lavapie (37° 12' S) (Brito 1994). There is also an unconfirmed report from an undetermined site in the extreme south, in Magallanes. Two individuals were rehabilitated, marked and set free in February 1993 by MMCNA; these are the first sea turtles to be marked in Chile.

Caretta caretta, Loggerhead Turtle.

This turtle is rare in the eastern Pacific and there are no records of nesting in this region (Frazier and Salas, 1986). It is the rarest of sea turtles found in Chilean waters, and in spite of earlier reports indicating that *C. caretta* is common in the extreme north of the country, there is no supporting evidence. The first Chilean record of *Caretta*, from Tarapaca in the north, is in Donoso-Barros (1961). Until recently there were only two Chilean records in the literature, although only one was confirmed by a specimen: an individual captured in Coquimbo (29° 55' S) is deposited in the Museo Nacional de Historia Natural in Santiago. Recently, Chandler (1991) and Yañez and Sufan (1991), mentioned a carapace of *Caretta* belonging to a Flaminio Ruiz collection in Santiago, without specific locality data, but said to be of Chilean origin.

Three more specimens were documented during this study: a juvenile, captured incidentally in a swordfish drift net west of Caldera (27° 05' S), now in MMCNA; a stuffed adult in the Museo Fonck of Viña del Mar, with no locality data; and the carapace and plastron of a juvenile, in the Museo of Quintay (33° 12' S), reported to have been captured in the same place by fishermen. This last specimen is the southernmost record from the eastern Pacific.

CONCLUSIONS

Dermochelys coriacea have been accidentally captured in drift nets set for swordfish, from Caldera south to Ancud, Chiloé. These data, including the southernmost record for the species, indicate that *D. coriacea* - and not *Chelonia mydas* - is the most abundant sea turtle in Chilean waters, and that they are present throughout the year. The remaining 3 species have also been caught accidentally in fisheries activities, with new southern records for in *Caretta caretta* at Quintay, and *Lepidochelys olivacea* from Punta Lavapie, and possibly as far south as Magallanes. Together with *Chelonia mydas*, these species occur mainly during the austral summer. In regard to legislation on sea turtles, the Government of Chile proclaimed decree-law number 873, 1975, published on 28 January 1975 in the Official Newspaper of the Republic, ratifying the Convention on International Trade of Endangered Species of Wild Flora and Fauna (CITES). However, it was not until 11 November 1995 that a decree was passed banning for 30 years the capture of different species of cetaceans, pinnipeds, sea birds and five species of sea turtles, including *Eretmochelys imbricata*, which has never been recorded in Chilean waters. The Museo Municipal de Ciencias Naturales y Arqueología of San Antonio plans to raise funds and continue the monitoring project, and to determine the status of sea turtles in Chile.

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SUBSISTENCE HARVESTING OF MARINE TURTLES IN THE SOLOMON ISLANDS

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The Solomon Islands, in the South West Pacific (Fig. 1), have a predominantly Melanesian population (380,000) most of which (86%) is dependant on a subsistence based economy (NEMS 1993). From the late 17th Century to 1992, Solomon Islanders traded hawksbill turtle shell (bekko) to Europeans. This trade was important in shaping society. For example, McKinnon (1975) linked the trade in bekko to the origin of head-hunting raids directed against the people of West Solomon Islands by people of New Georgia and the weapons exchanged for shell were used to extend and maintain control over turtle hunting grounds. Head-hunting raids had ceased by early 1900's and after 1992, trade in other marine products replaced trade in turtle shell.

Between 1993 and 1996, I investigated the subsistence harvest of green and hawksbill turtles by people from three communities (Kia, Wagina and Katupika). These communities are within 50 km of a hawksbill turtle rookery at the Anarvon Islands (green turtles seldom nest here) which, prior to 1992, was the source of much of the shell exported to Japan. While the more distant communities of Kia and Katupika claim rights to Anarvon Islands, it is the Gilbertese people at Wagina who are the primary users of these islands. Currently these three communities are working together to manage the marine and terrestrial resources at the Anarvon Islands.

My own research has three themes.

(i) The social context of harvesting was investigated using ethnographic information.

(ii) The structure of local populations of marine turtle, and, impacts of the turtle harvest were investigated using demographic information.
(iii) The partitioning of local populations of marine turtle among regional breeding stocks, and, the determination of which breeding stocks are subject to harvesting were assessed using genetic information.

This paper is concerned with the first two themes; genetic aspects are discussed elsewhere (Broderick and Moritz, 1996).

News of harvested turtles and planned turtle hunts was obtained in the course of daily surveys. Details of the hunt were recorded and, where possible, I observed butchering, weighed and measured turtles, and assessed sex and maturity (following Limpus, 1992 and Limpus and Reed, 1985). Edible and non-edible portions of turtle were weighed separately.

A total of 94 hawksbill and 165 green turtles were tagged in the hunting grounds. Most were caught by free diving at night along the edges of reefs, a technique common among turtle hunters in this region. After capture, turtles were beached to facilitate weighing and measuring, and all turtles were released at or near their capture location. Thirty percent of tagged hawksbill and 11.5% of tagged green turtles were recaptured; nearly half of these recaptures were harvested animals. The frequency of tagged turtles being harvested reflects, in part, the high site fidelity among those turtles using the reef edge habitat at night and, therefore, may over-estimate the harvesting intensity on the total population.

I have estimated that a minimum of 1893 turtles were harvested per year (Table 1). However, the harvest varies across time in composition and between communities, and this variation is not directly attributable to differences in the sizes of communities (about 1000 people at Kia and Wagina and 500 at Katupika). The meat of green turtles is more highly valued than hawksbill turtle, and this preference is reflected in the composition of the catch at Kia and Katupika (Table 1). At Wagina, which is close to Anarvon Islands, hawksbill turtles are encountered more often and, hence, harvested more often than at Kia or Katupika.

Harvested turtles are larger (mean curved carapace length = 65.13 cm for 174 greens and 70.28 cm for 132 hawksbill turtles) than those turtles encountered in the tagging study (mean CCL = 56.18 cm for 165 greens and 50.4 cm for 94 hawksbill turtles; $t=5.04$, $p<0.001$ for green and $t=10.2$, $p<0.001$ for hawksbill turtle). Thus, hunters are biasing their choice of prey to large individuals.

Most harvested green turtles were immature; 96% of females and 73% of males. Because village people consider pubescent female green turtles to be adult, it is likely that in the areas where they hunt they seldom encounter adult female green turtles. This suggests that the hunting areas serve as developmental habitat for green turtles and that the observed population structure is not a result of over-harvesting.

Most harvested hawksbill turtles are adult animals; 70% females and 80% males. Furthermore, gonad examinations revealed that 69% of the adult males and all of the adult females were in breeding condition when harvested. The proportion of experienced to inexperienced breeding females in a nesting population can give an indication of the level of past exploitation. In populations where mortality is low, the vast majority of females nesting in any one season are experienced (Limpus, these proceedings). In contrast, less than 10% of the hawksbill turtles nesting in the study area were experienced breeders suggesting that the level of exploitation in the past was probably high. Further work is needed to partition impacts of harvesting into those arising from trade in bekko, that has now ceased, to those arising from the continuing subsistence harvest.

The social context of the harvest is complex and varies between communities. At Kia the majority of turtles (57.7%) are consumed in the context of feasts. At Wagina and Katupika fewer turtles are consumed at feasts (42.4% and 21%, respectively). The relatively low value recorded at Katupika arises because people have limited access to markets and, hence, cannot afford the dive torches needed to capture turtles at night. They are limited to spearing turtles over the reef flats on high tide and full moon. If feasts coincide with full moon, then, turtle is likely to be consumed. These restrictions on hunting opportunities at Katupika explain why the catch by this community is dominated by green turtles.

At each community many turtles are captured incidentally (Table 1) when people are targeting crayfish, beche-de-mere, trochus or fish to sell at market. Efforts directed at limiting the turtle harvest in this region may prove more successful if they focus on restricting the incidental capture of turtles rather than intruding upon long established and socially significant patterns of turtle consumption.

In conclusion: (i) The hawksbill breeding population has been over-harvested in the past and determining the sustainability of the current levels of subsistence use is problematic. (ii) Species differences in size and sex classes that are targeted by the subsistence harvest indicate that impacts will be different for populations of green and hawksbill turtle. (iii) Because patterns of harvesting are highly variable between communities, no single management strategy will be suited to all areas. However, (iv) the processes that underlie variation between communities can be used to investigate potential management strategies and to assess the outcomes of those strategies.

ACKNOWLEDGMENTS

Special thanks to Dr. Peter Dwyer, Dr. Colin Limpus, Dr. Craig Moritz, The Solomon Islands Government and the people in Kia, Wagina and Katupika, who, in different ways, have made this research possible.

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Table 1: Estimated number of turtles harvested per year in each of the communities studied.

	Kia	Wagina	Katupika	Total
Green turtle	753	201	114	1068
Hawksbill turtle	360	450	15	825
Total	1113	651	129	1893
Incidental captures (% of total)	38	69.2	16.7	

Total	1113	651	129	1893
Incidental captures (% of total)	38	69.2	16.7	

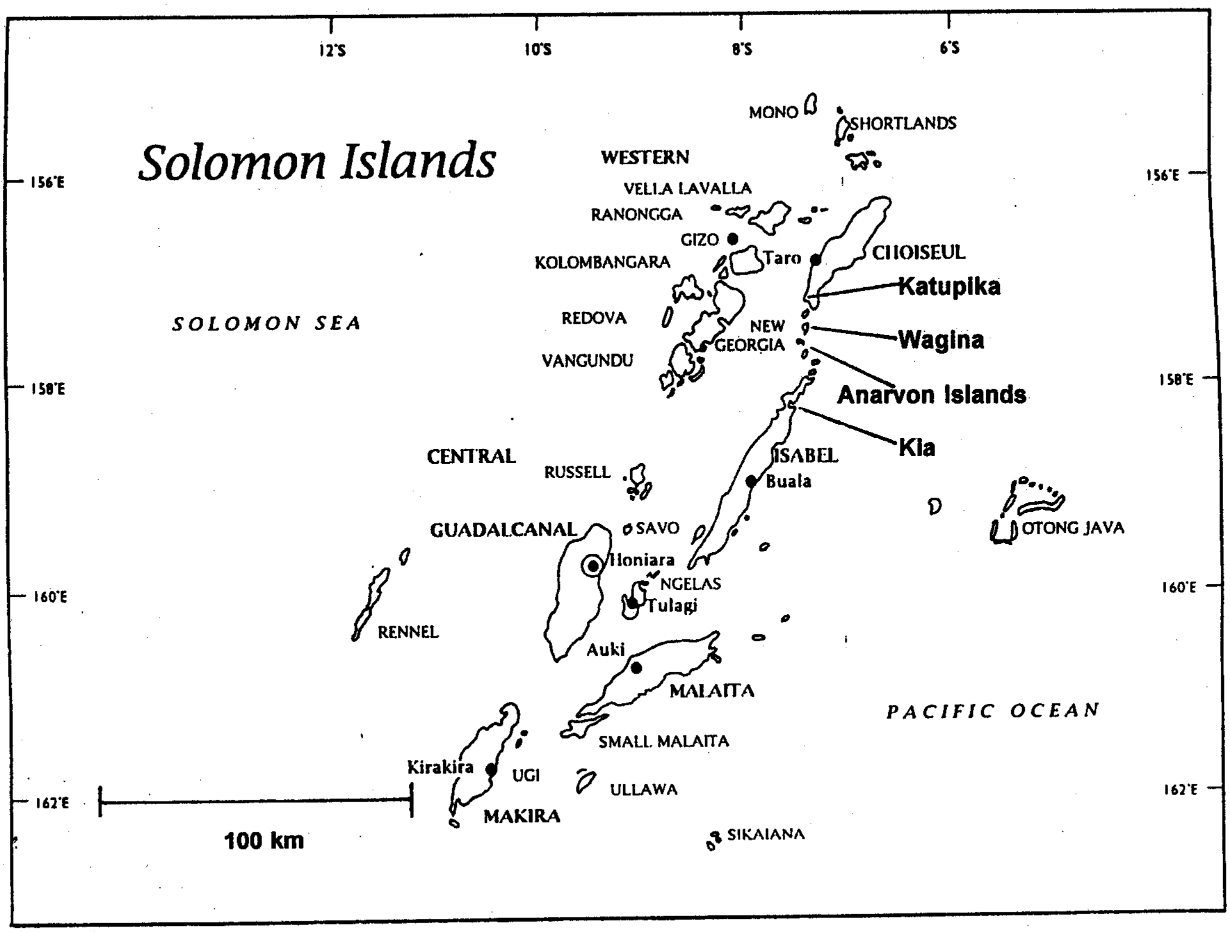

Figure 1: Map of the Solomon Islands showing the location of the study sites (after NEMS 1993).

REPRODUCTION, NESTING AND NEST PREDATION OF THE CAROLINA DIAMONDBACK TERRAPIN IN NORTHEASTERN FLORIDA

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In 1995 we discovered a diamondback terrapin nesting beach in northeastern Duval County, Florida, and we have collected data there over two reproductive seasons. Nesting was concentrated in May and June, decreasing through 19 July when our last nest was discovered. A few recaptures in late June suggest that multiple clutching by some females occurs in this population. A mean clutch size of 6.7 (S.D. = 1.45; R = 3-10; N = 122) was determined from x-rays of 102 gravid females and egg counts from 20 nests.

We surveyed the beach for depredated nests on the last weekend of each month from April through September 1996. We recorded 671 raided nests on this 2.3ha beach. Because most nesting occurs in May and June, and some predators key in on nesting scents, we expected nest predation to be concentrated in those months. Instead, nest predation later in the season was more pronounced suggesting that predators also key in on hatching scents. This phenomenon has been noted for several sea turtles as well. Nest predators included raccoons and fish crows.

ESTIMATION OF WATER TURNOVER RATES BY DEUTERIUM OXIDE DILUTION IN CAPTIVE KEMP'S RIDLEY SEA TURTLES EXPOSED TO FRESH WATER

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Estimations of metabolic and water turnover rates by isotopic dilution techniques in reptiles have previously been published, however, the technique has yet to be reported in sea turtles. The objective of the study was to quantify, by deuterium oxide (D_2O) dilution, water turnover rates in sea turtles acutely exposed to fresh water. Two groups (CS and GAL) of 4 turtles/group held in salt water (SW) were each dosed i.p. with 2 - 3 D_2O/kg body mass. After dosing, subsequent blood sampling occurred at 12h, 2d and 4d in both groups. In CS, water in the animals' pools was switched to fresh water (FW) and blood samples were taken at 2d and 4d. After the 4d FW sample, water in the pools was switched back to salt water (RESW) and samples followed on 2d and 7d. Samples were lyophilized and D_2O in water measured by fixed filter infrared spectrometry (4). Turnover rates in GAL (0.98$\pm$ 0.09 1/d; 102.8 $\pm$ 8.9 ml/kg/d) were similar to CS during SW and RESW. Within CS, turnover rates increased significantly during FW phase, from 1.21 $\pm$ 0.08 to 1.54 $\pm$ 0.06 1/d, as well as on a per kg basis (123.0 $\pm$ 6.8 to 156.5 $\pm$ 10.3 ml/kg/d). Upon reentry to salt water, levels were significantly reduced and were lower than original value (1.04 $\pm$ 0.13 1/d; 110.0 $\pm$ 20.2 ml/kg/d). Marine reptiles are capable of drinking salt water and obtaining a net gain in solute free water by secreting large amounts of sodium and potassium from their salt glands. Data provide the first estimations of water turnover rates and the first application of stable isotopes in sea turtles. The increase in turnover rates during FW phase indicates these animals do not possess a mechanism to cease drinking behavior in hypoosmotic environments. The turtles were able to re-establish basal electrolyte and osmolarity levels by replenishing lost electrolytes via mariposia. Replenishment of lost electrolytes may have been succored by other means such as lachrymal/renal conservation mechanisms. Research was conducted under USFWS permit #PRT 689914 to David Wm. Owens.

HOW DO WE GET THERE FROM HERE? IMPLEMENTING EFFECTIVE CONSERVATION POLICY

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Sustainable use has been promoted by the IUCN for almost 20 years (IUCN, 1980), based on the belief that people must derive value from protected resources. By allowing some use, value is provided. If the use scheme is secure, people will limit current use in order to preserve resources into the future and obtain further value. While sustainable use has been promoted at a policy level, the number of use schemes in practice is limited, particularly for marine turtles. Furthermore, IUCN's attempt to institutionalise use via use guidelines has met with great resistance. This paper considers factors in this resistance. The most commonly cited argument against using marine turtles is their biology and life histories. Nevertheless, opinions on the possibilities of using marine turtles vary, and while marine turtle biology poses constraints on use regimes, I argue that resistance to or support for use in general is based on more than the interpretation of available data. Understanding resistance is necessary if we are to move beyond the current impasse on the use issue. To address "how we get there from here?", I consider three issues. Firstly, to establish where 'here' is, I describe characteristics of the present conservation discourse. Secondly, I consider the influence of individual perceptions of 'here' on the implementation of sustainable use. Finally, I discuss possible directions for marine turtle conservation in relation to sustainable use.

CHARACTERISTICS OF 'HERE'

The key characteristic of 'here' is IUCN's definition of conservation as "...the management of human use of organisms or ecosystems to ensure such use is sustainable. Besides sustainable use, conservation includes protection, maintenance, rehabilitation, restoration, and enhancement of populations and ecosystems" (IUCN, 1980, 1). Three related characteristics are also important. Firstly, southern countries have asserted that environmental concerns cannot supersede those of development in light of existing underdevelopment and poverty. Secondly, 'sustainable development' is a major contemporary catch-phrase, an rests on the belief that, by employing rational management techniques based on best science, economic development can be reconciled with conservation. Thirdly, the role of local people is central in both conservation and development dialogue. Calls initiated in the development literature for more grass roots approaches to development, local empowerment, and community control (Chambers 1983), are echoed in the conservation literature - most prominently in newly popularised definitions of 'community conservation' (Western and Wright, 1994). Economic incentives alone are not enough to secure local support for conservation activities; participation and control are crucial (Heinen, 1993; Parry and Campbell, 1992).

Sustainable use reflects characteristics of the contemporary conservation discourse, and the 'reality' that they define. Accepting sustainable use implies accepting this reality, *i.e.*, the legitimacy of southern developmental concerns and of the importance of involving local people in conservation projects. Otherwise, there is no real incentive to move toward use.

PERCEPTIONS OF USE IN THE MARINE TURTLE SPECIALIST GROUP

The MTSG Strategy (MTSG, 1995) recognises some of the characteristics of 'here', particularly those related to the necessity of using science to inform rational management. Management is identified as the solution to the depletion of marine turtle populations, without which "marine turtle populations are expected to continue to decline to extinction" (ibid., 3), and science is identified as the ultimate means for informing management. While the Strategy cites the need to involve local people in management, it explicitly trades this off against science, advocating "informing and involving local people in the decision-making process while continuing to base management decisions on science." (ibid., 3). Also, while the Strategy adopts the use-oriented IUCN definition of conservation, it treats use with caution. While it recognises that turtles play a role in the lives of coastal people, it does not accept that use by local people is sustainable. Without opposing all use, the Strategy is clear that the MTSG cannot support non-sustainable use, regardless of local tradition.

At an individual level, the extent to which the Strategy's position on use is accepted varies. Firstly, while calls for good science are almost universal, the way in science is traded off against socio-economic issues varies. Socio-economic constraints on use are seen as equally if not more important by some individuals, who also believe that, in some cases, current scientific knowledge is sufficient to design use regimes. Secondly, local traditional use is accepted by some individuals, even when not clearly sustainable, while others directly discount local human need. Thirdly, some individuals promote more commercial forms of use. At a more general level, many people contemporary resourcist visions of the environment, and call for reduced human consumption and a change in human environment relations. They also identify their views as unrealistic, and emphasise the need for a pragmatic approach to conservation. For many, sustainable use represents such pragmatism.

Use in its various guises - farming, ranching, adult and egg harvesting, subsistence or commercial - has divided the MTSG for the past 20 years. If equally qualified and respected scientists can reach different conclusions on the feasibility of using marine turtles, then there is something other than science at work. When defending positions on sustainable use, many individuals begin their justifications in terms of science, but eventually refer to wider views and beliefs about resource management, environment ethics, risk, and local people. As the science surrounding marine turtles is used to support a variety of positions on use, it may be more useful to focus on these wider beliefs when considering conservation conflicts.

FUTURE PROSPECTS FOR SUSTAINABLE USE

When considering the future of sustainable use, the full implications of promoted policies must be considered. Ecotourism is promoted as a form of non-consumptive use but there has been little discussion in the MTSG of its implications for rural 'host' communities. Ecotourism was first defined as travel to view nature, and was predicted to provide economic incentives for local people to protect nature, and to earn funds for conservation. Definitions have expanded to include criteria for local development, in recognition that socio-economic sustainability (often lacking in traditional tourism) is crucial (Stewart and Sekartjakrarini 1994, Wild 1994). Ecotourism will have trouble meeting socio-economic objectives for several reasons. Firstly, destinations will be subject to the whims of tourist preference. Secondly, definitional debates about ecotourism assume that tourism to small rural communities will be planned, and that planning with community development goals in mind will ensure their achievement. This presumption of planning is problematic, as national tourism planners interested in foreign exchange earnings may not prioritise small scale, locally relevant ecotourism. The private sector may take over, and there is a sense that the ecotourism concept has been high-jacked by tourism operators. Thirdly, while Boo (1990) suggested ecotourists would 'naturally' be interested in local cultures, research has countered this belief (Jacobson and Robles, 1992). If ecotourism is accompanied by restrictions on resource use, ecotourist values of turtles are explicitly ranked above those of local people, and traditional livelihoods are undermined. Moral questions aside, if the financial benefits fail to reach local people, resentment of displacement may result in hostility. The repercussions of traditional tourism, and the growth of ecotourism, should make those interested in conservation or local development dubious that ecotourism can deliver either. Nevertheless, it was the major conservation organisations and park agencies that began the ecotourism debate

(Wild, 1994). When this promotion is considered in the context of the wider emphasis on sustainable use, however, it becomes more understandable. Ecotourism may be seen as preferable to other types of use, as the impacts are more manageable, predictable, and less immediately ‘fatal.’ Given that some kind of use must take place, ecotourism may make the best of a bad situation, and may reduce dependence on existing more consumptive forms of use. But consider the implications. Ecotourism is linked to the global economic order, and as such it maintains the status quo between southern and northern countries. It remains dependant on northern demand for a destination, and prioritises northern views of nature over those of southern local inhabitants. By separating nature as an object for viewing, ecotourism promotes a disjointed view of human nature relationships, which is in part responsible for environmental degradation. Furthermore, the potential for ecotourism to achieve the broad socio-economic objectives is questionable. It may bring an influx of capital to rural communities, but how much of that capital stays in the community, the sustainability of the investment, the extent to which such investment and the social, cultural, and environmental impacts thereof can be controlled is problematic. The physical impacts of ecotourism on turtles may be controllable (this in itself is questionable), but the long term socio-economic objectives may not be reached, and thus the sustainability of the system undermined. Alternatively, local consumptive use, which may involve a higher level of scientific uncertainty and have more immediately fatal impacts, may be more sustainable from a socio-economic perspective, and more appropriate. Comparing the socio-economic impacts of ecotourism and consumptive use will only be done if we believe that the long term socio-economic sustainability is important, at least as important as biological sustainability, and if we are willing to discuss trade-offs between the two goals, not only among ourselves, but with the people who they will most affect. This involves moving beyond the impasse which currently exists over the use of marine turtles, with both opponents and proponents of use insisting that their views are based on “science.” As Wildavsky emphasises, recognising multiple views of the world - cultural bias - is crucial to policy making in a multi-cultural world (in Roe, 1996). The extent to which marine turtle specialists recognise their biases - towards environmental management, use, and local people - may be key to understanding and possibly overcoming opposition to sustainable use initiatives.

ACKNOWLEDGMENTS

My research is supported by the Canadian Social Sciences and Humanities Research Council.

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EVIDENCE FOR RETROVIRUS INFECTIONS IN GREEN TURTLES FROM THE HAWAIIAN ISLANDS

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To initially screen green turtles (*Chelonia mydas*) for the presence of retrovirus, we employed the sensitive polymerase enhanced reverse transcriptase (PERT) assay. Three additional experimental approaches: sucrose gradient analysis, electron microscopy, and SDS-PAGE were used to provide evidence in support of the contention that retroviral infections are widespread in Hawaiian green turtle populations. Strikingly, all turtle tissue samples were positive for PERT with levels high enough to quantitate by the conventional reverse transcriptase (RT) assay. Samples of skin, even from asymptomatic turtles were also RT positive, although the levels of enzyme activity in healthy turtles hatched and raised in captivity were approximately 10 to 20 fold lower than those observed in asymptomatic free ranging turtles. individual fibropapillomas and tumors displayed a broad range of reverse transcriptase activity. Skin and eye fibropapillomas and a heart tumor were further analyzed and shown to have reverse transcriptase activity that banded in a sucrose gradient at 1.17g ml^{-1} indicative of retroviruses. The putative retrovirus purified from the heart tumor displayed a temperature optimum of 37° C and showed a preference for Mn^{2+} over Mg^{2+}. Sucrose gradient fractions of this sample displaying elevated reverse transcriptase activity contained primarily retroviral sized particles with prominent envelope spikes, when negatively stained and examined by electron microscopy. Sodium dodecylsulfate-polyacrylamide gel electrophoresis (SDS-PAGE) analysis of gradient purified virions revealed a conserved profile among four independent tumors and showed seven prominent proteins having molecular weights of 116, 83, 51, 43, 40, 20 and 14 kD. The data suggests that retroviral infections are widespread in Hawaiian green turtles and a comprehensive investigation is warranted to address the possibility that these agents maybe involved in the cause of green turtle fibropapillomatosis.

MODELING GREEN TURTLE SURVIVORSHIP RATES

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Reliable survivorship estimates are needed for modeling sea turtle population dynamics. But survivorship is a complex time-dependent function comprising confounded time effects and subject to sampling or measurement error. A statistical modeling approach was presented to uncouple these effects and to control for sampling error. We used this approach to derive age-, year- and cohort-specific survival rate estimates for green turtles resident in a southern Great Barrier Reef foraging grounds of the spatially structured sGBR genetic stock. These are the first comprehensive survivorship estimates for a sea turtle stock based on a long-term foraging ground sampling program. We also compare these AYC-based survival rates with estimates derived from a time-dependent Cormack-Jolly-Seber model.

METHODS

The data set comprised capture-recapture profiles for green turtles (sGBR genetic stock) that were double titanium tagged in the sGBR foraging grounds between 1984 and 1992. Only turtles with recapture intervals ≥12 months were included in this data set. Capture-recapture profiles recorded for each turtle included the sex and reproductive status determined from visual examination of gonads using laparoscopy. Turtles were assigned to 3 developmental stages based on size and reproductive status criteria - juveniles, subadults, adults.

We analysed the individual capture-recapture profiles stratified by sex for each stage using the multinomial Cormack-Jolly-Seber (mCJS) modeling approach (Lebreton *et al.*, 1992). We also used the more flexible Poisson likelihood approach (Cormack, 1993) to evaluate the mCJS model findings and to derive stage-specific population size estimates for the sGBR foraging ground stock (to be reported elsewhere). These CJS-type models derived time-dependent estimates of survival and recapture rates for each stage. But the mCJS model neglects in its common form the age and cohort structure inherent in capture-recapture programs (Lebreton *et al*., 1992). So we extended the mCJS analysis by using the age-year-cohort (AYC) modeling approach advocated by Chaloupka and Musick (1997) for time varying demographic processes.

The AYC approach is an extension of the cohort-based CJS model used for instance by Lebreton *et al*. (1992). The AYC model was estimated for the green turtle study discussed here by using a two-stage approach. (1) by obtaining mCJS estimates for each tagging cohort (Lebreton *et al*., 1992) to derive the AYC structure from the individual capture-recapture profiles. (2) by applying to the AYC structure a Poisson likelihood modeling approach (*glm*), which also accounted for excess sampling variation due to heterogeneity by incorporating Breslow's (1990) negative binomial procedure. The AYC-structured glm was used to evaluate by analysis-of-deviance whether survival rates for each developmental stage were age-, year- or cohort-specific. We then supplemented this model with an AYC-structured GAM model also accounting for extra-Poisson variation (Hastie,1993) to evaluate whether age and year effects were nonlinear. The AYC-structured GAM model provides age-specific survival rate estimates for direct comparison with the time-dependent mCJS estimates.

RESULTS AND DISCUSSION

The best fit model based on goodness-of-fit criteria (AIC, AIC adjusted for overdispersion, analysis-of-deviance) and biological considerations for each developmental stage was - (1) juveniles and subadults (constant survival rates but time-dependent recapture likelihood) and (2) adults (time-dependent survival rates but constant recapture likelihood). There was no evidence for sex-specific survival rates or sex-specific recapture likelihood within any of the 3 stages.

Nor was stage-specific survival a function of variable sampling effort over the 9 year sampling period (1984-1992). The stage-specific survival rates estimates derived from these mCJS models are summarised in the Table 1a.

The stage-specific survival rates estimates derived from the age-year-cohort based GAM models accounting for overdispersion are summarised in the Table 1b. GAM model results for the juvenile stage only are summarised graphically in Fig. 1. The age effect for juveniles was linear yielding a juvenile age-specific survival rate of 0.8914 (95% CI: 0.846-0.939; see Table 1b). Age-specific survival was also significant and linear for subadults and adults (see Table 1b for survival rate estimates). The year effect was significant nonlinear for juveniles suggesting an abrupt but temporary increase in survival rates during the late 1980s (Fig. 1, middle panel). Year effect was not a factor affecting subadult or adult survivorship. Significant cohort effects were found for juveniles (Fig. 1; right panel), subadults and adults. When age, year and cohort effects are taken into account, most stage-specific survival rate estimates are lower compared to the mCJS estimates (Table 1). These results show why age-year-cohort modeling is an important part of estimating stage-specific survival rates for sea turtles.

We have also derived stage-specific mCJS-type survival rate estimates for a sGBR loggerhead foraging stock reported elsewhere in these proceedings in relation to a risk-based evaluation of trawl fishery impacts on loggerhead population viability.

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G603 demonstrated a similar distribution of landings on Sandy Point as did the population from 1982 to 1985 (Eckert, 1987). G603 laid 72.9% of her nests (N = 37) on the Sandy Side (stakes -3 to 50) as did the entire population from 1982 to 1985 (71.11 %, N = 582). This demonstrates a landing preference for the Sandy Side which is a much wider, easily seen beach from the ocean than Is the Grassy Side(stakes 51 to 116). When we further break the Sandy Side into a Safe Zone (stakes -3 to 20, 19% of nesting habitat) and an Erosion Zone (stakes 20 to 50, 25% of nesting habitat) we find that G603 laid 17 nests in the Safe Zone and 10 in the Erosion Zone. By contrast, she laid 10 nests on the Grassy Side (56% of nesting habitat). This might indicate a preference for the historically Safe Zone on this beach. Thus, G603 may not fall within the majority of turtles which display no landing preference among zones of the beach (Eckert, 1987).

G603 has consistently laid a higher quantity of yolked eggs (103.1, N = 33) than a ten year average for the entire population (80.1, N = 918) (Boulon, 1992). Her lowest years of egg production were on either side of her one three year internesting interval (Figure 2). This may support the theory that a nutritional deficiency required her to add one year to her internesting interval in order to regain reproductive health. Annual hatch success for G603 has varied from 46.6 to 65.8 percent with the highest hatch success in 1990 and the lowest in 1992 (Figure 3). It is interesting to note that the highest hatch success followed the three year internesting interval from 1987 to 1990. With the exception of 1983, the success of G603's nests have been below the mean success for the season and have shown a gradual decline with the exception of 11990. Were it not for the dramatic increase in that year the trend might be considered indicative of a decline due to an age related decrease in viability cf her eggs.

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

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

ACKNOWLEDGEMENTS

The success of this project is due in large part to Earthwatch of Belmont, Mass. and the volunteers who have assisted in patrolling the beach. US Fish and Wildlife Service, ESA, Section 6 appropriations have provided most of the funding for the project. Special thanks are due to past and present Field Directors of the project; Scott and Karen Eckert, Susan Basford and Robert Brandner and Peter Dutton and Donna

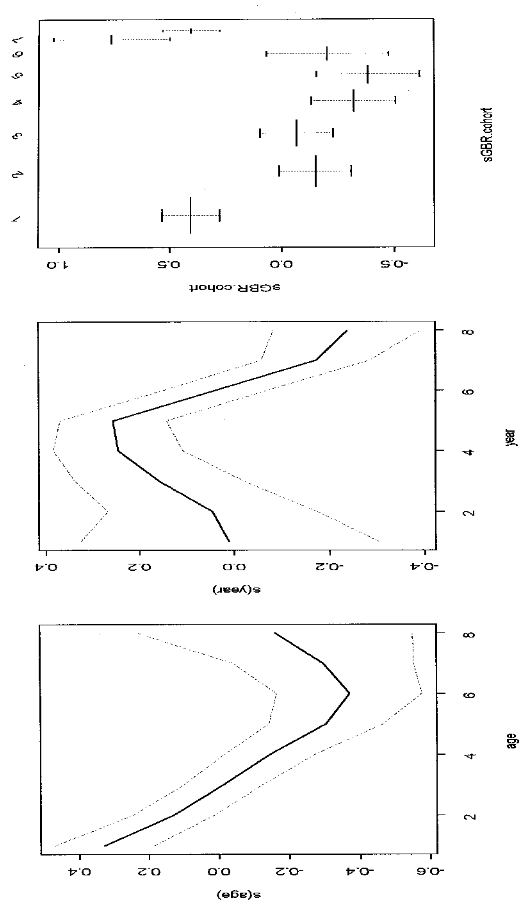

Figure 1: Summary of GAM age-year-cohort (AYC) model results for the sGBR juvenile stage only. GAM survival rates estimates derived with accounting for extra-Poisson sampling variation and nonlinear functional form. Response (survival rate) shown on y-axis in a scaled GAM form. Time predictors (age, year, cohort effects) shown on x-axis. Width of cohort factor effect is proportional to sample size with the 95% confidence interval shown by the cross bar. Solid curve first two panels is a smoothed functional response conditioned on all covariates using a GAM regression and cubic spline smoother. Dotted curves are 95% confidence curves.

SIMULATION MODELING OF TRAWL FISHERY IMPACTS ON SGBR LOGGERHEAD POPULATION DYNAMICS

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We developed a simple stochastic simulation model of the population dynamics for loggerhead sea turtles (*Caretta caretta*) comprising the southern Great Barrier Reef (sGBR) stock - the model considers both feeding and breeding ground components of the stock. The model was designed to support risk-based evaluation of trawl fishery impacts on the viability of the sGBR loggerhead stock given other competing mortality risk factors.

METHODS

The model used finite difference equations linked with dynamic vital rates characterised by nonlinear, time variant, distributed lag and stochastic properties. It comprised a stage-structured demography comprising both age-based and reproductive status-based stages. A conceptual map of similar dynamical systems models is shown in Chaloupka and Limpus (1996).The demographic parameters were from a long-term research program on sGBR loggerheads (Limpus *et al*., 1994). Mortality rates were derived from (1) known hatching rates (Limpus *et al*., 1994 and references therein), (2) proxy hatchling mortality estimates for green sea turtles from the same sGBR location (see Gyuris, 1994) and (3) mCJS statistical modeling of immature and adult sGBR loggerhead survival rates (see Chaloupka and Limpus elsewhere in these proceedings for survival rate modeling methodology). Demographic stochasticity was included with stage-specific logistic probability density functions reflecting 95% confidence interval estimates of immature and adult survival rates. Environmental stochasticity was included by using a 2-state stochastic breeding likelihood function derived from empirical breeding rates (Limpus *et al*., 1994). Stage-transition rates were based on Erlangian functions to ensure distributed maturation and to avoid design defects in models that assume knife-edge maturation and a lack of a threshold developmental (aging) period within a stage (see Chaloupka and Musick, 1997). The stage-specific distributed maturation rates resulted in adult maturity ranging between 25-35 years.

RESULTS AND DISCUSSION

We used the simulation model here to investigate simultaneously the potential impact of various competing mortality risk factors on the long-term viability of the sGBR loggerhead stock at all stages of the life cycle. The main source of egg loss was fox predation estimated around 90% annual clutch loss from 1965 to the mid-1970s at some of the major southern Queensland mainland nesting beaches. The egg loss was estimated jointly with two trawl fishery loss scenarios estimated to have occurred in some of the sGBR loggerhead foraging grounds from the late 1970s to 1995 (see Fig. 1).

Fig. 1a shows the competing risk of the fox predation/high trawl mortality scenario on the long-term population trend for the sGBR loggerhead stock. There is no evidence to support such a high trawl fishery related mortality on this stock during the simulation period **-** it has been included to simulate a worst case scenario only. Fox predation was forecast to have a detrimental but temporary (at least in the long-term) impact on population viability. Fig. 1b shows the joint impact of fox predation and a moderate level of trawl mortality on the long-term population trend for the sGBR loggerhead stock. There is evidence supporting this level of trawl fishery induced mortality on the sGBR loggerhead stock (see Poiner and Harris, 1996). What is apparent from Fig. 1 is that egg production loss due to fox predation (10 year duration) was forecast to have a greater impact than the expected level of trawl induced mortality sources from the late 1970s to the present day (17 year duration). Properly identifying and then comparing competing risk factors is essential for supporting informed debate on the population viability of threatened species.

Sustained egg production loss, even for as short a period as 10 years, will have a major impact on stock viability. The duration of the impact will depend on just how long the egg loss continues. We used the simulation model to further investigate the risk of sustained egg loss on the long-term viability of the sGBR loggerhead stock at all stages of the life cycle in the absence of other major mortality factors. The results of six specific loss scenarios for two duration periods are shown in Fig. 2 indicating the outcome of sustained egg loss on the sGBR adult stock resident in the foraging grounds. An egg production loss of say 90% for 50 years will very seriously deplete the stock as indicated in Fig. 2b for the adult stock component. Quite simply, harvesting eggs is a risky business **-** eggs matter and are no less important than any other life cycle stage.

These simulated risk-based outcomes are predicated on the model assumptions and demographic parameters included. Density-dependent processes have not been included here because of insufficient empirical information on the affects of food stocks on survival, growth and breeding likelihood. Nonetheless, the model produces expected population trends consistent with empirically based reference behaviours (*e.g.*, the annual Mon Repos nesters) as well as expected time series behaviours such as red-shift power spectra for say the annual Mon Repos nesters. Application of stock reference behaviours (benchmarks) is essential for assessing the validity and consistency of models yet has been lacking in most sea turtle modeling work (see Chaloupka and Musick, 1997).

The sGBR loggerhead simulation model is subject to ongoing development to improve its heuristic capability and our insights into the population dynamics of this stock. Future developments of the model will include time varying demographic processes such as age-dependent breeding likelihood, spatial demographic structure of the sGBR loggerhead stock as well as the spatial structure of the regional trawl fishery. Inclusion of spatial structure in the model might well result in different findings.

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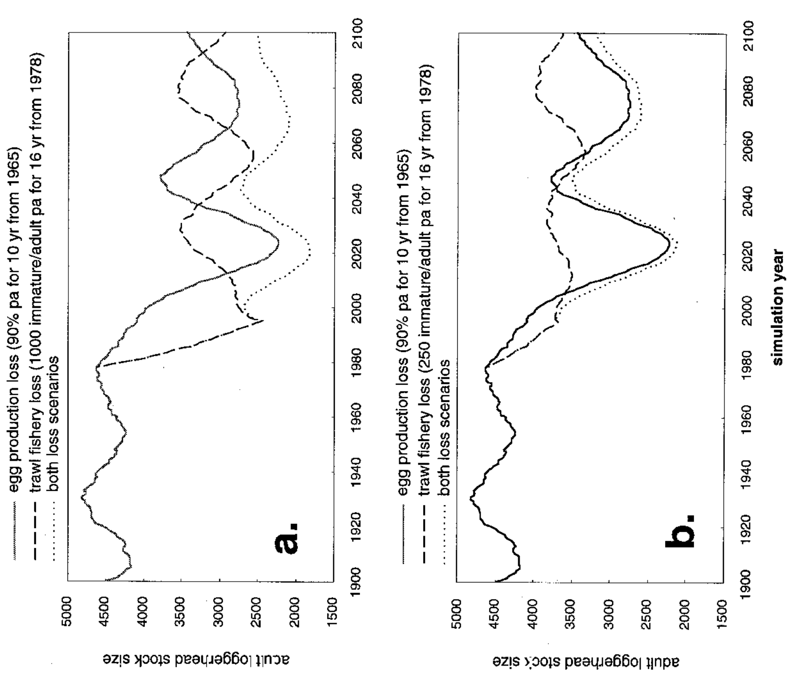

Figure 1: Simulated long-term impact on sGBR adult loggerhead stock size as a joint function of 90% egg production loss due to fox predation and (a) a high trawl fishery loss (N=1000 immature/adult loggerheads) and (b) a moderate trawl fishery loss (N=250 immature/adult loggerheads).

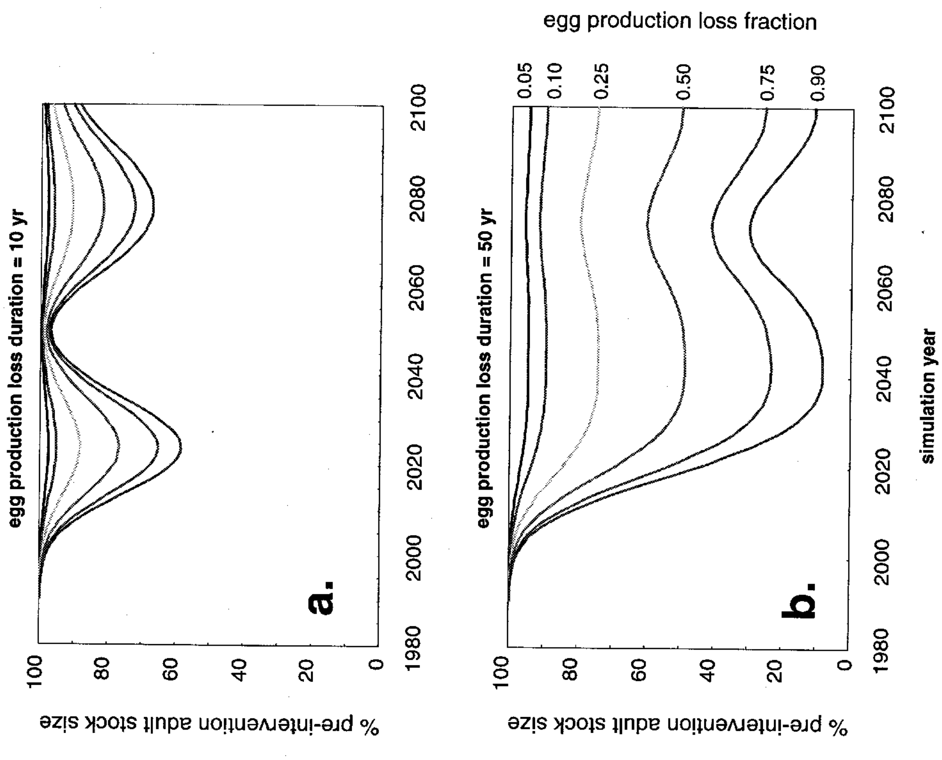

Figure 2: Simulated long-term impact on sGBR adult loggerhead stock size as a function of 6 egg production loss scenarios for (a) a 10–year continuous egg loss duration and (b) a 50–year egg loss duration.

THE POST-NESTING LONG RANGE MIGRATION OF THE GREEN TURTLES THAT NEST AT WAN-AN ISLAND, PENGHU ARCHIPELAGO, TAIWAN

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Wan-An Island, PengHu Archipelago is one of the remaining green turtle nesting sites in Taiwan. The nesting beaches have been designated as a sanctuary by the Council of Agriculture since December 1995 (Cheng, 1995; Council of Agriculture, 1995). Nesting ecology has been studied extensively (Chen and Cheng, 1995). However, little is known of the whereabouts of the nesting turtles while they are in the ocean. The purpose of this study was therefore to use satellite telemetry to determine the post-nesting migration routes and resident foraging areas of the Wan-An Island nesting green turtles.

MATERIAL AND METHODS

Seven adult female turtles were equipped with Argos-linked satellite transmitters (Telonics, Mesa, AZ, U.S.A.) during the nesting seasons of 1994 through 1996. Two models of PTT's (platform terminal transmitter) were used, ST-6 and ST-14. After nesting or false-crawling, the turtles were captured before reaching the ocean and held in a rectangular plywood "pen" in a natural prone position. The procedures for attachment followed Balazs *et al*. (1966). The dates of capture and release of the seven green turtles are listed in Table 1.

The repetition rate for both types of PTT's was 50 seconds. The duty cycle of the ST-14 was 3 hours on, 3 hours off. The ST-6 PTT's were on constantly. The transmitted data were received and processed by the Argos system. The completion of a migration was defined as a tagged turtle stayed in the last location of the migration route for at least 7 days.

RESULTS AND DISCUSSION

PTTs lasted from just over one month (Wan-An No. 7) to 13.7 months (Wan-An No. 5) (Table 2). All but two (Wan-An Nos. 1 and 7) PTTs operated for more than 3 months and provided enough information to reveal post-nesting migrations.

The migration routes of the seven turtles are shown in Fig. 1. Four of the seven turtles migrated to the northeast and the others migrated to the southwest of Wan-An Island. The migration distances ranged from 317 km (Wan-An No. 2) to 1954 km (Wan-An No. 6), and the migration periods lasted from 9 (Wan-An No. 4) to 66 days (Wan-An No. 3). The turtles' estimated swimming speeds ranged from 1.1 to 2.4 km/h, with a mean of 1.6 km/h (Table 3). These rates of travel are comparable to those found in other studies. The final locations of the turtles are shown in Fig. 1 with a star mark.

The results of the present study, which is the first to investigate the post-nesting migrations of green turtles in northeast Asia, suggest that dispersal occurs from Wan-An Island to various locations on the continental shelf to the east of mainland China. Genetic analysis of mtDNA has shown that the Wan-An rookery is distinct from other rookeries that have been examined to date in the Pacific, including Japan, Hawaii, and Australia (Dutton, personal communication).

The present study demonstrated clearly that the green turtles that nest at Wan-An Island are an internationally shared resource. Because the turtles dispersed into the waters of Japan, Taiwan, mainland China and the Ryukyu Archipelago, conservation of the Wan-An rookery clearly cannot depend solely on Taiwan or PengHu County. Thus, a regional program and strategy for long-term research and conservation of green turtles and their habitats, are urgently needed to save this endangered species (IUCN, 1995). Such a program would necessarily involve international cooperation and multinational agreements.

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Table 1. The date of capture, transmitter tagging and release of green turtle nesting at Wan-An Island, PengHu Archipelago, Taiwan between 1994 and 1996.

Turtles	No. 1	No. 2	No. 3	No. 4	No. 5	No. 6	No. 7
PPT	ST-6	ST-6	ST-14	ST-14	ST-14	ST-14	ST-14
Capture date							
year	1994	1994	1995	1995	1995	1996	1996
month/day	8/27	8/28	8/4	8/6	8/9	8/8	8/9
tagged/release							
month/day	8/28	8/29	8/5	8/7	8/10	8/9	8/10

Table 2. Duration of transmission of PTT's deployed on the green turtles nesting at Wan-An Island, PengHu Archipelago, Taiwan between 1994 and 1996.

Turtles	No. 1	No. 2	No. 3	No. 4	No. 5	No. 6	No. 7
PPT	ST-6	ST-6	ST-14	ST-14	ST-14	ST-14	ST-14
year deployed	1994	1994	1995	1995	1995	1996	1996
duration (days)	60	166	328	161	410	141	32

Table 3. The post-nesting migration distance, duration and swimming speed of the green turtles nesting at Wan-An Island, PengHu Archipelago, Taiwan between 1994 and 1996.

Turtles	post-nesting migration distance (km)	traveled duration (days)	swimming speed (km/h)
Wan-An No. 1	1703	59	1.2
Wan-An No. 2	317	10	1.5
Wan-An No. 3	1756	66	1.1
Wan-An No. 4	305	9	1.4
Wan-An No. 5	928	16	2.4
Wan-An No. 6	1954	41	1.9

Wan-An No. 7	562	15	1.6

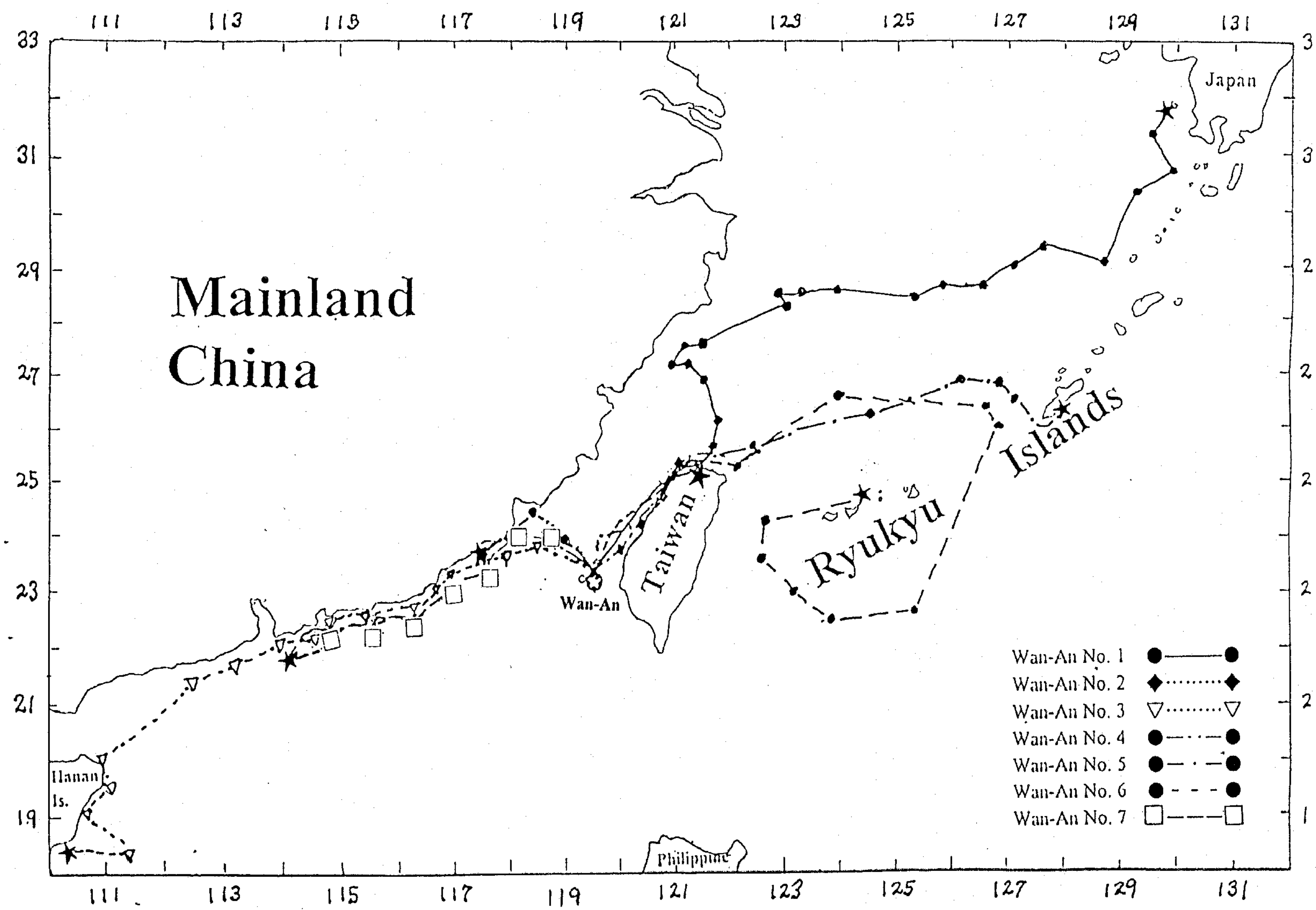

Figure 1. The post-nesting migration routes of seven green turtles that nested at Wan-An Island, PengHu Archipelago, Taiwan between 1994 and 1996. The end points are denoted by a star (★).

QUANTIFYING THE EFFECTS OF THE BEACH ENVIRONMENT ON SEA TURTLE REPRODUCTIVE SUCCESS AT SEBASTIAN INLET, FLORIDA: AN UPDATE

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INTRODUCTION

Statement of Problem: The state of Florida provides nesting beaches for 90% of the Western Atlantic loggerhead population (*Caretta caretta*; Fig. 1). It is therefore imperative that beach conservation efforts are established and maintained to help ensure a self sustaining, healthy global population. However, 40% of Florida's east-coast beaches are eroding, primarily due to coastal development, sea level rise, and the hydrodynamics of tidal inlets (Clark, 1989). In response to this erosion, numerous beach nourishment projects have been completed or proposed in areas where the recreational or protective function of the shoreline has been compromised. To date, roughly 300,000,000 yds^3 of sand have been placed on Florida's east coast beaches (Fig. 2. Unless these projects select fill material identical to the native beach and utilize procedures that emulate natural deposition, the physical attributes of the local nesting environment will be altered. This alteration may lead to reduced reproductive success by modifying (1) nesting behavior, (2) embryo development, or (3) hatchling success.

Statement of project goal: The goal of this project is to evaluate the relationship between physical attributes of a high density nesting beach and sea turtle reproductive success.

STUDY AREA

The study area is located within the Archie Carr National Wildlife Refuge, east-central Florida (Fig. 1). In 1992, the Sebastian Inlet Tax District Commission contracted with the Florida Institute of Technology to monitor the effects of beach renourishment on physical attributes thought to influence sea turtle nesting and reproductive success (Parkinson *et al*., 1992). Since 1992, physical monitoring has been conducted during each nesting season (May - October). During these four years, physical attributes were quantified at randomly selected stations along crosshore and alongshore transects on two beaches in close proximity to the inlet. The north beach is located 3,000 ft updrift of the inlet and not significantly effected tidal hydrodynamics (Venanzi, 1992). The south beach is located approximately 4,000 ft downdrift of the inlet and is subjected to distinct inlet hydrodynamic conditions and occasional beach nourishment.

In an effort to correlate observed differences in physical attributes with sea turtle reproductive success, a biological monitoring program was added to the physical monitoring program in 1994. This program involved the measurement of biological parameters, including hatchling success, emergence success, and addled egg mortality, at both beaches. By integrating results from the physical monitoring program with results from the biological monitoring program, suggestions will be made as to the effect of differences in physical attributes on sea turtle nesting and reproductive success within the project area.

PRELIMINARY RESULTS

The results of our physical monitoring program are shown in Table 1. As can be observed, the south beach is significantly wetter, harder, finer grained, cooler and more carbonate rich. These differences have persisted since the study began in 1992 and the effects of the 1992-3 beach nourishment project are not obvious (*i.e.*, a distinct set of physical attributes are not present in the 1993 monitoring data). This suggests that physical differences between the north and south beaches are more likely related to natural, inlet hydrodynamics than beach nourishment. Certainly, nourishment will effect the physical conditions of the beach over a period of months, but our data suggests that in the long-term, these differences are masked by those generated by the presence of the inlet. We have completed the initial analysis of the 1996 data set and the results are consistent with previous years.

The biological data has only been compiled since 1994. We have just completed the 1996 data analysis, which will be presented in a separate report. No significant differences were noted in the 1994 data and the 1995 data suggests hatching success, emergence success and addled egg mortality were significantly different (Table 2). Inspection of the 1996 data suggests the biological results are similar to the previous year.

FUTURE WORK

We will continue to investigate the relationship between the physical aspects of high density nesting beaches and sea turtle reproductive success. This investigation includes comparisons between biological and physical data, as well as the inter-relationship between various physical parameters. We have begun the 1997 monitoring season and hope, in the end, to provide recommendations that can be used to evaluate the potential effects proposed borrow material on sea turtle reproductive success, analogous to the engineering evaluations currently mandated by regulatory agencies.

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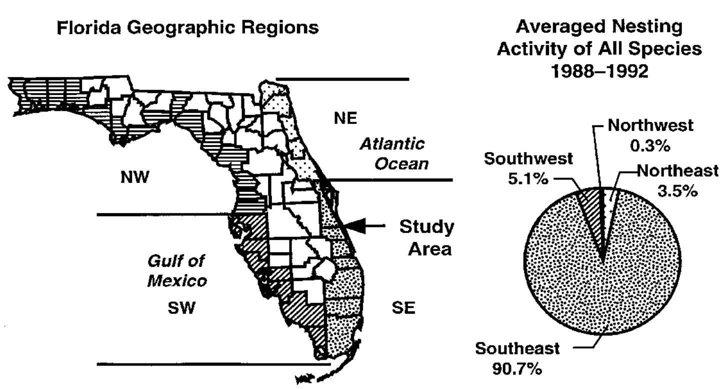

Figure 1. Average nesting activity of all species grouped by geographic regions of Florida. (Adapted from Meylan *et al.* 1995; FDEP)

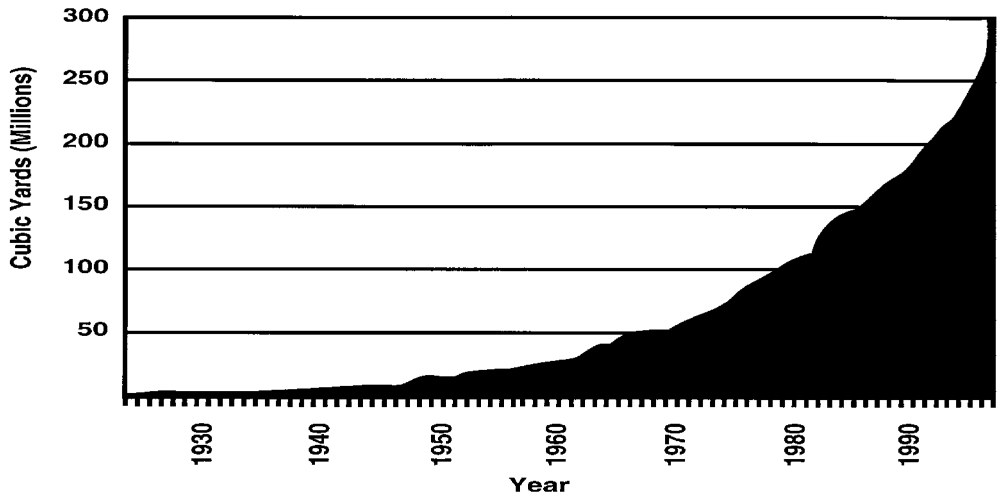

Figure 2: Florida east coast cumulative nourishment volume. (source: Program for the study of developed shorelines, Duke University, 1996)

	1992				1993				1994				1995				
PHYSICAL ATTRIBUTE	NS	*	**	***	NS	*	**	***	NS	*	**	***	NS	*	**	***	COMMENTS
Water content																	
30 cm	25	25	12	38		60	20	20	50		33	17			33	67	South beach is consitantly
60 cm	38	12	38	12	20	20	40	20	17	17	16	50	33	33	33		1-2% wetter
Penetration resistance																	
30 cm				100				100	17		50	33			33	67	South beach is consistantly
60 cm				100				100				100			33	67	harder by 200-300 psi
Mean-grain size																	
30 cm				100				100				100				100	South beach is consistantly
60 cm				100				100				100				100	finer by 0.3 mm
Temperature																	
30 cm				100		20		80				100			33	67	South beach is consistantly
60 cm				100		20		80				100	33			67	cooler by 1 deg. C
Carbonate content																	
30 cm	Data not available				Data not available						33	67			33	67	South beach consistantly
60 cm												100			33	67	contains 20% more carbonate

	1994			1995		
	North Beach	South Beach	Level of Significance	North Beach	South Beach	Level of significance
Number of nests inventoried	61	25	NT	22	14	NT
Mean Clutch Size	110	104	NT	113	108	NT
Hatching Success	0.78	0.62	NS	0.85	0.58	*
Emergence Success	0.77	0.61	NS	0.83	0.58	*
Addled Egg Mortality	0.10	0.18	NS	0.07	0.15	*

NT = statistical test not conducted. NS = Not significant. * = results were significant $p<0.05$.

Table 1: Statistical significance of comparisons (north vs. south beaches) ; results of long-term physical attributes monitoring program (1992-1995). The two beaches have been consistently different since monitoring was implemented in 1992. Note that there is no apparent deviation in the 1993 data, collected immediately following a beach nourishment project. Hence, we suspect the differences to be a consequence of inlet-related hydrodynamics.

Table 2: Summary of biological results indicating reproductive success was persistently higher on north beach. Additional data has been collected during the 1996 nesting season and it is anticipated that these new data will provide the basis for a more effective evaluation of the relationship between physical and biological data.

TURTLES, TEDS AND CONGRESS: IT'S NOT OVER YET

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On December 13, 1996, the National Marine Fisheries Service (NMFS) finalized modifications of the Turtle Excluder Device (TED) regulations for shrimp trawlers in southeastern U.S. waters. The regulations became effective March 1, 1997, in the so-called Shrimp Fishery/Sea Turtle Conservation Areas and prohibit the use of soft-TEDs, require hard TEDs in try nets greater than 12 feet of headrope, and require modifications to the installation of bottom-opening hard TEDs to ensure more efficient escape by sea turtles. Effective in December, 1997, TEDs will be required in try nets everywhere and soft-TEDs will be decertified for use everywhere, unless they can be shown to be effective at excluding turtles before then.

These rules did not come about casually, or quickly. In November, 1994, in response to huge increases in sea turtles strandings in the Southeast, particularly the Gulf of Mexico, NMFS concluded there likely were three contributory factors: 1) incorrect installation and improper use of TEDs; 2) certification of inefficient TEDs; and 3) intensive pulses of fishing effort (leading to multiple recaptures).

To address theses problems, NMFS proposed, among other things, to: 1) increase enforcement; 2) increase TED technology transfer; 3) identify areas requiring special sea turtle management; 4) examine certain TEDs and decertify inefficient TEDs; 5) propose a vessel registration system; and, 6) mitigate impacts of intensive nearshore shrimping effort. Over the subsequent 2 ½ years, NMFS has worked on a number of these areas, some with greater success than others. In particular, they have taken steps to address the first four items identified. However, they have yet to propose a vessel registration system or mitigate impacts of intensive nearshore shrimping effort.

The delay in addressing certain elements of their own plan has not been entirely a matter of obstinacy; the finalization of the regulations decertifying soft-TEDs was a difficult and painful process. NMFS staff were required to justify and rejustify the regulations time and again, and still were subject to threats regarding the agency's future funding from both the industry and Members of Congress and their staff. As a recent email posting on CTURTLE so eloquently put it, NMFS staff were caught between a dog and a hydrant.

During this process, CMC argued repeatedly that the sooner NMFS just bit the bullet and finalized the regulations the sooner the dust would settle and we could all get on with our other work. Nevertheless the agency chose time and again to try to satisfy the demands of the opposition. Even so, we waged a pitched battle over this issue for much of the fall. Ultimately, some 5200 people sent letters to the agency (and many to their Members of Congress) in support of the regulations, while only 400 opposed them. Thank you, they did make a difference, and we have the regulations. But, I do not envy the NMFS staff their position in this situation.

So, where does all of this leave us now? We cannot declare victory, wash our hands and go home. Instead we must be vigilant on several different fronts simultaneously. For example:

1. We must monitor enforcement and strandings diligently this year, to ascertain how much impact the soft-TED decertification and TEDs in try nets rule has on nearshore sea turtle mortality. This may require more than just counting dead turtles on beaches. Ironically, the fact is that, if sea turtle numbers begin to increase because turtles are surviving due to TEDs, eventually the number of dead sea turtles may rise, as there are more of them to interact with trawls and other mortality sources. We need to determine a way to distinguish between increased strandings due to increased mortality problems and increased strandings due to increased turtle populations. NMFS' Sea Turtle Expert Working Group, on which I serve, is investigating this issue currently.

2. We must also monitor the Federal Appropriations process to ensure NMFS gets the money necessary to implement enforcement and TED technology transfer as well as to monitor strandings, maintain observers on offshore vessels, and continue in-water monitoring for the status of sea turtle populations.
3. We must watch very closely as NMFS follows up on a promise made to the Louisiana Congressional delegation and language inserted into their FY97 Appropriations report from Congress. Next week, NMFS will begin working with industry representatives to try to identify ways in which soft-TEDs might be made more efficient at turtle exclusion, and therefor avoid de-certification. We need to ensure that, if any soft-TEDs are not de-certified, they are in fact 97% efficient at sea turtle exclusion, under normal working conditions.
4. We must work hard to obtain a strong, reauthorized Endangered Species Act. Wemust oppose amendments designed to either cripple the Act, which provides the underlying authority for the TED regulations, or give special exemptions to shrimp fishing interests. Several such amendments, including ones specific to TEDs, have been proposed in the past.
5. We must continue to urge NMFS to complete the actions it laid out in November of 1994, and proceed with a proposal to register all shrimp vessels, and to reduce intensive shrimp trawl fishing effort, at least at certain times and places.

To do all of this, CMC will need, and be counting on, your help. So keep watching for our Action Alerts and bulletins on CTURTLE, and keep sending those letters and phone calls. If you haven't already, sign up for our Ocean Action Network at our booth, or see me or David Dickson. CMC's sea turtle activists are some of the most dedicated ones we have.

THE EFFECTS OF CURRENT VELOCITY AND TEMPERATURE UPON SWIMMING IN JUVENILE GREEN TURTLES *CHELONIA MYDAS* L.

John Davenport

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The swimming of green turtles (*Chelonia mydas* L.) has attracted much study, most attention being paid to swimming by simultaneous beating of the forelimbs, though green turtles, like other cheloniid sea turtles, use other swimming modes at low speed. The study reported here was designed to investigate how the swimming mechanism of young green turtles was affected by current speed and by temperature. Twelve green turtles were sent as recent hatchings from the Lara Reserve, Cyprus to the School of Ocean Sciences, University of Wales, Bangor, where they were held in large seawater tanks of sea water (salinity 34o/oo, 25°C) and fed upon commercially-available floating trout pellets. They were studied about 1 month after arrival in the U.K. using an oceanographic flume (Fig. 1); at this time their body lengths (snout to tail) ranged from 105-122 mm and their weights from 33.5-70.5 g. After study the animals were returned to the Mediterranean. Turtles responded to increasing current velocities by swimming upstream for a greater proportion of the time. At temperatures of 21-25°C currents equivalent to 1-2 body lengths s^{-1} induced continuous upstream swimming. At low current velocity the turtles usually employed 'dogpaddle' (ipsilateral synchronized) swimming. At swimming speeds of 0.8-1.4 body lengths s^{-1} (Table 1) they switched to synchronized forelimb flapping, with stationary rear limbs. Maximum dogpaddle speed was about 40% of maximum speed using synchronized foreflippers; the latter mechanism is clearly capable of generating far more propulsive power. Superficially, since drag increases roughly with the square of the swimming speed, the data suggest that turtles develop around six times as much power when swimming with synchronized forelippers as when dogpaddling. However, the increase in maximum speed will not simply result from the greater propulsive efficiency of synchronized foreflipper flapping, but will involve a component of avoidance of the high-drag zone at and near the air-water interface. Maximum sustained swimming speeds at 25°C, 21°C and 15°C were 3.31, 2.96 and 2.09 body lengths s^{-1} respectively; the speed at 15°C was significantly lower than at the other two temperatures, and could not be sustained for more than 2-4 minutes before instability in pitch, roll and yaw prevented the animal from swimming upstream. A detailed analysis of the swimming mechanism at different temperatures (Table 2) demonstrated a significant degradation of coordination of swimming at 15°C, even though the lethal temperature of green turtles is well below 10°C. This suggests that young green turtles become helpless and incapable of swimming against currents at temperatures which do not pose an immediate threat to life.

ACKNOWLEDGMENTS

The author thanks Mr. A. Demetropoulos, Department of Fisheries, Cyprus for arranging the supply of hatchling turtles.

Table 1. Effect of temperature on speed at which young green turtles switch from 'dogpaddle' swimming to synchronized foreflipper flapping. ANOVA showed that temperature did not have a significant effect on transition speed (p=0.294).

Temperature (°C)	Mean transition swimming speed (body lengths s^{-1})	SD (n=3)
25	1.32	0.29
21	1.44	0.50
15	0.83	0.52

Table 2. Effect of temperature on foreflipper flap frequency, vertical amplitude of foreflipper movement and angle of body pitch in juvenile *Chelonia mydas* swimming at maximum sustained speed in a flume. ANOVA revealed significant temperature effects on foreflipper flap frequency (p=0.012), pitch angle (p=0.000) and vertical amplitude of foreflipper movement (p=0.000).

Temperature (°C)	Mean foreflipper flap frequency (limb cycles s^{-1})	SD (n=4)
25	1.47	0.33
21	1.32	0.21
15	1.05	0.20
	Mean foreflipper amplitude (mm)	SD (n=4)
25	64.3	11.9
21	72.3	6.9
15	73.5	6.5
	Pitch angle (°)	SD (n=4)
25	2.6	3.4
21	6.4	5.5
15	11.9	6.9

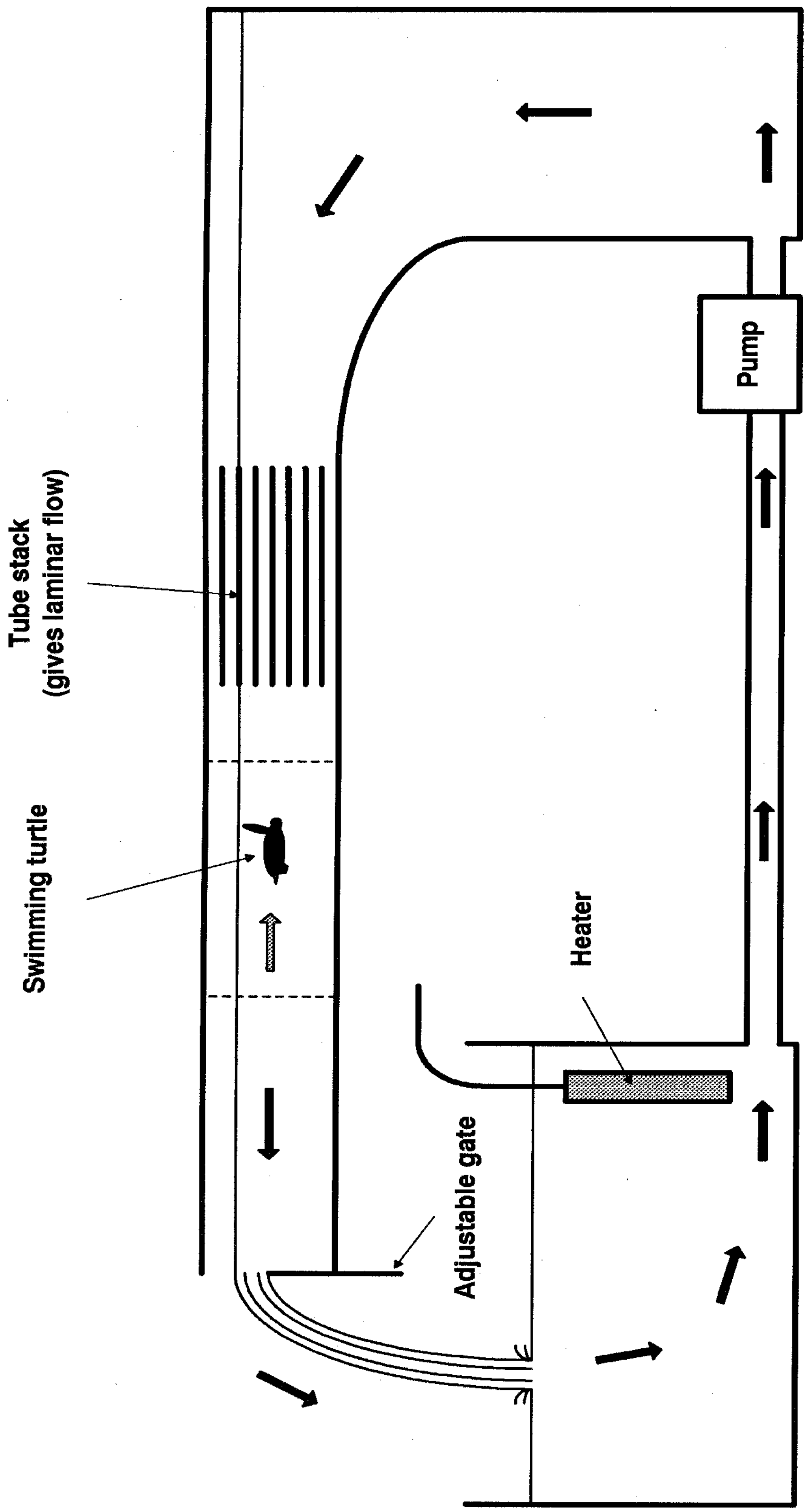
Tube stack
(gives laminar flow)
Swimming turtle
Pump
Heater
Adjustable gate

Fig. 1

et al. 1989), we believe they are more likely to be reported than untagged wild ridleys (see also Eckert et al. 1992). Regardless, our analyses suggest that both wild and head started Kemp's ridleys are vulnerable to capture by hook and line, and the impact of this type of capture may be underestimated by the available data bases,. It is possible that some live Kemp's rldleys released after capture by hook and line rnay suffer from ill effects of hooks lodged in the esophagus or stomach.

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SEA TURTLE NECROPSY AND HEALTH ASSESSMENT EXAMINATIONS: VALUABLE TOOLS FOR BIOLOGISTS, VETERINARIANS, AND MANAGERS

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While the scientific community has expanded our knowledge base of sea turtle biology, we still have much to learn about the physiology and pathology of these critically endangered animals, when compared to land-based species. While data are scarce in many areas of the United States, the Southeastern U.S. maintains an effective reporting system centered in the National Marine Fisheries Service's Miami laboratory. Since 1987, the percentage of carcasses examined versus the number reported has never risen above the 20% mark - though it has increased in recent years.

Table 1. The number of sea turtle carcasses examined has increased over the last decade (Teas, 1987-1993).

Year	Carcasses #examined/#reported	Percent
1987	233/2373	9.8%
1988	148/1991	7.4%
1989	126/2192	5.7%
1990	219/2515	8.7%
1991	172/1656	10.4%
1992	159/1742	9.1%
1993	232/1786	13.0%
1994	→ 1996-not yet published	

Thorough post mortem examinations provide important medical information to experienced veterinarians and pathologists concerning the health of the individual animal. However, the same data can be extremely useful to novice veterinarians, biologists, and managers. The clinical veterinarian on call to a stranding network is expected to provide emergency treatment for sea turtles with essentially no training from his/her veterinary school. After opening and examining a few turtles, however, the veterinarian gains knowledge and insight into a species previously foreign to them.

Biologists working with live turtles will benefit by learning more about the animals they work with on a daily basis. Basic anatomy and physiology are best understood when studied in the proper context such as a necropsy exam. Stranding network members gain a more meaningful understanding of the nuances of a particular species they find on the beach by performing thorough exams. A necropsy examination can reveal previously unknown significant information to the prosector - regardless of experience.

Information gleaned from necropsy exams can assist in managing natural resources by documenting causes contributing to death. If the carcass found on the beach is not opened and examined internally - we can only speculate as to the cause of death. A fisheries entangled animal may have become debilitated from disease which predisposed it to entanglement. Conversely "natural mortalities" are often assumed in the absence of obvious physical trauma or entanglements, however, with thorough examination and sampling, contaminants might be implicated as the cause of death. The dilemma of addressing fisheries management, regulation of industrial waste discharges in critical areas, and other concerns - such as habitat use-can be simplified when a cause of death can be determined.

Carcass sampling is easily accomplished and can yield a wealth of information to all concerned. Histopathology, microbiology, virology, and toxicology, etc., can contribute to forming a database of extremely valuable information for retrospective studies in the face of a mass mortality or die-off. Several manuals and texts exist to assist veterinarians, biologists, and managers in appropriate sample collection (Rainey, 1994; Wolke *et al*., 1981).

With live turtles, the use of health assessment criteria using a suite of indicators can provide insight into the causes of population decline and the impacts of environmental contaminants, thus providing valuable information for the evaluation of sea turtle status. Current research indicates that animals are negatively impacted by exposure to a wide variety of contaminants that have been and/or are being introduced into the environment. The sources of these contaminants include urban runoff, and industrial and agricultural pollution. The compounds in question range from persistent, bio-accumulated organochlorides (*e.g.*, DDT, PCBs) no longer used in the U.S., to short-lived but highly toxic pesticides and herbicides now in common use. Of the 10 U.S. estuarine drainage areas in terms of highest hazard to living marine resources based on both the quantities and toxicity of agricultural pesticide uses, most are in the Gulf of Mexico and middle Atlantic regions (Pait *et al*., 1992).

The high prevalence rate of these pesticides increases the potential for additive chronic toxicity of these pesticides to living marine resources in these areas, since many of these pesticides are known as Endocrine Disrupting Chemicals (EDC), with the potential to disrupt and alter development and reproduction. Recent animal studies, both *in vivo* and *in vivo* have demonstrated that many of these chemicals act as estrogen mimic in vertebrates and that combinations of low doses of pesticides exhibit additive estrogenic activity (Arnold *et al*., 1996; Sota *et al*., 1995). Therefore, EDCs may alter endocrine function particularly during sensitive stages of development. Transgenic effects may also occur which can be manifested for subsequent generations. In addition to reproductive dysfunction and endocrine changes, contaminants can cause immune dysfunction, neurotoxicity, altered metabolism, and many other problems.

Most of the toxicological tests are performed using bioassay organisms and representative species of these areas. However, the effects of these compounds cannot be directly assessed on protected and endangered species and there is a void of information in this area. The NMFS is currently conducting research to estimate and eventually monitor health assessment indices of local bottlenose dolphin stocks throughout the Southeast Region. The health assessment studies of bottlenose dolphins consists of conducting a live capture and sampling of bottlenose dolphins. An algorithm model based on selected chemistry and hematology parameters is being refined, and when used with other information should provide a means of estimating the effects of some indirect, human-induced impacts, such as environmental contaminants on dolphin stocks. Data from these studies have indicated significant correlations between contaminant levels and health parameters with the strongest association between total PCBs, DDE, nonachlor, and poor health scores.

Anthropogenic contaminants have been demonstrated to cause negative impacts on health and reproduction of aquatic animals. The use of health assessment techniques, such as those currently being used for bottlenose dolphins, has potential application in assessing the health of sea turtle populations. Similar to some marine mammals species, turtles are very long-lived, and contaminants accumulate in the tissues of these animals. Since long-lived species have low reproductive rates, the negative effects on reproductive rates, and thus population decline, would not be recognized for many years using conventional population assessment methods.

Information on sea turtle health and reproductive condition relative to indirect, anthropogenic impacts is necessary to accurately assess the current status of sea turtle populations. NMFS will conduct a workshop on sea turtle health assessment in 1997 and develop an integrated sea turtle health assessment National Research Plan. The objectives of the workshop will be to identify reliable indicators of health. To do this, we need to assess the advantages and disadvantages of current indicators, determine new indicators/biomarkers that may have potential application, and to validate these. Collection sites need to be identified from suitable existing field projects as well as selecting and characterizing new sampling and reference sites. A comprehensive, systematic approach and standardized protocols will help to provide assessment tools to develop health assessment indices and critical databases for both stranded and living sea turtles.

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GENETIC STOCK IDENTIFICATION OF SEA TURTLES CAUGHT IN THE HAWAII-BASED PELAGIC LONGLINE FISHERY

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Analysis of mitochondrial DNA (mtDNA) control region sequence variation for green turtles (*Chelonia mydas*) indicates that eastern, western, and central Pacific nesting populations are genetically distinct and suggests these regional nesting assemblages represent independent demographic units for management purposes. In contrast, regional leatherback *(Dermochelys coriacea*) rookeries are less differentiated, perhaps due to the pelagic nature of this species. Analysis of data from microsatellite loci and mtDNA sequences shows restricted gene flow between Indo-Pacific and eastern Pacific leatherback nesting stocks. Two major nesting populations in México and Costa Rica could not be distinguished based on mtDNA sequence data. To date, samples have been obtained from two leatherbacks caught in the Hawaii-based pelagic longline fishery. One had a haplotype only found in the Indonesian population, while the other had a haplotype only found in the eastern Pacific populations. Based on mtDNA sequences, 95% of the incidental take (n=24) of loggerheads (*Caretta caretta*) in the same longline fishery are of animals from Japanese nesting stock. Significant allele frequency differences at 2 microsatellite loci corroborated the mtDNA data, showing that the Japanese and Australian loggerhead rookeries are genetically isolated, and confirming that pelagic loggerheads in the north Pacific originate from the Japanese nesting stock. Mitochondrial DNA sequences from three green turtles caught in the longline fishery show that one is from local Hawaiian nesting stock (French Frigate Shoals), while two had a haplotype that has only been found in the eastern Pacific rookeries. The take of any eastern Pacific animals in the longline fishery is noteworthy, since the Hawaiian nesting population is considered Threatened, while the eastern Pacific populations are considered Endangered under the U.S. Endangered Species Act. Genetic stock assessment work is ongoing, with continued sampling of animals (including olive ridleys, *Lepidochelys olivacea*) caught in the longline fishery, and additional sampling of key nesting populations throughout the Pacific.

PERSPECTIVES ON THE USE OF SATELLITE TELEMETRY AND OTHER ELECTRONIC TECHNOLOGIES FOR THE STUDY OF MARINE TURTLES, WITH REFERENCE TO THE FIRST YEAR LONG TRACKING OF LEATHERBACK SEA TURTLES

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Improvements in electronic technologies have vastly increased the capacity of sea turtle biologists to "get off the beach" and study how and where sea turtles spend the other 99% of their lives. Devices such as Time-Depth-Recorders, Velocity-Distance Recorders, Heart-Rate Monitors, Temperature Loggers and increasingly sophisticated telemetry instruments have allowed the acquisition of detailed and highly accurate information on the behavior and physiology of marine turtles *in situ*.

VHF (Very High Frequency) transmitters are probably the oldest electronic technology that has been applied to marine turtles. A single transmitter can be attached to a turtle where it transmits a radio signal with a pre-programmed pulse rate and width at a specific frequency, so that it can be individually identified. A directional antennae can be used to determine the direction of the signal, which is usually logged as a compass bearing. After establishing at least 2 simultaneous bearings from different reception locations the approximate location of the turtle/transmitter can be determined using triangulation. Advantages of such a system are that it has relatively low cost, is simple to use, and has been available for so many years that the technology is well developed. Disadvantages are that it has only limited accuracy because most skilled technicians rarely have better than ±2° accuracy (which means that the transmitter location will lie within a polygonal area 6 kilometers on a side at 20 km distance), and that the turtle can only be detected upon surfacing.

SONIC TELEMETRY

Sonic telemetry is in many ways similar to VHF telemetry, except that a sonic signal is transmitted underwater, rather than sending radio waves through the air. Instead of a directional antennae, a directional hydrophone is used. Advantages of this technology is that it has been utilized for many years, so that it is quite reliable, and that the turtle can be tracked underwater. It is generally more expensive than VHF telemetry, but the cost is still quite reasonable. Furthermore sonic pingers can encode data, such as temperature or depth into the signal. The primary disadvantage of sonic telemetry is that range is very limited, and that it must almost always be conducted from a boat. Also, there is inherently more interfering noise underwater, so the receivers must have well designed filtration to prevent the signal being masked.

TIME-DEPTH RECORDERS

Time-Depth-Recorders (TDR's) are essentially electronic data loggers that sample pressure and translate that pressure to depth. The resulting data can then be integrated over time to determine dive depths, dive durations, ascent and descent rates. Other information such as time spent at depth and bottom time can also be calculated. The best developed of these instruments are microproccesor controlled, which allows reprogramming of the operation of the TDR for specific uses, such as increasing the sampling rate for higher resolution dive data, or controlling data acquisition periods. Since the instrument is basically a data logger, other sensors can be incorporated such as swim velocity or distance traveled and temperature. Cost of the instruments is moderate, depending on configuration. As electronic technology has improved, these instruments have become quite compact, weighing less than 100 gms. The biggest disadvantage of such recorders is that they must be recovered to obtain the data. Another significant issue associated with such recording devices is accuracy. It is critical to understand the accuracy of each instrument, so that it is utilized properly. In some cases this may mean that the investigator might be required to calibrate the instrument before deployment. For example, time depth recorders utilized pressure transducers with range dependent accuracy so that a 750 m range TDR will only have ±3 meter resolution and a 250 m range TDR will be accurate to ±1 meter. When analyzing TDR data such resolutions must be taken into account. Another example of where sensor accuracy is important is with velocity recorders. The "sensor" of this instrument is usually some form of paddle wheel. However, different paddle wheels will have different minimum startup or stall speeds that may be as high as 0.4 meters per second. For the leatherback which has a modal swim speed of about 0.6 m/s such a recorder would not be useful as the results will be biased to reflect only faster swimming by this species.

HEART RATE COUNTERS

Heart Rate Counters (HCR) are a special type of data logger and current designs are of two categories: analog recorders and digital counters. The analog recorder is essentially an ECG recorder that (in most cases) uses a magnetic tape to record the trace. Sampling rate is usually quite high (in excess of 60 samples per second) and has all the advantages and disadvantages of standard ECG traces including the inability to avoid interference from myogenic sources. Probably the largest problem with such a system is that most are only capable of recording for a few days and that the instruments are quite large. Digital counters attempt to count only the R wave portion of the ECG signal and integrate that count over time. The advantage of such a design is that they only store information on heart rate (not the entire ECG signal) and can thus be made in a very small package that is entirely electronic, and that it can record for many days. However, these instruments have great difficulty distinguishing interference signals from the R wave and are thus highly prone to giving spurious data, which often cannot be detected during analysis. In their current configuration (as counters), I can't recommend their use. However, as technology improves, digital ECG recorders (as opposed to counters) should become available that resolve many of the accuracy problems of the digital counters.

SATELLITE TRANSMITTERS AND SATELLITE LINKED DATA RECORDERS

The use of satellite telemetry provides another means to monitor the post-nesting movements and behavior of sea turtles and has been attempted by a number of researchers. Currently, ARGOS CLS provides the only earth-or biting satellite system daily global location for monitoring of transmitters attached to wildlife. This system consists of two TIROS-N satellites in low-Earth polar orbits with on-board radio receiver and transmitter units, a series of Earth based receiver stations and several Earth-based Global Processing Centers (GPCs). Each satellite makes one orbit in 101 minutes, crossing the equator at a fixed time each day. The ground-track covered during each pass is about 5,000 km wide and overlaps 2,100 km with the previous pass at the equator. The amount of overlap increases with latitude so that satellite coverage (from both satellites) at specific locations increases from 6 satellite overpasses per day at the equator to 28 passes per day at the poles. The satellite is within radio view of any point on the earth for about 10 minutes. All transmitters utilize the same frequency, 401.65 MHZ, with effective transmission power output between 1 and 1/4 watt. Repetition rate is limited by Argos to 40 seconds. Encoded in each transmission is an identification signal as well as sensor data from each transmitter.

In a recently completed study I deployed 3 prototype 1 watt satellite-linked-depth transmitters manufactured by Wildlife Computers on female leatherbacks turtles nesting at Matura Beach, Trinidad. Trinidad is located at the southern end of Caribbean Sea and supports one of the largest nesting colonies for the species in the world. Each transmitter was capable of 45,000 transmissions and has a built in Time-Depth-Recorder capable of monitoring dive depths and dive durations. Data is assembled every six hours into frequency distributions of dive depth, dive duration and time spent at depth. Four histograms (24h) for each variable are assembled and transmitted at each surfacing.

Two of the three transmitters functioned for an entire year after deployment with the third failing after a few weeks due to damage its sustained when the turtle was incidentally entangled in a gillnet. During that year, each of the two turtles swam a minimum of 11,000 km. Upon leaving Trinidad all 3 turtles left the Caribbean by swimming NE past Barbados and then diverging. Leatherback #20884 swam east and then north to the Bay of Biscay turning south at the end of November and arriving within 200 km of the coast of Mauritania by March. The turtle then turned back north with its transmitter batteries expiring as the turtle neared the Canary Islands. Leatherback #20886 swam up the center of the Atlantic Ocean to between 40 and 50 degrees latitude where it remained until the end of November. This turtle also then migrated directly to the African coast within a few hundred km of Mauritania.

Maximum dive depths for all three turtles were in excess of 750 m (the maximum depth capacity of the transmitter) and maximum dive duration in excess of 28 minutes. Most of the deep diving occurred just after leaving the Caribbean and while the turtles were still in the south Atlantic Ocean. Northern Atlantic behavior was generally categorized by typically shallower diving.

Results of this study represent the longest duration tracking of this species and the only study which monitored dive behavior of the species when they were far distant from the nesting area. It also demonstrates that the leatherback is a long distance migrant and that they may make annual southern migrations. Finally the results indicate that leatherbacks do not randomly wander the oceans, but rather have predetermined destinations and migratory patterns.

HABITAT PROTECTION REVISITED: DEBUNKING THE NOAH SOLUTION

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Speaking to a group of marine turtle conservationists and researchers about habitat protection is akin to "preaching to the converted." Virtually everyone attending this symposium is in agreement that, together with human overexploitation, habitat destruction is the major threat, not only to marine turtles, but to biological diversity as a whole. In searching for a title for this presentation I considered borrowing the phrase coined by James Carville during the 1992 presidential campaign ("It's the economy, stupid!") and modifying it slightly to become, "It's the habitat, stupid," but I discarded the idea in the interest of civility. Nevertheless, virtually all of us who work in wildlife conservation agree that the major threat to biological diversity is loss of habitat. While it is true that reptiles have been more vulnerable to overexploitation than any of the other vertebrate classes, it is also true that habitat loss is the primary threat to most of the vertebrate species currently facing extinction.

So why bring it up then; why "preach to the choir"; why reiterate something upon which we all agree? Because some things are so important that they bear repeating and because, perhaps, we have missed something. Perhaps we have failed to convey what we all perceive about the species-habitat relationship to our fellow man, the man-on-the-street, the typical voter.

To most of us the relationship between species and habitat goes deeper than just the dependence of a species upon biotic and abiotic environmental attributes. Although I've had some difficulty in finding the words to express this concept

I know that everyone who has worked with sea turtles in the field will understand the sentiment. It is simply the holism of the species-habitat relationship. It is the inseparability of species and habitat. It is the recognition that a species' predators, competitors, parasites and all of the other features of the natural community in which it lives are as fundamental to the essence of that species as are its heart and lungs and brain. It is the realization that to see a picture of a loggerhead or even to see a live loggerhead in an aquarium is to know that species poorly and incompletely. But to see, or envision, a crusty, barnacle-fouled loggerhead barging around in the shallow waters of, for example, lower Chesapeake Bay, scooping up mollusks, pulverizing them in those grist-mill jaws, swallowing shell, soft parts and all, then later passing the shell rubble, is to better understand what "loggerheadedness" is all about. To see, or envision, a green turtle cruising the grass flats of Florida Bay, snipping turtle grass and algae with those neatly serrate jaws, is to know the wholeness of that species better. To see, or envision, a hawksbill poking about a vertical reef wall at Mona Island, probing the crevices and crannies with that pointed beak, finding a morsel of sponge and ingesting it, glass spicules and all, affords insight to Eretmochelys character. To see, or envision, a Kemp's ridley searching the muddy waters of the northern Gulf of Mexico with those beady eyes, crunching crabs of all descriptions, is to appreciate the nature of the species more fully. To see, or envision, a leatherback in the North Atlantic would convey the same kind of understanding. I was given some better appreciation of the unity of beast and habitat by a paper presented 17 years ago at the American Society of Zoologists' annual meeting, in Tampa. David Owens organized a Symposium on the Behavioral and Reproductive Biology of Sea Turtles, in honor of Dr. Carr's 75th birthday. In one of the ancillary papers, James Lazell spoke of flying over the North Atlantic and seeing extraordinary, elongate "windrows" of jellyfish at the surface. Right in the middle of it all leatherbacks could be seen, surfacing with medusae hanging all over their heads, eyes and necks, gnashing and champing and swallowing as many as they could. Leatherbacks, being leatherbacks, in habitat. And so it is the essential unity of animal species and habitat that most of us know and understand. We feel it to our bones.

Be that as it may, it is my contention that we have failed to convey that concept to people outside of the inner circle: *i.e.*, the voting public, and that failure has impeded our efforts to preserve and protect habitat on many fronts. I have not taken a scientifically-based attitude survey but, as a long-time "observer of the scene," I base my contention on the interaction I have had with ordinary people in two subsets of the general population. I have led hundreds of "turtle watches" and spoken countless times to Lions and Kiwanis Clubs, home-owners associations, public school students and so on. The people that I've spoken with there reflect a broad cross-section of public opinion. Also, as a biology professor I speak about these issues with hundreds of young people who, I think, are representative of "the college student population."

A very common sentiment among all these groups, whether it is expressed as a question or in some other manner is: "Why can't we just take a pair, or several pairs, of individuals from species nearing extirpation, into zoological parks or aquaria, breed them there for generations and make the problem go away?" In other words, why not follow the biblical story of Noah and preserve our disappearing species in a figurative ark, 300 cubits by 50 cubits by 30 cubits? Not so long ago I had a conversation with a retired Protestant clergyman about the story of Noah. It led me to understand, as never before, how significant and fundamental is the story of Noah's solution to the problem of species endangerment in the thinking of many people who are otherwise not environmentally concerned. They may have some emotional or even religious concern for some of the charismatic megavertebrates, but the concept involves a complete disconnect of animal from habitat.

I want to digress briefly to give a zoologist's view of the reason that protecting marine turtle habitat is at least twice as difficult as for most other vertebrates. It is the great disparity between breeding (*i.e.*, nesting) and foraging habitats which, in turn, results from a kind of evolutionary "Catch 22" in which marine turtles find themselves. Among other improvements relative to the amphibian condition made by reptiles was the development of the amniote, or cleidoic, egg. These improvements allowed the reptiles to conquer the continental land masses; that is, to colonize the terrestrial habitats without returning to the water to breed, something their amphibian antecedents have never been able to do. The cleidoic egg had a protective but porous shell and four extra-embryonic membranes (amnion, chorion, yolk sac and allantois) which served as a life-support system for the embryo and it was designed to incubate on land, buried in the soil. Not long after turtles emerged from the pariesaurs, procolophonids or some other direct descendent of the first reptiles, some of them returned to the marine environment, becoming secondarily adapted to life in the water, especially in terms of locomotor adaptations. Now the cleidoic egg was something of a liability. Some of the other Mesozoic reptiles that went secondarily back to the marine environment became ovoviviparous, but the marine turtles never managed to adopt that reproductive mode. They need to return to the land to deposit that troublesome cleidoic egg, and that means that habitat protection is a dual problem for marine turtle conservationists. Clearly, we must protect the foraging habitats but, we must also protect the very disparate reproductive habitat, namely the nesting beaches. Let's take a look then, at "the good, the bad and the ugly of habitat protection in Florida.

The beaches of the 8-county area along the east coast of Florida are the best we have in the U.S. About 88% of the loggerhead nesting in the Western Hemisphere occurs there and about 99% of Florida green turtles nest there as well. Data compiled over the long-term show that nest production in South Brevard County has been at the highest level consistently for many years. But, as the nest production data began to accumulate in the 1980s, it also became clear that those beaches were under assault by development. As a result, the concept of a new National Wildlife Refuge, whose principal purpose was protection of nesting habitat, was born. Named for Dr. Carr, it was situated in south Brevard County (also partly in Indian River County), mostly on the basis of annual loggerhead and green turtle nest production totals. The refuge was authorized by Congress in 1990. In that same year loggerhead nest production rose by 52% above the previous average and has remained significantly higher since that time. Green turtle nest production has also risen dramatically, at least in even-numbered years, since about 1989. And that is "the good." We recognized the need to protect habitat, we took some bold action and, although the task is not yet complete, we're in a position to preserve some of the best nesting habitat that we have.

Now, "the bad." Until about three years ago we had reason to be confident that Florida government, with an expressed policy in opposition to armoring, was an ally in the effort to preserve the beaches. All of that fell by the wayside as the political climate of the nation and this state underwent a "sea change" in the 1990s. Last year the legislature passed and the governor signed, a bill that makes it easy, almost laughable, to get permits to build sea walls, rock groins, etc., even within the boundaries of the greater Carr Refuge area. The result has been the construction of an 800 ft steel bulkhead wall on the very doorstep of the Carr Refuge and the certainty that similar projects will follow, up and down the coastline. The Florida population is exploding (ca. 800/day) and tourism is setting new records each year (43 million visitors in 1996). Much of this extraordinary growth goes to the coast and it translates to a massive accumulation of population, wealth and political power at the very margin of the land. It is, to use the analogy of a mechanic's vice, one of the jaws of that vice that is squeezing the very life out of marine turtle nesting habitat.

The other jaw of the vice is Sea Level Rise (SLR). The UNEP/IOC Team on Implications of Climatic Change in the Wider Caribbean has predicted a possible regional rise in sea level of 10 cm by the year 2025. This implies an average shoreline recession of 10 meters! It is a bigger problem than most people think and it constitutes the "other jaw" of the vice putting pressure on sea turtle nesting habitat.

The jetties that are built to protect man-made ports and inlets constitute an exacerbating factor. The jetties interrupt the long-shore flow of sand, resulting in excessive erosion of beaches downdrift from the inlets. By one estimate, 787 miles of Florida coastline, including most of the good nesting beaches, is excessively eroded and 85% of that is due to the jetties at ports and inlets. So, with each increment in population and wealth along the coast, each mm of SLR, and in the absence of a solution to the erosion problem, the prospects for preservation of marine turtle nesting habitat deteriorate, and this is "the bad."

Turning now to foraging habitats, I'd like to use the Indian River Lagoon as a kind of "case study." The IRL is a 220 km brackish estuary stretching along the east coast of Florida. One hundred years ago it was characterized by clear water, white sandy bottom and extensive sea grass beds. It was about a century ago that we began to pollute it in a number of ways. Effluents from hundreds of waste water treatment plants and thousands of stormwater outfalls have contributed to the degradation of the system. Freshwater, diverted from the source marshes of the St. Johns River and carrying agricultural wastes, upsets the salinity regime and elevates coliform counts to unacceptable levels. Over 80,000 lbs. of pesticide enter the lagoon each year. The consequence has been the production of a highly degraded estuarine system.

The consequence for marine turtles brings me to "the ugly," green turtle fibropapillomatosis (GTFP). The IRL is a year-round foraging habitat for juvenile green turtles. Unfortunately, the prevalence of GTFP in that population has held at 40-60% since at least 1982. Studies of two other "populations" of green turtles occurring at essentially the same latitude on the Florida coast but in less degraded oceanic habitats (over near-shore reefs and at a Port Canaveral turn basin) have produced no evidence of the disease in more than four years and with the examination of more than 400 juvenile green turtles. The good news is that there are many programs now in place that are striving to improve the condition of the IRL, although it will take a lot of time and money to clean it up.

In summary, then, there seems to be genuine concern and action to improve the IRL (foraging habitat), but a reversal in the policies that we were counting on to protect the nesting beaches. The task of continuing to improve the lagoon and the fight to maintain the natural attributes of our beaches promise to occupy marine turtle conservationists and others for at least 30-40 years. These tasks will be more difficult because of an electorate that is largely ignorant of the species-habitat relationship and for whom the Noah solution is good enough.

POPULATION STRUCTURE OF LOGGERHEAD TURTLE (*CARETTA CARETTA*) NESTING COLONIES IN THE ATLANTIC AND MEDITERRANEAN AS INFERRED FROM MITOCHONDRIAL DNA CONTROL REGION SEQUENCES

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Mitochondrial (mt) DNA control region sequences were analyzed for 249 Atlantic and Mediterranean loggerhead turtles (*Caretta caretta*) to elucidate nesting population structure and phylogeographic patterns. A total of 10 heplotypes were resolved among individuals from 10 major loggerhead nesting areas in the region. Two distinct phylogenetic lineages were distinguished, separated by an average of 5.1 percent sequence divergence. Haplotype frequency comparisons between pairs of populations showed significant differentiation between regional nesting aggregates and revealed six demographically independent nesting populations, corresponding to nesting beaches from: (1) North Carolina, South Carolina, Georgia and northeast Florida, (2) southern Florida, (3) northwest Florida, (4) México, (5) Brazil, and (6) Greece. The re-defined relationships among nesting aggregations in the western Atlantic region (southeastern U.S. and adjacent México), prompts a reconsideration of management strategies for nesting populations and corresponding habitats in this region.

GENETIC IDENTITY OF GREEN TURTLES IN BERMUDA WATERS

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The green turtles present in Bermuda today occupy a single life history stage: “developmental habitat”. We have sequenced a ~490 bp segment of the mitochondrial control region (D-loop) of 50 randomly selected green turtles caught in Bermuda. All but three of the resulting sequences were confirmed by matches to published control region sequences from Atlantic nesting beaches. Haplotypes known from eight of the nine major Atlantic green turtle nesting populations were also found in Bermuda. Maximum likelihood analysis suggests that at least 4 of these rookeries contribute to the Bermuda feeding ground population.

This is Contribution #7, Bermuda Biodiversity Project (BBP), Bermuda Aquarium, Natural History Museum and Zoo.

BEACH DRIVING AND SEA TURTLES: WHAT KIND OF RISK?

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Throughout the world, traditional land uses often come into conflict with endangered species conservation. In this paper, we provide an overview of the process by which these conflicts are resolved in the United States and then assess how effective the resolution process worked in the case of sea turtles threatened by a rather unique recreational land use in Volusia County, Florida.

Volusia County is located on Florida’s east central coast just north of Cape Canaveral. It has a total shoreline of about 80 km, 30% of which is contained in state and federal public park lands. The County has responsibility for unified management of the remaining 57 km of beaches.

Beach users have been able to access Volusia County’s beaches by car since the early days of the automobile. The wide, flat, hard-packed sands of these beaches are ideal for off-road driving. This legal and traditional beach use has continued into recent times. During the six month period from April through September of 1996, an estimated 1.2 million private vehicles accessed the County’s beaches.

Volusia County beaches provide nesting habitat for at least four species of sea turtles. Each summer, between 250 and 500 nests are deposited on County-managed beaches. However, this represents only about 25% of all nests within the county, as the majority of nesting occurs in the public park lands at Canaveral National Seashore. As for most areas of Florida, the preponderance of nesting in Volusia County (99%) is by the threatened loggerhead sea turtle (*Caretta caretta*).

Clearly, the operation of a million vehicles in and around sea turtle nesting habitat has considerable potential for impacting the reproductive process. Potential impacts range from outright mortality resulting from collisions of cars with adult nesting and hatchling sea turtles to indirect impacts ranging from disturbances to the nesting process to alteration of the nesting habitat. Any impact whether direct or indirect is considered take under the U.S. Endangered Species Act of 1973, as amended (ESA).

The ESA specifically allows for balancing land use and protected species conservation conflicts. In 1982 Congress amended the Act, through addition of Section 10, to allow for incidental take by non-federal entities. Anyone can apply for an Incidental Take Permit (ITP) and the application must be processed in accordance with provisions of the ESA. The process to be followed during preparation of a permit specifically requires that social and economic interests be considered along with endangered species protection (USFWS, 1996). It is a process of compromise involving participation by all stakeholders.

In Volusia County, the beach driving issue was extremely polarized with some factions calling for unrestricted access and others calling for a complete ban on the practice. Assessments of economic impact associated with a ban or reduction in beach driving also varied widely. One of the principal impediments to an outright ban was the lack of adequate off-beach parking. In the absence of on-beach parking, the County could not assure it residents and visitors of reasonable beach access.

The ITP process has previously been used to resolve conflicts regarding species as diverse as butterflies, desert tortoises, and red-cockaded woodpeckers. However, it had never before been used to resolve land-use conflicts involving sea turtle nesting habitat. Although each permit application is unique, the same general process is followed. The permitting agency must issue a permit if the following issuance criteria are met:

1. The take occurs incidental to the conduct of otherwise legal activities (*i.e.*, it is unintentional),
2. The anticipated level of take will not jeopardize the continued existence or recovery of the species in the wild,
3. A Habitat Conservation Plan (HCP) is developed to specify measures that will be taken by the applicant to minimize and mitigate take to the maximum extent practicable,
4. The applicant has ensured adequate funding for the HCP.
5. The applicant has developed procedures for dealing with unforeseen circumstances (*i.e.*, unusual situations not considered during review of the permit application), and
6. The applicant agrees to comply with all conditions attached to the permit.

In November 1996, the U.S. Fish and Wildlife Service (USFWS) issued an Incidental Take Permit to Volusia County. The HCP developed in support of the County's permit application provides a framework for managing vehicular access to County Beaches in a manner and extent compatible with the protection of sea turtles.

In anticipation of issuance of an ITP, Volusia County voluntarily elected to perform a rehearsal of certain elements of the HCP during the 1996 sea turtle nesting season. This provided an opportunity to preview the effectiveness of the HCP in protecting sea turtles. The general philosophy used in the HCP for minimizing incidental take was to separate, to the greatest extent practicable, cars from sea turtles in both time and space. This was accomplished by restricting public vehicular access times, recognizing discrete beach management areas, and establishing a marked conservation zone.

The vast majority of sea turtle nesting and hatchling emergences occur at night. Until recently, cars were allowed to access the beaches well after dark, and the potential for take was appreciable. Under the HCP, the public is only allowed to access the beach by vehicles between 8:00 AM and 7:00 PM. This single management measure considerably reduced the risk to sea turtles.

Based on historical nesting data and traditional beach use patterns, three discrete Beach Management Areas (BMAs) were established under the HCP. Natural BMAs are those sections of beach where nest densities are relatively high, development is limited and beach use is not very intense. Public vehicular access is prohibited in these areas. Natural BMAs, together with public park lands account for about 2/3 of the County's coastline.

Urban BMAs are highly commercial areas where nest densities are very low and development and beach use patterns are intense. Transitional BMAs are intermediate to Urban and Natural BMAs. The public is permitted to access the beach by car in Urban and Transitional BMAs. The newly established BMA designations reduced the area accessible to vehicles by about 35% relative to pre-HCP driving conditions.

Within Urban and Transitional BMAs, sea turtle nests are further protected by routing traffic to those seaward sections of beach that are frequently overwashed by the tide. While this area of hard-packed sand is ideal for beach driving, it provides relatively poor nesting habitat. Separation of vehicles from areas of good quality nesting habitat was accomplished through the establishment of a marked conservation zone (CZ). The eastern boundary of the CZ is marked by 4X4 wooden posts placed at 50-foot intervals. All parking and driving is prohibited landward of this boundary. During 1996, the width of the CZ was 30 ft (9.1 m) throughout vehicular access areas.

During the 1996 nesting season, 385 of the 500 nests (77%) documented on County-managed beaches occurred in newly designated Natural BMAs where driving is now prohibited. Within the Urban and Transitional BMAs, 104 of the 115 nests (90%) occurred within the marked CZ. Thus, based on 1996 nest distributions, the combination of Natural BMAs and CZ would have kept 98% of all nests on County-managed beaches separated from vehicles. The potential for impacts to sea turtles was reduced even further, because many (about one-half) of those nests laid outside of the CZ had to be relocated because of threatening tidal inundation.

In addition to the protective measures described above, the HCP contains a number of other minimization and mitigation programs. An upgraded and standardized daily nesting survey of County-managed beaches has been implemented. This program performed by two independent volunteer organizations, Volusia Turtle Patrol and Volusia Sea Turtle Society, yields the type of data required to assess the effectiveness of the HCP. During the surveys, volunteer monitoring personnel conspicuously mark all nests. Thus, nests deposited outside of the CZ in Urban and Transitional BMAs are clearly identifiable to the driving public. Vehicle operators accessing the beach are provided with materials describing the HCP program. Furthermore, GPS readings are taken for each marked nest so lost barriers can be replaced in a timely manner.

The HCP requires mandatory training for all county employees and contractors that operate vehicles on the beach or have beach management responsibilities. The HCP also contains numerous provisions for the location, timing and management of special events, requires removal of ruts seaward of any nest due to hatch, and mandates a comprehensive public awareness program. Perhaps the most important mitigation measure contained in the HCP is a commitment from Volusia County to address beachfront lighting impacts.

The HCP is a dynamic document and requires on-going assessments and revisions, as needed, to address any identified deficiencies or otherwise improve its conservation value. The County is required to perform an annual review of HCP programs over the life of the 5-year ITP. Although not formally required, an annual review was performed for the 1996 nesting season. Some deficiencies were identified, but there were only a few reports of direct impacts, all involving hatchlings. A total of three individuals were involved in these incidents. There were also a few occasions when ruts caused problems for hatchlings trying to reach the ocean, but there were no indications of mortality. There were no reports of nests being run over by cars.

The ITP process in Volusia County was closely monitored by diverse interest groups. Although many continue to harbor strong feelings about the appropriateness of cars on the beach, when actual impacts are separated from potential impacts, much of the rhetoric that has surrounded this issue has proven to be unfounded. Based on data collected during 1996, it appears that the risk posed by beach driving in Volusia County (given the protective measures that are in place) is relatively minor, particularly in comparison to other beach issues such as lighting, armoring and coastal construction.

Nevertheless, Volusia County's HCP will be closely monitored by the USFWS and a variety of other stakeholders to ensure that it performs as envisioned. The ITP can be revoked at any time if permit conditions are not adhered to or if the HCP is shown to result in unacceptable levels of take. During recent years, the ESA has been under attack because of its perceived failure to consider social and economic interests. Demonstrative projects, such as the one in Volusia County, are needed to show that adequate protection for threatened and endangered species can be achieved through implementation of reasonable measures while maintaining social and economic values of the affected land.

Hopefully, the Volusia County HCP will prove to be one of the success stories in the application of the ESA to resolve land use and endangered species conservation conflicts.

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SOME EFFECTS OF INCUBATION ENVIRONMENT ON THE MORPHOLOGY AND PHYSIOLOGY OF LOGGERHEAD HATCHLINGS

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A study was conducted in the Ten Thousand Islands (Florida) to determine if incubation environment influenced characteristics of loggerhead hatchlings that might be important to survival. To detect the influence of the incubation environment, the characteristics of siblings from eggs incubated at different sites were compared. Because there are differences in the incubation environment within a clutch, the characteristics of hatchlings from eggs that were at various locations in clutches (top, middle, bottom; center or periphery) were also compared. There were differences in the levels of serum total protein and glucose after the swimming frenzy period and in the amount of swimming activity during the frenzy period that appeared to be attributable to incubation environment. Hatchlings that exhibited more swimming activity during the frenzy period also grew faster and were larger after ten days than those that were less active during the frenzy period.

EVALUATION OF PHYSICAL PARAMETERS AS INDICATORS OF NESTING BEACH SELECTION FOR THE LOGGERHEAD SEA TURTLE IN THE TEN THOUSAND ISLANDS OF FLORIDA

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Loggerhead sea turtles nest in numerous substrate and beach types within the Ten Thousand Islands of southwest Florida. Nesting beach selection was analyzed on 12 unique islands within this archipelago. Numerous physical characteristics were analyzed in an attempt to identify the interconnectedness or lack thereof of these variables and

determine their importance for nesting beach selection in *Caretta caretta*. These characteristics, collected along transects, include: overall slope, beach slope, slope of offshore approach, beach width and height of canopy. Sand samples from each transect were analyzed for pH, %H_2O, %organic content, %carbonate and particle size (8 size classes). Ordinal aspect of beaches and beach length also were analyzed. These variables were chosen after evaluating the islands, conducting literature searches and soliciting personal communications. All of the variables were analyzed at once, incorporating the nesting data into the analysis. In the Ten Thousand Islands, loggerheads appear to prefer wider beaches that inherently have less slope, and secondarily, wider beaches that have low amounts of carbonate.

THE GREEN TURTLE (*CHELONIA MYDAS*) IN CUBA

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INTRODUCTION

The green turtle is one of the turtles with highest occurrence in Cubans waters, traditionally representing 30-45% of the total catch of marine turtles. The aim of this work is to present the existing information in Cuba on this species based on research carried out by Cardona and de la Rua (1972); Blanco and Cardona (1983); Nodarse *et al*. (1986); Moncada *et al*. (1986, 1987, $1996_{a,b}$) and Moncada and Nodarse (1990), among others.

METHODS

The information used was based on sampling, fishery statistics, surveys, tagging and field observations carried out in the Cuban Archipelago, mainly from 1982 to 1996.

RESULTS AND DISCUSSION

Distribution

The green turtle is distributed throughout the Cuban shelf, from San Antonio Cape to Maisí Point, both in the north and south coast. According to the historical catches the areas of highest abundance are found in the northern coast, with about 50% of the total catch. Adults and subadults are mainly found in the shelf, the latter called 'jacos' by Cuban fishermen. Little animals and juveniles are also observed, although the information on these is scarce, reports on catches and incidental observations are found about some places, like in lagoons and area surrounding the Doce Leguas Keys (Rabihorcado, Palomo and Boca de Guano); Sabana-Camaguey Archipelago and Peninsula of Guanahacabibes, where specimens between 20 and 40 cm have been seen.

Reproduction and Spawning

The reproductive season of the green turtle in the Cuban shelf takes places from May to August, mainly, in June and July (Cardona and de la Rua, 1972; Moncada *et al*, 1986, 1987). The spawning beaches are mainly located in the south coast, both, to the south east and south-west, although some beaches are also reported in the north coast. In the south-eastern area the main beaches are along the south coast of Doce Leguas Keys (Jardines de la Reina Archipelago); in the south-west, at the Canarreos Archipelago; mainly in the Isla de la Juventud, Cayo Largo del Sur and San Felipe Keys. Other important beaches in the region are located at the peninsula of Guanahacabibes. In relation to the north coast, nestings are mainly located in the keys of Sabana-Camaguey Archipelago, although reports also include some coastal beaches of the isle.

Nesting data, compiled by Nodarse and Moncada (unpublished) in Playa Larga, south of the Isla de la Juventud, revealed a maximum of 177 nests, 5 km approximately. Protection activities carried out in this beach have allowed to protect from 1982 to 1994 a total of 850 nests with an average of 110 eggs per nest the same average number reported for this species in others areas. A total of 96,668 eggs have been collected with a hatching success of about 49% in almost all the years. Nesting intervals observed in Playa Larga are in general 7-14 d (9 and 11 the most common), with 7 spawnings as a maximum for a season. Nesting data in other beaches report 150-200 nests in Cayo Largo del Sur, each reproductive season (Avila, personal communication).

<u>Migrations</u>

Studies carried out by Moncada *et al*. (1995, 1996) (by means of the tagging technique and collected tags from other animals caught in Cuba and coming from other regions) indicate that there is a high exchange of different populations of green turtles in Cuba, since animals come in and out of the Cuban shelf. Of among 432 tagged specimens in Cuba, 15 have been recovered in Cuban waters and 15 in waters of Nicaragua, Panama, U.S.A. (Florida), Honduras and Costa Rica. Additionally, specimens in Cuba have been recovered from Costa Rica, Great Cayman, México, Bahamas, Virgin Islands and Venezuela (Aves Isle) which apparently enter the Cuban shelf for feeding and growing.

<u>Catch, Effort and Yield</u>

Up to 1994, the commercial catch was carried out throughout the Cuban shelf, with fluctuations resulting from different regulations and events affecting fisheries. From 1968 to 1975 the highest catches were reached, when there was not close season; there the average annual catch was 413 t. From 1976 a reproductive close season was established in June, July and August, although catches decreased, the average annual catch was 287 t from 1976 to 1987. In 1988, the close season was modified, being established per fishing zones in May, June and July; and in 1994 a complete close season was established, with the exception of two locations of traditional catch: Nuevitas and south of Isla de la Juventud. The average catch from 1988 to 1993 was 208 t, and from 1994 to 1996, 64 t.

Concerning the effort and yield in the green turtle fisheries, the effort in reference to the amount of fishing boats, progressively decreased between 1979 and 1996. However, the catch per unit of effort unit increased. Studies by Blanco y Cardona (1983), about the catch per unit of effort in separated periods found significant increases of this parameter. Analysis based on the numbers of fishing nets standardized) did not shown any variation practically.

<u>Composition per Size</u>

Samplings of commercial catches give an illustration of the size composition of population caught, as well as on the minimum, medium and maximum sizes in the 4 fishing grounds. Moncada and Nodarse (1990) found that the most frequent length class in the south-eastern and south-western area was 80-84 cm, in the north-western 90-94 cm, and 75-79 cm in the north-eastern area, the means being 82.0, 82.8, 82.1 and 87.0 respectively, without significant differences.

<u>Sex Ratio</u>

An analysis of the female-male ratio for the population caught (Moncada *et al*., 1987) indicated that sex ratio favored females all the year, males reaching their highest percentage in March and August, in the months close and included the reproductive season . The analysis of the behavior per fishing ground revealed that males had their highest values in April in the north-eastern area; in May for the north-eastern and south-eastern areas, and in June for the south-eastern. More recent studies up to 1994, indicated a similar behaviour in the sex ratio. These results could be explained because the wild population can be deviated to the females, since the birth, taking into account that the sex is determined by the incubation temperature.

<u>Sexual Maturity</u>

Surveys carried out from females with eggs, indicated that the sexual maturity in the green turtle occurs from 80 cm, although mature animals below that size have been also found. In relation to the nesting females, the smallest animal found measured 86 cm.

<u>Diseases</u>

Moncada and Prieto (1996) found an incidence of 0.59 % specimens, presenting fibropapiloma out 3,390 sampled green turtles in the period 1984-1994 in the following fishing grounds of the cuban shelf: Doce Leguas Keys (8), Las

Tunas (7), north of Pinar del Rio (3), Holguín (1) and Cayo Largo del Sur (1). Tumors were mainly in the neck, the fins and around the eyes, and 50% of the affected animals had sizes between 70 and 84 cm.

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ANATOMY OF A SUCCESSFUL SEA TURTLE CONSERVATION EDUCATION PROGRAM

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In 1993, the Caribbean Conservation Corporation (CCC) established the Sea Turtle Survival League program to begin directly engaging in issues affecting marine turtles in the United States. This permanent program complements CCC's ongoing research and conservation projects overseas and capitalizes on over three decades of experience in marine conservation and advocacy. The STSL's mission is to improve the survival outlook for sea turtles in the U.S., primarily in Florida, by reducing human-caused threats and preserving nesting beaches and critical marine habitats.

In keeping with the generally-accepted notion that education and public awareness are key to the protection and eventual recovery of sea turtles, last year the Sea Turtle Survival League tried something new by organizing and nationally promoting an education program directed at school children in the U.S. The idea was to use the satellite-tracking of sea turtles as a hook to get kids interested in learning more about the species and the various threats they face. The STSL also hoped to turn their interest into action--by encouraging students to write letters and speak out in defense of marine turtles.

The STSL decided the most efficient way to reach numerous students at once would be through a home page on the internet that teachers and students would utilize at school. An increasing number of schools, especially in the U.S., are getting access to the internet and using the World Wide Web as an educational tool. The Sea Turtle Migration-Tracking Education Program was created to capitalize on that trend. Once the STSL designed a graphics-oriented web page and filled it with virtually everything a kid might want to know about sea turtles and their conservation, the next step was to entice students and teachers to begin using the resource.

During a pilot project two years ago, the STSL recognized that many people, especially children, are fascinated by satellite telemetry. There is just something about being able to monitor the movements of an animal as it migrates to far off places that captivates people's imaginations. We were very fortunate that Barbara Schroeder (formerly with the Florida Marine Research Institute) and Dr. Llew Ehrhart (University of Central Florida) were willing to let the STSL use data from their ongoing telemetry research to plot the movements of the four turtles on digital maps that could be accessed by anyone visiting the STSL's web page. Since 1994, Schroeder and Dr. Ehrhart have been tracking the migration of green turtles after they nest in the Archie Carr Refuge on Florida's central east coast.

To generate public awareness about the new education program, the STSL turned the release of one of the study turtles into a publicity event that generated news coverage all over the country. A number of TV stations in Florida covered the event and national media, including CNN, ran the story for days afterwards. The League also convinced Florida's Commissioner of Education, Frank Brogan, to come to the turtle's release and promote the education program. The Commissioner had been very supportive of using the internet as an educational tool and agreed to link the State's education resource home page to the STSL home page. All of the media coverage helped the STSL to reach the desired audience with news about the program.

Shortly after the well-publicized release of the turtle, the STSL was contacted by the Turner Network and asked to discuss the program on a series of live educational shows, which were broadcast directly into participating schools. Through these shows alone, the STSL was able to reach approximately 250,000 teachers and students with information about sea turtles and threats to their survival. This exposure also attracted numerous teachers and students to the STSL home page, where they could "watch" the migrating turtles and learn even more about the species.

When people first link to the STSL home page, they are given a menu of items to choose from. They can link to a section with background information on sea turtle biology and life history; they can access a biography on Archie Carr; they can learn all about the Archie Carr National Wildlife Refuge; or they can go directly to the section covering satellite telemetry. It is here that maps are available showing the updated movements of each of the four turtles being tracked. The STSL web address is www.cccturtle.org.

The web site also allowed teachers to submit a form requesting a free 40-page Educator's Guide. The Guide gave instructions on how best to incorporate the program into the classroom and included student handouts and ideas for classroom activities. The Guide also included timely suggestions on how students could help sea turtles by making their voices heard on current issues.

After about six months of promoting the program, well over 1,000 teachers were participating. This translates into approximately 70,000 students reached. Many classes began letter writing campaigns on timely sea turtle issues. Two issues that students seemed particularly concerned about were the impacts of shrimping on turtles and the loss of habitat in the Archie Carr Refuge.

Before the program began, the STSL anticipated that students would have lots of questions regarding sea turtles or satellite telemetry. To handle these questions, an interactive bulletin board was created on the web page. It was here that students could post their questions. Either Barbara Schroeder or staff with the STSL would post the answers. Hundreds of questions were eventually received and answered.

In conclusion, the STSL's Sea Turtle Migration-Tracking Education Program helped many children learn about marine turtles. People's fascination with satellite telemetry, combined with the ability of the internet to instantly deliver information to the classroom, helped make this program very successful. The STSL plans to conduct the program again and invites the participation of other researchers who may be conducting satellite telemetry studies.

ACKNOWLEDGMENTS

The STSL would like to acknowledge the following financial supporters of the education program: The Educational Foundation of America, the Geraldine R. Dodge Foundation and Snapper, Inc. We also want to thank Barbara Schroeder and Dr. Llew Ehrhart for allowing their data to be used in the program. And we thank Andrea Mosier (FL Marine Research Institute) for generating the maps depicting the turtles' movements.

CONCENTRATIONS OF CHLOROBIPHENYLS AND ORGANOCHLORINE PESTICIDES IN MARINE TURTLES FROM THE MEDITERRANEAN AND EUROPEAN ATLANTIC WATERS

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Levels of chlorobiphenyls and organochlorine pesticides in marine turtles from the Mediterranean and European Atlantic waters are described. Samples were obtained from *Chelonia mydas*, *Caretta caretta*, and *Dermochelys coriacea* stranded on the coasts of Scotland, Cyprus, and Greece between 1994 and 1996. Descriptive data and preliminary inter- and intraspecific comparisons are presented. These are the first published data on burdens of organic contaminants in Mediterranean marine turtles, showing levels to be within detectable limits, but generally low. Levels in *D. coriacea* are surprisingly lower than the herbivorous *C. mydas*. Ecological comment with regard to diet separation is made.

THE TROPHIC STATUS OF MEDITERRANEAN MARINE TURTLES DETERMINED USING STABLE ISOTOPE ANALYSIS

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The Mediterranean populations of *Chelonia mydas* and *Caretta caretta* are largely isolated and detailed knowledge of their biology beyond nesting ecology is lacking. Animals found dead provide the only realistic opportunity to gather dietary data. However, this only gives proximate indications and relies on items being present and identifiable at the point of discovery. Stable isotope analysis of assimilated proteins overcomes these problems since it provides a measure of trophic status and diet over an extended period. This preliminary study employed stable isotope analysis ($d^{15}N$ and $d^{13}C$) of bone collagen and egg protein to investigate trophic status, clearly demonstrating interspecific trophic and dietary differences. This is the first time this technique has been used in the study of marine turtle feeding biology. This approach has shown clear potential as an analytical tool and the authors would be interested in corresponding with possible collaborators in order to investigate the trophic status of additional species and populations.

THE BERMUDA TURTLE PROJECT: STUDIES OF IMMATURE GREEN TURTLES AT AN OCEANIC FEEDING GROUND, 1968-1997

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Green turtles (*Chelonia mydas*) are the predominant species in the waters of this isolated island group. Although Bermuda adopted the Western world's first marine turtle conservation legislation in 1620, the nesting population that occurred there in the 1600's was extirpated -- apparently during exploration of the New World. All of the 1549 green turtles captured in nets since 1968 as part of the project have been immature, as have all 39 green turtles that have stranded on Bermuda shores since 1990. Research includes studies of population structure, genetic identity, habitat use, growth rates, and migrations. This project is also an important vehicle for educating the general public including the 150,000 annual visitors to the Bermuda Aquarium and the 75 - 150 volunteers that assist with the project each year.

BASKING IN GALAPAGOS GREEN TURTLES

Derek Green

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Basking in Galápagos green turtles (*Chelonia mydas*) was first recorded during the days of the buccaneers. These British buccaneers would take refuge in the islands after relieving Spain of some of its gold along the Pacific coast of South America. The earliest record is June 1684 and was made by both William Dampier (1699) and William Ambrose Cowley (Slevin, 1959), two pirates who were on the same expedition. Basking has been reported by many visitors since then, including other buccaneers, whalers, fur sealers and early naturalists. While not as common as in those early days of the buccaneers, basking in green turtles still occurs in the archipelago.

Basking takes place on many of the Galápagos nesting beaches. These include the islands of Isabela, Baltra, Santa Cruz, Santiago, Española, and Floreana. Basking also takes place on beaches on islands where nesting is not known to occur, such as Fernandina Island. Turtles basking on the beaches were sometimes as far as 50 meters from the water's edge, although usually much closer and often soundly asleep. They also gave the appearance of being exhausted: when approached they would open their eyes but would make little or no effort to return to the sea. The most turtles that I saw basking at one time was eight (all females) on a beach adjacent to Turtle Cove on northern Santa Cruz; six more females were resting in the shallow water of the tide wash. Usually the turtles basking on the beaches were females, although I did observe one male basking on a beach at Punta Espinoza on Fernandina Island and Bob Tindle (pers. comm.) encountered four males on the beach at Quinta Playa on Isabela Island. Snell and Fritts (1983) reported that four of 43 turtles they observed basking on Galápagos beaches were males. Captain Woodes Rogers, who visited the archipelago in May 1709, saw males as well as females on the beaches (Kerr and Eldin, 1824) and Dampier (1699) infers the presence of both sexes.

Basking, however, is much more common in the lagoons, especially around Isabela Island. I commonly saw females and subadults, and occasionally males and juveniles, basking on rocks, on mudbanks, among mangrove stilt roots and other border vegetation, against the trunks of fallen trees, at the edge of the lagoon touching bottom in shallow water, or at the surface. In most cases, the exposed portion of the carapace was completely dry. As on the beaches, the turtles often seemed to be asleep, certainly immobile and even when lightly bumped by the boat or captured took some time to become aware of what was happening. The floating turtles rested with their flippers either spread (as in pre-copulatory behaviour) or tucked alongside the edges of the carapace. At Punta Moreno A Lagoon (Elizabeth Bay, Isabela Island) on 13 October 1975, I counted at least 30 turtles basking at the surface in this manner and several more were caught up in mangroves at the edges of the lagoon. Basking usually started around mid-morning and continued until late afternoon, although I sometimes observed turtles sunning themselves as early as 0700 hrs. Turtles bask year-round.

The question arises as to whether these basking turtles crawled out of the water onto the land or were simply left there by a receding tide. In the lagoons, the latter is probably the case because I have often seen semi-comatose floating turtles drift toward the lagoon edge where they became caught on a rock or fallen trunk or amongst vegetation and were subsequently left high and dry. On only one occasion did I witness a lagoon turtle (a female) crawl out onto land and that was to cross three meters of rock in order to change from one tide pool to another, possibly as a result of being disturbed. On the beaches, too, most of the turtles beach passively. However, evidence from the position of the tracks in relation to the state of the tide indicated that at least some of the turtles actively hauled out. This was particularly evident on the beaches adjacent to Turtle Cove, an important area for copulation, where females at the water's edge made little attempt to follow the ebbing tide and so become marooned. Snell and Fritts (1983) reported that all but 4 (two males and two females) of 43 basking Galápagos turtles stranded passively.

Basking appears to serve several functions. According to Bustard (1972), the basking turtles on Bountiful Island in the Gulf of Carpentaria, Australia, are all females and thus he suggests that basking is a way of avoiding the unwanted attentions of the courting males since males can not mount females unless they are in at least 60 cm of water. Such beaching to avoid males has also been reported for Australian green turtles by Booth and Peters (1972), for green turtles at Tromelin Island in the Indian Ocean (Hughes, 1974), and for Ascension Island green turtles in the Atlantic Ocean (Mortimer, 1981). While passive stranding of green turtles in Australian waters (Rocky Island, Gulf of Carpentaria) was also reported by Garnett *et al*. (1985), the authors concluded that such strandings were not to avoid the unwanted attentions of males, but the optimization of energy use (cf Bustard (1972) for the same area -- Gulf of Carpenteria). Avoidance of males seems to be the case for many of the females basking today on the Galápagos beaches. The presence of the occasional male on the beaches may have been accidental or even the result of overzealousness; perhaps they were too exhausted or not inclined to move back into the water after having followed the females too closely inshore. One factor possibly contributing to the apparent exhaustion shown by the females has little to do with the presence or absence of males. Many of them (and males, too, for that matter) undertake journeys of 2,000 km or more from the mainland of South America to nest in Galápagos (Green, 1984).

Because many subadults as well as females bask in the lagoons in Galápagos, avoidance of males can not be the main reason in these areas. The lagoons bordering Elizabeth Bay on western Isabela where most of the basking was observed are used primarily as resting areas (Green, in press). While some feeding takes place in these lagoons, much of the feeding occurs in the main bay and turtles leave periodically to feed. The lagoons are usually well protected by mangroves so that the waters are calm and with little current. Large sharks such as hammerheads (*Sphyrna* spp.) and the tiger shark (*Galeocerdo cuvier*) that occur in Galápagos waters are absent from these lagoons. Apart from basking at the surface, the turtles also spend much of their time resting on the bottom. Surface basking would allow turtles to breathe without periodically having to swim to the surface to do so. Thus conservation of energy could be a major function in the Galápagos lagoon baskers. Garnett *et al*. (1985) came to a similar conclusion for their Australian turtles.

In the Hawaiian Archipelago, males and immatures as well as females bask on both the beaches and rocky shores throughout the year (Balazs, 1980). While more common in the daytime, basking in Hawaii also occurs at night and Balazs suggests that basking, especially at night, may be a possible adaptation to predation by tiger sharks, particularly since these sharks are principally nocturnal predators. However, he concedes that nocturnal basking could also be the result of a scarcity of underwater resting sites; nevertheless, basking would certainly reduce exposure to predation. Most of the basking occurring at Rocky Island, Australia was during the night (Garnett *et al*., 1985). I have not observed nor do I know of any reports of nocturnal basking in Galápagos green turtles.

Another function of basking is thermoregulation. Hughes (1974) believes that the basking behaviour of green turtles in calm seas off Europa Island in the Indian Ocean may be a warming process after turtles have spent an hour or so sleeping on the bottom. During basking, the body temperature increases in both land baskers and in floating turtles. Balazs (1980) found a maximum cloacal-sea temperature difference of 5°C in land-basking Hawaiian Chelonia and Sapsford and Van der Riet (1979) recorded an increase of 3.3°C in two hours for a 42-kg loggerhead floating at the surface of a large open-air tank. Such an increase in body temperature may serve to aid digestion. Thermoregulation as a function is also likely with Galápagos green turtles, since some of them were observed basking in the lagoons as early as 0700 hrs.

Contrary to earlier conclusions, basking is not restricted to green turtles. Hughes and Richard (1974) observed groups of olive ridleys (*Lepidochelys olivacea*) basking at sea on calm days off Nancite, Pacific Costa Rica. Basking at sea has also been reported for the loggerhead in Madeira and the Canary Islands (Thomas Dellinger, pers. comm.). It is noteworthy that apart from the avoidance behaviour of female green turtles on Ascension Island (Mortimer, 1981) there are no accounts in the literature of basking in Atlantic green turtles.

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STRESS, SEX, AND STEROIDS IN KEMP'S RIDLEY TURTLES (*LEPIDOCHELYS KEMPII*)

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Plasma corticosterone, glucose, and testosterone concentrations were measured in wild, subadult Kemp's ridley turtles (*Lepidochelys kempii*) captured by tangle net near the Cedar Keys, Florida. Initial blood samples were collected immediately after capture and additional samples were collected 30 and 60 minutes after the initial sample. Plasma corticosterone and testosterone concentrations were determined by radioimmunoassays. Plasma glucose concentrations were determined by an enzymatic-colorimetric assay. A significant increase was observed in mean plasma corticosterone concentrations over time indicating that the hypothalamus-pituitary-adrenal axis of subadult Kemp's

ridley turtles is sensitive to capture stress. A significant increase was also observed in mean plasma glucose concentrations indicating a hyperglycemic response to capture stress. Mean plasma testosterone concentrations were not significantly different over time and the response after 60 minutes of captivity was extremely variable. Turtles were sexed using initial testosterone concentrations and the criteria from Coyne and Landry (in press). Fifty-nine percent of turtles were classified as female, 33 % as male, and 8% as indeterminant. Recommendations were given for the analyses of other types of steroids to differentiate sex in marine turtles.

ACKNOWLEDGMENTS

We would like to thank Wayne Witzell and the National Marine Fisheries Service Miami Laboratory for their financial support. The following individuals are acknowledged for their generous contributions to this study: Timothy Gross, Alan Bolten, Karen Bjorndal, David Owens, Rhonda Patterson, and Michael Coyne.

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HELMINTHS IN GREEN TURTLES (*CHELONIA MYDAS*) FROM FLORIDA

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Fifty six freshly dead turtles were salvaged from 1992 to 1996 from coastal Florida and examined for helminths at the University of Florida. All internal organs were dissected and examined for helminths using standard procedures and fecal flotations and sedimentations were performed. Prevalence and intensity of infection data will be discussed for the more commonly occurring 30 species of digenetic flukes recovered. The seven most commonly detected species were: Angiodictyum parallelum, Cricocephalus albus, Deuterobaris proteus, Neoctangium travassoi, Octangium sagitta, Pronocephalus obliquus and Schizamphistomoides spinulosus. Prevalence ranges from 2% to 52% for species of fluke. The highest intensity was 1960 flukes in a single turtle. The highest number of different fluke species in a turtle was 16. The occurrence of a larval trypanorhynch tapeworm will also be mentioned.

POTENTIAL BIOLOGICAL REMOVAL: A CONSERVATIVE WAY TO SET BYCATCH LIMITS FOR MARINE MAMMALS, BUT WHAT ABOUT SEA TURTLES?

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Marine mammalogists have struggled to set bycatch limits using models that seemed biologically realistic, but could not be parameterized because of limited survival and growth data. Recently, an equation was developed to calculate a "safe" number of animals that can be removed without significantly increasing probability of extinction or slowing population recovery. The simple and flexible equation, termed Potential Biological Removal (PBR), is based on a minimum estimate of population size (N_{min}), the population's maximum growth rate (R_{max}), and a threatened/ endangered recovery factor (Fr): $PBR = N_{min} \times (R_{max})/2 \times Fr$. To adopt PBR into sea turtle management, we will need to consider life stage- and area-specific population estimates. With modification, this kind of approach may be very useful to biologists and managers.

BUOYANCY PROBLEMS IN SEA TURTLES: CAUSES AND DIAGNOSIS

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Buoyancy problems in captive and free-ranging sea turtles are common and are seen as either difficulties in diving or floating at an angle to the surface. Buoyancy problems can result from infectious diseases and noninfectious diseases such as trauma and congenital defects in organ development. Viral, bacterial, fungal and parasitic infections may result in respiratory tract disease and may be manifested as buoyancy problems. Gas collecting in the gastrointestinal tract may result in the turtle floating with the affected side up. Trauma to the lung and/or penetrating wounds such as from boat injuries may result in pneumocoelom. Blunt trauma to the caudal carapace from boat injuries, often result in cord transection and floatation problems. Diagnostic techniques for determining causes of buoyancy problems in sea turtle include conventional radiographic imaging, magnetic resonance imaging and CAT scans, and endoscopy/bronchoscopy.

THE TURTLE CONSERVATION PROJECT (TCP) ENVIRONMENTAL EDUCATION PROGRAMME: A PARTICIPATORY APPROACH TO MARINE TURTLE CONSERVATION EDUCATION IN SRI LANKA

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In 1995 the TCP established a national school turtle conservation workshop and beach survey programme, a participatory community environmental education programme at the TCP field site in Rekawa, Southern Sri Lanka and a tourist education programme aimed at reducing the market for tortoiseshell items. This paper discusses the participatory process of developing these programmes and suggests certain recommendations applicable to future programmes in the SAARC region.

FROM GREEN TO BLACK AND BACK: TAXONOMIC DISTINCTIVENESS OF THE BLACK TURTLE, *CHELONIA AGASSIZII*

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The taxonomic distinctiveness of the Black turtle (*Chelonia agassizii*) has been debated and revised several times over the past 10 years. In gross, external morphology (predominantly color), the black turtle is much darker and smaller than the typical green turtle. What role environmental conditions play in the formation of the black turtle is unknown. Osteological studies have indicated that the black turtle, although somewhat specialized, is not markedly different from green turtles. Mitochondrial DNA sequence variation can clearly distinguishing green turtle populations into major ocean basins and sometime specific nesting rookeries. According to this data, however, the genetic distance between the Atlantic and Pacific green turtle is greater than that observed between the black and the pacific green turtle. Furthermore, black turtles fail to assort as a single taxonomic assemblage, but instead are paraphyletic with respect to other green turtles. Analyses of three single-copy nuclear DNA loci confirm the mtDNA data and do not support taxonomic distinctiveness of the black turtle. In questions of conservation, however, taxonomic distinctiveness needs to be considered within a larger rubric of economic, political and social concerns. It is important to remember that the absolute (if not taxonomic) distinctiveness of the East Pacific populations has been demonstrated in terms of biogeographic isolation, skull morphology, and population-level genetic partitions (mtDNA and nDNA genotype frequency shifts), and this should be sufficient to warrant conservation efforts. In these situations, I propose the application of a Geopolitical Species Concept (GSC) to designate the limits of significant conservation units. Geopolitical species are groups of individuals associated with specific geographic or politically defined areas and are independent of considerations of evolutionary, genetic and breeding relationships with other such groups. The GSC recognizes political or geographic boundaries that serve as surrogates to true biological or evolutionary processes limiting dispersal. Species and subsequent management units can be defined by abiotic factors that are assumed to reflect true biological entities.

FACTORS AFFECTING NESTING BEACH SELECTION BY SEA TURTLES: A MULTIVARIATE APPROACH

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A number of studies have hitherto been made to elucidate factors affecting the nesting beach selection by sea turtles. In those previous studies, each factor has been analyzed separately by univariate methods. The nesting beach is likely to be selected under the influence of complicated interactions of various factors. We thus employed a multivariate method to progress the analyses.

MATERIALS AND METHODS

During nesting seasons in 1994-96, we surveyed for body pits and other emergence traces of sea turtles on 101 beaches in Okinawajima and adjacent islands. Correlations between relative density of body pits (as a measure of nesting frequency) and various beach characters were examined using a multiple regression analysis.

RESULTS AND DISCUSSION

Results of the preliminary observations of hatchlings strongly suggest that most of the nesting traces analyzed in this study were made by the loggerheads. Our analysis has selected the sand softness, distance from the nearest human settlement, presence of lagoon, and beach height as positive, and beach length as a negative factors that influence the nesting beach selection of females. Of these, the sand softness, which has been quantified for the first time in this study, seems to be the most important factor.

RESULTS OF MARINE TURTLE RESEARCH AND CONSERVATION PROGRAM IN CROATIA

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Three species of marine turtles were recorded for Croatian fauna: loggerhead turtle *(Caretta caretta*) as the most common species, green turtle (*Chelonia mydas*) which last records are dated from the 19th century, and leathery turtle (*Dermochelys coriacea*), an occasional visitor in Croatian waters.

Until 1993 when Adriatic Marine Turtle Program was started in Croatia, there were no other information on marine turtles status, except for a few items of sporadic data in the literature relating to a few records of individual specimens. Furthermore, all three species were without basic legal protection by the State.

In preliminary research, data on 1,286 specimens based on literature information, questionnaires, and field observations were gathered . Incidental catch of at least 2,500 specimens throughout the year were estimated.

Analysis of incidental catch was carried out on 96 specimens, 94 of which were captured in fishermens' nets, mostly by trawlers (66 ex., or 70.2%). Turtles were generally found in deepness of 20 to 50 m (62 specimens) on muddy or sandy sea bottom. Sixty seven specimens (71.3%) were caught during the "winter period" (between November and May), 62 of which by bottom trawling. Although the activity of animals in that period is still unknown, such high percentage of incidental catch of marine turtles during the winter by bottom trawlers indicate the possibility of existence of overwintering areas in some appropriate parts of Adriatic Sea. Thanks to research and public awareness activities of Program, marine turtles are under the legal protection in Croatia from July 12th 1995.

DEFINITION OF "ADULT" FOR MARINE TURTLE GROWTH MODELS

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There has been considerable discussion over many years of what is the size at which a marine turtle reaches sexual maturity. Conclusions in relation to this issue are regularly applied in growth models. This study examines size of sexually mature turtles in wild populations of several species of cheloniid turtles at multiple feeding sites in eastern Australia. Maturity is defined from gonad examination and observed breeding activity during breeding migrations from these sites.

Long term growth records of adult turtles originally tagged when immature display a common growth pattern: individual turtles rarely commence breeding at the minimum breeding size; some turtles commence to breed at sizes much larger than the average breeding size; growth slows with approaching maturity; growth continues at a slow and decreasing rate after first breeding. Size alone is an inadequate descriptor of maturity in marine turtles. A maturity function describing the proportion of adult turtles throughout the size range of a population has been developed for each species and feeding study site. These are presented as the most appropriate data for growth models for determining the size at which breeding commences.

CENSUS DATA: EARLY WARNING SIGNALS OF A POPULATION CHANGE

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Annual census counts of nesting females (or of their clutches or eggs) are increasingly available for many marine turtle populations. Such counts remain the most appropriate measure of the size of the breeding population within the total genetic stock throughout its dispersed feeding range. However, given the delayed maturity, longevity of the turtles and variable nature of all demographic parameters, it is extremely difficult to distinguish between long term natural fluctuations in a population and population declines resulting from anthropogenic impacts. This can apply even when decades of census data are available.

A number of demographic parameters that vary between first time breeding females and females with a long breeding history are examined for turtle nesting populations in eastern Australia to provide guidance in recognizing changes in the structure of the nesting population. In particular, analysis of time series data for size of nesting females, remigration interval and recruitment rate to the breeding female component of the population may provide indications of population change before the change is detectable in typical census data.

DENSITY AND BIOMASS OF GREEN TURTLES IN DEVELOPMENTAL HABITAT IN BERMUDA

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The entrapment netting method used in the Bermuda Turtle Project is unique among in-water sampling methods in that the net is highly portable and encloses a known area of feeding ground with a minimum of disturbance to foraging or resting turtles. With this sampling method, it is possible to estimate the density and biomass of green turtles on sea grass beds in Bermuda. These data provide a minimum estimate of the historical density of green turtles and thus can help in the development of criteria for the recovery of green turtle populations. They also allow further examination of the ecological role of green turtles in seagrass ecosystems.

This is contribution #4, Bermuda Biodiversity Project (BBP), Bermuda Aquarium, National History Museum and Zoo.

CORROBORATION OF THE DEVELOPMENTAL HABITAT HYPOTHESIS FOR MARINE TURTLES

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The idea that the life cycle of some marine turtles includes an identifiable stage that follows the “lost year” and precedes occupation of adult foraging grounds has been used by many authors. The term most frequently applied to this stage is “developmental habitat.” Evidence from our studies in Bermuda and Panama, and from the literature, suggests that this stage occurs in the life cycle of green turtles, hawksbills, loggerheads and Kemp’s ridleys, and (1) contains immatures only (maturation occurs elsewhere), (2) is usually found inshore or nearshore, (3) is entered and departed at regular sizes that are species specific (but may vary geographically), and (4) includes a mixture of turtles from different nesting populations in those cases studied to date.

This is contribution #5, Bermuda Biodiversity Project (BBP), Bermuda Aquarium, National History Museum and Zoo.

THE INFLUENCE OF ARTIFICIAL SPECIFIC GRAVITY CHANGE ON DIVING BEHAVIOR OF LOGGERHEAD TURTLES

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The record of diving behavior in loggerhead turtles during internesting period was obtained by a 3 channel data logger. The logger recorded diving depth, swimming speed and ambient water temperature for about 10 days in 5-second intervals. These records indicated that the dive of loggerhead turtles had basically four phases. At first, the turtle dived to a maximum depth (first descent), immediately ascended up to a certain depth (first ascent), then gradually ascended (gradual ascent) and finally surfaced (final ascent). The turtle often swam only during the first descent and first ascent phases and did not swim at all during the gradual ascent and final ascent phases. Especially in the gradual ascent phases, the turtle was able to stay at some depth without swimming, therefore, neither downward force nor lift affected the turtle. Thus, we can say that the turtle had neutral buoyancy during this phase. The depth at the beginning of gradual ascent phase significantly correlated to dive duration. This indicates the turtle stored more air in its lungs because the lungs are the major oxygen storage organ during loggerhead turtle dives. In addition, it can be hypothesized that loggerhead turtles are neutrally buoyant at the depth where they remain, using their lungs as buoyancy organs. We next examined the effect of the artificial change of the specific gravity of turtles on the staying depth to investigate whether the turtles determine the staying depth in advance or not. Data loggers were attached together with lead weights to 3 turtles after they had laid eggs. The weights added about 1.2% to their specific gravity. These weights were detached by the wirecutter device set up to operate after 4 days. As a result, the weighted dives were shallower than the normal ones. This suggests that the staying depth is determined passively; that is, the turtles only regulate the staying depth in order to be neutrally buoyant.

VYING FOR THE SAME RESOURCES: POTENTIAL CONFLICT ALONG MIGRATORY CORRIDORS

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Sea turtles are clustering in space and time along migratory corridors as was reported for adult leatherback turtles. Since 1990, we have been tracking juvenile Kemp's ridley and loggerhead turtles during their long-distance migrations from northeastern U.S. waters. Through the synoptic view provided by satellite, we have noted that these young turtles also are traveling within a narrow corridor extending southward for at least 700 km. There is alarming overlap in human activities along this same corridor, including boat traffic and major commercial fisheries. Safeguarding this migratory corridor is crucial as we exert increasing pressure on the same diminishing marine resources.

STATUS AND CONSERVATION OF SEA TURTLES IN THE REPUBLIC OF SEYCHELLES

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BACKGROUND

The Islands. The Republic of Seychelles comprises some 115 islands spread over an area of 1,300,000 km^2 in the western Indian Ocean, northeast of Madagascar. Geologically there are three types of islands: the granitic Seychelles clustered in the northeastern part of the country, the sand cay islands (including the Amirantes, Platte and Coetivy, Farquhar and Providence) spread across a wide swathe in the central and south east regions, and the more distant upraised limestone reef islands (including Aldabra, Assumption, Cosmoledo, and Astove) in the far southwest. More than 99% of the human population of 70,000 resides on only three islands in the granitic Seychelles--Mahe, Praslin and LaDigue.

The Turtles. Both nesting and foraging turtles occur at virtually every island. Green turtles (*Chelonia mydas*) nest primarily in the remote Aldabra and Cosmoledo island groups. Hawksbills *(Eretmochelys imbricata*) nest primarily in the granitic Seychelles, the Amirantes group, and at Platte and Coetivy. The hawksbill nesting populations of Seychelles are unique in that they are among the largest remaining in the world today, and consist of animals that nest almost exclusively in the daytime (a trait shared only with a few small populations of hawksbills in the western and central Indian Ocean).

Sea turtles are relatively more numerous in Seychelles than elsewhere, due largely to the fact that Seychelles was not inhabited until 1770; however, they are much reduced from historic levels (Mortimer, 1985; Frazier, 1984). Turtles have been legally protected for almost three decades at several sites in Seychelles including remote Aldabra atoll which is now a World Heritage Site, and in the granitic Seychelles at Ste. Anne Marine National Park, Curieuse Marine National Park, Cousin and Aride Islands.

Past Exploitation. The people of Seychelles view turtles as an integral part of their culture and economy. Turtles are featured as the motif for the Central Bank and on stamps and currency. Until 1968, large quantities of calipee from green turtles were exported to Europe from Seychelles for the production of turtle soup, and until recently, green turtle meat also featured prominently in the local diet in both fresh and salted ("kitouz") forms. People have slaughtered Seychelles' hawksbills for their shell for more than 200 years, historically exporting large quantities to Europe. In recent decades the primary market for raw hawksbill shell has been Japan, while the remainder has been used locally to fashion curios for the tourist trade. Traditionally Seychellois do not eat hawksbill meat since they consider it poisonous, as in fact, it occasionally is (see review in Mortimer, 1985; Ranaivoson *et al*., 1994). In recent years, however, some people have acquired a taste for it.

CONSERVATION OF SEA TURTLES IN SEYCHELLES TODAY (EMPS PROJECT J1)

Phase I: Artisan Training and Compensation. In 1989 and 1990, the Government of Seychelles developed an Environmental Management Plan for Seychelles (EMPS). Among the 50 projects included in the plan was Project J1 focusing on the protection of endangered sea turtles. To qualify for GEF funding from the World Bank, one of the requirements was to initiate legislation outlawing the use of hawksbill shell in the local tourist trade. Prior to passing such a law, it was necessary to ensure that the curio artisans did not suffer undue economic hardship. To this end, the government devised and implemented the first phase of Project J1 entitled "Artisan Training & Compensation." The goal of this project, funded jointly by the Seychelles Government and the World Bank, was to compensate and to retrain the artisans who made their living working hawksbill shell. In brief, 21 workshops employing 40 artisans were identified. Negotiations were conducted and the artisans agreed to be compensated at a rate that averaged about $15,000 per artisan. The artisans also agreed to sell their remaining stocks of raw shell to the Seychelles Government. A total of 2.5 tonnes of raw hawksbill shell was purchased at a cost of approximately $250,000 and placed in a locked container (Collie, 1995). In 1994, the "Wild Animals (Turtles) Protection Regulations of the Wild Animals and Birds Protection Act" were passed completely protecting sea turtles and banning all commercial trade in their products. Today, the ban on the sale of tortoiseshell products is well-enforced in the Seychelles.

Phase II: Turtle and Tortoise Conservation. In 1995, the senior author (JAM) was hired to conduct the second phase of the J1 Project entitled "Turtle &Tortoise Conservation." This project, funded jointly by the World Bank and the Government of Seychelles, allows for continuation and expansion of work begun by JAM in 1981 when a three-year-long turtle survey was conducted with funding from WWF International and the Seychelles Government (Mortimer, 1985). In the intervening years, turtle monitoring has continued in the Marine National Parks, at Cousin Island (Mortimer and Bresson, 1994) and at Aldabra Atoll (Mortimer, 1988). In 1987, with funding from the Smithsonian Institution and the Seychelles Islands Foundation, we (JAM and JC) initiated what is now an ongoing study of growth rates among juvenile green and hawksbill turtles at Aldabra. Educational materials for the school children of Seychelles were produced in 1986-87 in collaboration with the Seychelles Ministry of Education and WWF-International. Among the materials produced were booklets for school children (Mortimer, 1986a) and their teachers (Mortimer, 1986b) along with instructional videos ("Nesting on the Verge of Extinction" about the natural history and conservation of hawksbill turtles in Seychelles and "Turtles, Tortoises and Terrapins of Seychelles--their natural history and conservation" both produced in collaboration with the National Audio-Visual Centre of Seychelles).

Today, the "Turtle & Tortoise Conservation" Project J1 supports production of a Management Plan for Turtles and a wide range of activities that include the following:

1) Turtle Biology. Monitoring of turtle populations at nesting beaches and foraging grounds is being conducted throughout the country in collaboration with staff from the Marine Parks Authority and the Conservation Section of the Division of Environment, the Seychelles Islands Foundation (at Aldabra), BirdLife International (at Cousin and Frigate Islands), The Wildlife Trusts (at Aride Island) and also the owners and managers of some of the privately owned islands (especially Cousine, Bird and Denis Islands). The migratory patterns of both adult and juvenile animals in the western Indian Ocean are being examined through a combination of physical tagging and analysis of mtDNA (in collaboration with Dr. Craig Moritz at the University of Queensland). The long term growth rate study of juvenile turtles foraging at Aldabra continues and new growth rate studies have been initiated at other sites. Hundreds of blood samples have been collected from foraging animals and sent to the lab of Dr. Louis Guillette and Drew Crain at the University of Florida to determine sex ratios within foraging populations.

2) Turtle Habitats. We are identifying critical nesting and foraging habitats with the goal of providing special protection where it is needed.

3) Human Impacts. We are assessing levels of poaching, destruction of nesting and foraging habitat, and the impact of feral animals on nesting beaches, and recommending what measures are needed to address these problems.

4) Institutional Strengthening. The Seychellois personnel mentioned above in item "1)" are being trained through a combination of on-the-job-training and special full day workshops conducted by JAM entirely in the local language (Seychellois Kreol). Monitoring protocols have been standardized for all the study sites and booklets prepared to document them. The data bases are being computerized. Equipment procured through the project includes boats, a truck, computers and printers, turtle tags, etc.

5) Legislation and Judiciary. Recommendations for revision of legislation are being made. Steps have been taken to improve collaboration between the Division of Environment and the Attorney General's Office when prosecuting cases involving turtles. Special seminars are being given to sensitize key personnel including the Magistrates, the AG's Office, the Police, and the Coast Guard.

6) Public Awareness. We are conducting public awareness campaigns for the general public as well as more specialized programs aimed at school children. For the general public we utilize television, radio, newspapers, workshops, and public presentations. We find television, however, to be particularly effective, in part because there is only one TV station in the country, and in part because the management and staff of the Seychelles Broadcasting Corporation (SBC) are keenly interested in conservation issues. SBC willingly airs news items pertaining

to turtle biology and conservation issues, has hosted round-table discussions about turtle conservation, and recently produced an excellent one-hour-long documentary about turtle conservation expressly for the Seychellois audience.

To sensitize school children we are collaborating with the Ministry of Education which now has several Seychellois teachers who have been trained overseas as specialists in environmental education. Our program includes presentations in the schools, production of new teaching aids about turtles, and encouraging the use of materials produced in the past. During the coming nesting season we will work with the 15 branches of the Wildlife Clubs of Seychelles to generate enthusiasm for turtles among their young membership.

We believe that campaigns to promote public awareness are key to successful turtle conservation. During the past 15 years in Seychelles we have noted a major change in attitudes toward turtles (especially among young people). In our sensitization campaigns we try to instill an appreciation for the beauty of the living animals, an understanding of the complexity of their life cycles, as well as an awareness that live turtles can be a strong tourist attraction if marketed properly. And tourism is now the major source of badly needed foreign exchange in the Seychelles.

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CONSERVATION OF LONG-LIVED MARINE ANIMALS

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Animals that have a long life span, grow slowly, and mature at a late age are particularly vulnerable to mortalities induced by man. Many long-lived species also produce very few young, thus reducing even further their capacity to compensate for mortalities above those naturally caused by predators or diseases. In the ocean several diverse groups of animals share life history limitations that make them uniquely vulnerable to such human excesses as overfishing or incidental bycatch mortality. Among these are most species of sharks and sea turtles, many cetaceans, sturgeons, and many species of teleosts such as groupers and Pacific rockfishes. Similar life history limitations may render long-lived species that are taxonomically unrelated vulnerable to similar population reductions. Likewise, similar conservation strategies may be of value across taxonomic boundaries. A synthesis of the demographics of long-lived marine animals, and effective conservation strategies is sorely needed.

EVALUATION OF SEA TURTLE NESTING BEACHES FOR THE PURPOSE OF PROMOTING PARTICIPATORY CONSERVATION AND PUBLIC AWARENESS PROGRAMMES AT SUNDARVAN BEYT DWARAKA, INDIA

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Gujarat coast between 15-18 October and 16-22 November, 1996. The methodology
A survey to evaluate nesting habitats of sea turtles was carried out a Beyt Dwaraka, off included interviews with locals and beach assessment. Track evidences, depredated nests and sightings in water confirm sea turtles frequent three separate nesting beaches.

Track size, bone fragments including an intact skull prove the presence of two species, green (*Chelonia mydas*) and olive ridley (*Lepidochelys olivacea*). There are unconfirmed reports of leatherbacks (*Dermochelys coricea*). Threats to population are from incidental catches and nest depredation by jackals and wild boars. The conservation education component includes exposing students to the marine ecosystem with emphasis on sea turtle biology, also encouraging them to participate in beach patrol.

OSMOTIC RESPONSE OF KEMP'S RIDLEY SEA TURTLES TO ACUTE FRESH WATER EXPOSURE

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In reptiles, manipulations such as change of salinity, saline infusion and adrenalectomy, have previously been shown to elicit alterations in plasma electrolyte levels. However, hormonal responses typically associated with such variations in plasma electrolytes have yet to be examined in sea turtles. Captive Kemp's ridley sea turtles (*Lepidochelys kempi*) held in College Station (CS) and Galveston, TX, (GAL) were studied. Each group consisted of 4 turtles/group. CS and GAL animals were maintained in salt water of slightly varying salinities (27-29 and 32-34 ppt., respectively). An initial blood sample was taken from each animal in both groups to compare intraspecific differences at varying salinities. After 4 days, water in the CS pools was switched to fresh (<5 ppt) for 4 days, and 2 blood samples were taken (2d and 4d). After exposure to fresh water, water in the pools was switched back to salt water for 7 days, and blood samples were again taken at 2d and 7d. CS body mass decreased between 3-5% of their initial mass over the 15 days of the study. GAL corticosterone (B) and glucose were significantly higher than CS. Plasma osmolarity (pOsm), pNA^+, pK^+, and pCl^- decreased significantly during exposure to fresh water and subsequently increased upon returning to salt water. BUN doubled over the 15 days, however, levels did not change during exposure to fresh water. Aldo, B, and glucose levels did not change over the course of the study in CS. The present study provides the first published data on Aldo levels in sea turtles. The lack of differences in plasma electrolytes and osmolarity between GAL and CS animals suggest that the 15.2% difference in salinities was not sufficient to alter ionic or osmotic homeostasis. It would appear that Aldo and B in Kemp's ridley turtles are insensitive to environmental osmotic changes. However, it is possible that the hyponatremia-induced Aldo release mechanism was contradicted by the hypokalemic state during fresh water. It could not be determined if the changes in body mass and BUN in CS were attributed to the change in salinity or diet. Research was allowed under USFWS permit #PRT 689914 to David Wm. Owens.

MERCURY CONCENTRATION IN THE BLOOD OF THE KEMP'S RIDLEY SEA TURTLE

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Information on the relationship between sea turtle mortality and marine pollution pertains primarily to plastic-bag ingestion and exposure to petroleum while the role trace-metal uptake plays in these deaths is poorly understood. The current research summarizes mercury concentration in blood from Kemp's ridleys captured off Texas and Louisiana and develops a toxicological baseline heretofore unavailable for this critically-endangered species. Mercury levels were determined via an automated version of the cold vapor atomic fluorescence technique developed by Gill and Bruland (1990). Trends in mercury accumulation in wild and headstarted ridleys are presented according to sex and size.

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INITIATIVES TOWARDS AN ASEAN REGIONAL MANAGEMENT REGIME FOR MARINE TURTLES

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INTRODUCTION

The ASEAN Region is considered a critical habitat for sea turtles. Six species of marine turtles are known to occur in the Region, namely the green turtle (*Chelonia mydas*); hawksbill turtle (*Eretmochelys imbricata*); olive ridley (*Lepidochelys olivacea*); loggerhead (*Caretta caretta*); leatherback turtle *(Dermochelys coriacea*); and the flatback (*Natador depressus*). The region is also known to harbor significant turtle populations. These include major nesting populations of green turtles found in the Philippine-Sabah Turtle Islands-the Berau Northeast Indonesia area and clusters of rookeries in the Peninsular Malaysia- Sarawak - Southeast Kalimantan area. Pantai Utara Kepala Burung Irian Jaya, Indonesia and Terengganu, Malaysia for leatherbacks, while a number of nesting aggregations for hawksbill turtles have been identified in the Region (Limpus, 1994).

Sea turtles has been regarded as a traditional resource in the area with a long history of exploitation. The harvest of all lifestages from the eggs to mature nesters has been documented. The exploitation by coastal communities were initially at a subsistence level. The development of an international market, increased by-catch in fisheries and habitat degradation led to the unsustainable levels of harvests. Rapid decline of population in the last 50 years was recorded. Considering that sea turtles are highly migratory which transcends international boundaries, effective management can only be realized through a concerted and collaborated effort between range countries.

REGIONAL SEA TURTLE CONSERVATION PROGRAM

Working within the framework of the Association of Southeast Asian Nations (ASEAN), the ASEAN Working Group for Nature Conservation (AWGNC) became the forum in the development of the regional program for marine turtles. In 1991, during the second meeting of the AWGNC, the Philippines proposed the conduct of a regional symposium workshop on marine turtles as a preparatory activity towards the formulation of a regional program. The initiative was undertaken by the Pawikan Conservation Project of the Protected Areas and Wildlife Bureau. In the same meeting the body designated the Philippines as the lead country, and was authorized to secure funds for the conduct of the activity. Subsequently, all related developments concerning marine turtles in the AWGNC were submitted to the ASEAN Senior Officials on the Environment for endorsement.

In December 1993, the First ASEAN Symposium Workshop on Marine Turtle Conservation was conducted with support from WWF-Japan and USAID through WWF Philippine Program. Representatives from the Indonesia, Malaysia, the Philippines and Thailand attended the symposium. Dr. Colin J. Limpus was invited as resource speaker and adviser. The symposium provided a venue for experts and institutions involved in marine turtle conservation in the region to interact and present the status on the activities undertaken in their respective countries. This exercise gave the participants a broader perspective on the regional situation. The major output of the symposium-workshop is an ASEAN Regional Conservation Strategy for Marine Turtles. The regional strategy focused on the following concern (Proc. 1st ASEAN Symposium Workshop on Marine Turtle Conservation, 1994):

a. **Institution building -** An ASEAN Marine Turtle Specialist Network shall be created and organized to collaborate the implementation of the regional program. The Specialist Network will be tasked to formulate and recommend policies and programs to the AWGNC.
b. **Information -** To develop a regional information system for marine turtles through the establishment of a regional database and information network for marine turtles.
c. **Management-oriented research and monitoring -** enhance and collaborate research and monitoring activities. Major study areas of concern include the following:

- population status and distribution
- turtle harvest management
- augmentative researches relevant to the conservation and protection of all life stages of marine turtles

d. **Education, conservation awareness & publicity -** to coordinate training and education for appropriate personnel. Conduct of awareness community programs focusing on the need for community participation.
e. **Resource management -** recommend the declaration of globally and regionally significant habitats for marine turtles as an ASEAN Heritage/Conservation Areas. Identified significant marine turtle areas/habitats in the region include the following:

- Turtle Islands (Philippines, Sabah); Sipadan Island, Malaysia; and the Berau Islands, Indonesia for green turtles;
- Pantai Utara Kepala Burung Irian Jaya, Indonesia for leatherbacks and greens.

The program also encourages cooperation between the countries which share common boundaries, and formulate a specific conservation strategy in significant areas with special emphasis on the participation of the coastal communities.
f. **International efforts -** encourage member countries to accede to international and regional conventions on conservation, such as the Convention on the International Trade of Endangered Species; The Convention on Migratory Species (Bonn Convention),IUCN-SSC Marine Turtle Specialist Group among others.

ASEAN MARINE TURTLE SPECIALIST NETWORK (AMTSN)

As indicated in the program components of the ASEAN Regional Conservation Program, the establishment of an ASEAN Marine Turtle Specialist Network has been identified as a prerequisite towards the implementation of the regional program. The network as conceived shall serve as an advisory body to the AWGNC. The Network will involve the participation of agencies, institutions, non-government organizations working with marine turtles. During the 5th Meeting of the AWGNC in 1995, the body approved the Philippine proposal to create the AMTSN. Funding for the conduct of the organizational meeting of the AMTSN is currently under consideration by the Convention of Migratory Species and the ASEAN Coordinating Unit.

BILATERAL AGREEMENT FOR THE ESTABLISHMENT OF THE TURTLE ISLANDS HERITAGE PROTECTED AREA (TIHPA)

With the standing approval of the ASEAN Regional Conservation Program for Marine Turtles, a bilateral approach in the conservation of the only remaining major nesting population of green turtles in the region was initiated. The Turtle Island group of the Philippines and Sabah, Malaysia located in the Sulu sea lie adjacent to the international treaty limits that separate the Philippines and Malaysia. The Turtle Islands has nine islands of which six belongs to the Philippines while the remaining three to Malaysia. Tag recoveries of the Pawikan Conservation Project and Sabah Parks clearly indicate that it is single well defined rookery (genetic studies are underway to establish that it is a single population). It is in this context that both the Philippine and Malaysia initiated moves to establish a transfrontier protected area for the Turtle Islands. The general concept of establishing a transfrontier protected area revolves around the premise that the shared turtle resource should be managed as a single unit. After years of working independently on marine turtles in the area, the Pawikan Conservation Project (PCP) and the Sabah Parks realized the importance of collaborating and coordinating the initiatives undertaken in the area. As an offshoot of the first regional workshop, a series of informal and formal consultations were initiated by the PCP and Sabah Parks with the assistance and support from WWF Philippine Program. The issue of establishing the TIHPA was formally negotiated by the two

Governments during the second meeting of the RP-Malaysia Joint Commission for Bilateral Cooperation. A Joint Technical Working Group was duly created and finalized the agreement. In May 31, 1997, the Governments of the Philippines and Malaysia forged an agreement establishing the Turtle Islands Heritage Protected Area. A Joint Management Committee has been formed to operationalize the activities of the TIHPA. The JMC is slated to meet sometime April this year.

The unified management and conservation scheme focused on the following work areas:

a. **Research and monitoring -** integrated and uniform approach towards the wise management of the TIHPA. Areas of concern include: (1) population status and distribution; (2) turtle harvest and bycatch; (3) dynamics of turtle egg trade; (4) sex-ratio analysis; (5) resource and ecological assessment; and 6) socio-cultural-economic and investment opportunity assessment;

b. **Information -** establish a common data base linked with other institutions involved in coastal and marine turtle conservation;
c. **Information and education -** develop information & awareness program s for the coastal communities in the area;
d. **Resource management -** design and implement a scheme to enhance existing activities related to habitat protection;
e. **Eco-tourism -** develop a community based eco-tourism project in consonance with the principles of marine turtle conservation;
f. **Staff development -** institute developmental programs to upgrade the capability of the protected area staff; and
g. **Financing -** formulate a sustainable funding mechanism to sustain the program of the TIHPA.

RECOMMENDATIONS AND CONCLUSIONS

It is an accepted fact that a successful marine turtle conservation program cannot be achieve at a national level. In the last six years we have witnessed the importance of collaboration in the development of regional program towards our endless task of conserving our marine turtles. The spirit of having one common goal gave impetus to the realization of establishing the world s first transfrontier protected area for marine turtles. The Regional Marine Turtle Conservation Program has been reached the highest level in the ASEAN Organization (the ASEAN Coordinating Unit), which is a manifestation of ASEAN's commitment to conserve marine turtles. We have at hand a framework to work on. Much work has been done and much more work has to be done to realize our ultimate objective. Thus, there is a need to integrate all our efforts and support towards an common regional program. In recognition of the landmark agreement establishing the Turtle Islands Heritage Protected Area between the Governments of the Philippines and Malaysia, the Pawikan Conservation Project of the Philippines and Sabah Parks of Malaysia, was accorded the 20th J. Paul Getty Wildlife Conservation Prize along with Protamar Marine Turtle Conservation Project of Brazil.

ACKNOWLEDGMENT

To Dr. Eckert and my sister Marissa for making my trip possible. All my former co-workers at the Pawikan Conservation Project for the dedication and commitment, KKP/WWF for prioritizing support for marine turtles in the Philippines.

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RELATIVE ABUNDANCE AND DISTRIBUTION OF MARINE TURTLES INHABITING MOSQUITO LAGOON, FLORIDA, U.S.A.

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The objectives of this project are to: compare current population structure (1994-1996) and distribution to baseline data collected in 1977-1979 (Mendonça and Ehrhart, 1982), evaluate current seasonal distribution and occurrence of sea turtles (turtles caught per net km hour or catch per-unit-effort, referred to as CPUE), and provide updated statistical summaries of CPUE to determine regional "importance value" of this estuary.

Thirty-four sea turtles (*Caretta caretta*, loggerheads, and *Chelonia mydas*, greens) have been captured using tangle nets in the current project (80.1 net km hours, grand CPUE of 0.42) and all but one were juveniles. Data from the baseline project were collated from original field notes and calculation of CPUEs were made for six specific netting sites. Calculations from baseline data indicated a total of 453 net km hours with 95 turtles captured (grand CPUE of 0.21). Greens are caught at increased rates today (CPUE=0.36) with 85% of the turtles being greens as compared to only 21% in 1979 (CPUE was 0.04).

In contrast, loggerheads declined between the two periods with CPUEs of 0.16 in 1977-79 and 0.06 in 1994-96. A remarkable, concomitant decline in the incidental capture of *Limulus polyphemus*, a primary food item for loggerheads, has been observed. Net sets in the 1977-79 period typically included the capture of large numbers (unquantified) of these crabs and today it is rare to see any *L. polyphemus* in nets set in Mosquito Lagoon. *L. polyphemus* have been harvested at unknown rates in the region for use in various fisheries for bait and biomedical testing, this observed decline warrants concern and further study.

The sex ratio was not determined in previous studies and was estimated for the current study using testosterone radioimmunoassay for 21 turtles. A total of 94.4% of the greens were female (n=18) while 66.6% of loggerheads were female (n=3).

Greater than 50% of the green turtles collected in 1994-96 had the fibropapilloma virus as indicated by the presence of tumors. Tumor size was generally small with most being less than one cm in width. These tumors were not observed in earlier studies.

During the 1994-96 project only one green was recaptured in Mosquito Lagoon. Tumors were present on both occasions with fewer but larger tumors noted upon second capture. We assume that many of the earlier recorded tumors became confluent.

A green turtle with tumors was tagged and released in June 1995, and was collected in September 1996 by a fisherman in north eastern Cuba some 2000 km away. Additionally a green turtle was captured in our nets in November 1996 that had been previously tagged (1994) by National Marine Fisheries Service in Charleston Harbor, South Carolina, approximately 600 km north.

ACKNOWLEDGMENT

All field activities and funding were consistently supported by the NASA Kennedy Space Center Ecological Program, under NMFS permit #942 FL. We gratefully acknowledge assistance from L. Ehrhart, W. Redfoot, B. Schroeder, D. Owens, M. Hensley, L. Ernest, R. Smith, M. Keller, T. Richardson, C. Shadrix, Merritt Island National Wildlife Refuge and Canaveral National. Mary Mendonça graciously provided invaluable field notes form the 1970's that allowed us to calculate the CPUEs.

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ORIGIN OF LOGGERHEAD SEA TURTLES IN THE WESTERN NORTH ATLANTIC AS DETERMINED BY mtDNA ANALYSIS

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Loggerhead sea turtles inhabit Atlantic coastal waters between Virginia and Massachusetts on a seasonal basis, but the nesting colonies that frequent this foraging habitat have not been determined. We utilized mtDNA control region sequences to estimate the origin of 82 loggerheads which stranded in this region in 1995. Maximum likelihood analysis indicated that these stranded animals originated from three demographically independent rookeries in the southeastern United States and México. These data link these nesting populations with this feeding ground and also suggest that these rookeries are primarily affected by strandings in the northeastern United States.

EGGS AND HATCHLINGS OF THE ENDANGERED OLIVE RIDLEY SEA TURTLE, *LEPIDOCHELYS OLIVACEA* (ESCHSCHOLTZ)

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INTRODUCTION

Of living reptiles, Chelonians are the oldest reptiles which existed for over a hundred million years. The world's seven species of sea turtles have been placed as threatened or endangered species in the IUCN Red Data Book. Five of the World's seven species of sea turtles found in the Indian Ocean were placed under Schedule I of the Indian Wildlife (Protection) Act, 1972. These are: 1) *Dermochelys coriacea* (leatherback); 2) *Caretta caretta* (loggerhead); 3) *Eretmochelys imbricata* (hawksbill); 4) *Chelonia mydas* (green sea turtle); 5) *Lepidochelys olivacea* (olive ridley). Of these, the most common and the abundant one is the Olive (Pacific) ridleys. In India, on the East Coast, ridleys have their major rookery at Gahimatha Island in Orissa State, where one may observe the world's largest mass nesting called "Arribada". In winter months (November-February), larger numbers of ridleys migrate from the Indian Ocean to Gahirmatha for nesting. Some of these nesting turtles sporadically lay their eggs on the beaches of the Northern Andhra Pradest coastline (latitude 16°50'-18°25' and longitude 82°10'-84°10'). In recent years, increased human interference, on the breeding turtles, disturbances by the natural predators to the nests, and eggs and hatchlings are mainly responsible for the decimation of populations. The hatching success in natural conditions is from 3 to 40% (Das and Kar, 1986), however, under well protected conditions where human and predatory disturbances are less, the hatching percentage may increase. Hendrickson (1958) has estimated that only 1.7% of the hatchlings survive the first week after their emergence into the sea and altogether only 0.1% of the eggs laid will survive by the end of the year. Reasons can be assumed that the young ones below one year old are easily preyed upon as their shell is soft and completely defenseless. To avoid greater damage to the migratory nesting turtles, to the nests, eggs and hatchlings also for the protection of the nesting beaches, a Captive Management programme for the olive ridleys has undertaken over a period of 4 years (1983-1987) along the Northern Andhra Pradesh coastline, India.

STUDY AREA

The coastline between Kallngapatnam in the north and Hope Island in the south is 286 km of shoreline (16°50'-18°25' latitude and 82°10'-84°10' longitude and quite near the “Gahirmatha” Island where the mass nesting (*Arribada*) is held. This area has diverse shore conditions ranging from rocky to shallow, sandy shores with several extensions of hill ranges projecting into the sea. Seven rivers with their major tributaries from the estuary in this area and a number of creeks, back waters and streams also merge into the sea.

RESULTS AND DISCUSSION

Captive Breeding

This programme involves three main phases (1) collection of eggs and transportation to the hatcheries; (2) maintenance of the hatcheries; (3) captive rearing of the newly born hatchlings have grown sufficiently big and tough enough to protect themselves at least from small predators.

(1) **Collection and Transportation of Eggs**

Soon after the nests were identified, the nests were excavated by hand until the top layer of the eggs are exposed. Well ventilated wooden boxes were used to carry the eggs and the same nest sand was used to cover the inter-spaces between the eggs and egg layers. Each row of eggs in the nest was numbered as and when they are exposed while opening the nest. The marked eggs were placed in the container in the same position and without changing the axial orientation as they have been in the nest. The eggs were transported by road to the Central Hatchery, (Visakhapatnam) as early as possible.

(2) **Incubation of Eggs**

Incubation of eggs under complete captive conditions is of two types: a) nesting hatching; b) incubator hatching.

Nest Hatching

A total of 23 nests were protected individually, the clutch size of the nests had a range of 80 to 145 eggs with an average size of 118 eggs per clutch (Table 1). Of these, 10.54% of the eggs were infertile or met with early embryonic death and spoiled before the first week of their incubation. Another 34.36% of the eggs have spoiled before 45 days, while 10.21% of the eggs did not hatch but contained discernible embryos; 44.89% of the eggs hatched, but only 23.72% of the hatchlings were dead in the nest before they could emerge. These hatchlings were found infected with ants. The hatching success was obtained 34.24% of the total eggs. Hatching period was between 51 and 62 days while most of the nests hatched by the 57th day (Table 1).

Incubator hatching

Soon after the eggs were brought to the Central Hatchery (Visakhapatnam), the eggs were placed in sterile petri-dishes in between moistened cotton layers. The cotton layers were moistened with distilled water, were placed in BOD incubators in which the required temperatures were maintained (29.5°C, 30.5°C and 31°C). As the sex of sea turtles depends upon the incubation temperature (Pleau, 1971 and Dimond, 1982), hence it is essential that every care is taken before fixing the temperatures of the incubators. A total of seven clutches (891 eggs) were incubated under artificial conditions of which 127 were infertile and the rest of the fertile eggs are kept for artificial incubation. Out of 764 fertile eggs, 11.26% (86) were dead in pipped eggs. This occurred between 20 and 45 days of incubation, while 52 eggs (6.80%) were unhatched but contained discernible embryos, these were observed after the sixth week of incubation. Most of the unhatched eggs with discemble embryos, these were observed after the sixth week of incubation. Most of the unhatched eggs with discernible embryos were observed during the seventh and eighth weeks of incubation. Out of 764 eggs, seven clutches have been successfully hatched under complete captive conditions. The incubation time varied between 56 and 60 days. The overall hatching success was 81.94% (Table 2).

Hatchlings:
Immediately after hatching from the eggs, the hatchlings are dark black in colour and weight between 15 and 18 g and had a size range of 36-41 mm in carapace length and 34-40 mm of carapace width. The hatchlings have a single claw on each flipper. Hatchlings, after their emergence from the nest, encircle the nest and finally reach into the sea (Table 3).

Captive Rearing:
Freshly hatched young ones in the Captive Breeding Program were released into small tubs or hatching pools. Sea turtle hatchlings are very sensitive to salinity and temperature. It is good if the hatchlings are reared in clean flowing sea water. Flushing and refilling the tanks once or twice a day is an acceptable alternative. The salinity should be monitored and it is not desirable to keep the hatchlings in water with a salinity of less than 20 parts per thousand (Raja Sekhar, 1987). Floating vegetation and some smooth submerged rocks are to be provided in the tanks so that the hatchlings can have different hideouts and resting places in the tanks. The newly born hatchlings of Olive Ridleys did not feed on any of the food items provided, until they were 5 or 6 days old and later attempted feeding on marine algae of *Gracillaria* sp. However, a few hatchlings which appeared to be weak and inactive were forced to feed with vitamin drops and glucose water. On the whole, the following food types are provided to the hatchlings during the captive rearing: a) marine algae, b) polychaetes, c) crustaceans, d) molluscans, e) marine fish (Table 4). The hatching success in natural conditions is from 3 to 40% (Das and Kar, 1988), however, under well protected conditions where human and predatory disturbances are less, the hatching percentage may increase. Hendrickson (1958) has estimated that only 1.7% of the hatchlings survive the first week after their emergence into the sea and altogether only 0.1% of the eggs laid will survive by the end of one year. Reasons can be assumed that the young one below one year old are easily preyed upon as their shell is soft and completely defenseless. During the first two months the hatchlings were fed with mainly the marine algae and molluscans. They rarely relished other varieties of artificial food; boiled eggs and fine chopped meat are eaten on rare occasions from the fifth month. The feeding on marine algae gradually decreases while feeding on molluscans and ranks high throughout the rearing period. After one year the hatchlings gained an average weight of 800-1000 g, with prominent scutes, hard shell and nails, and not an easy predation even after released to their natural habitat (Subba Rao, 1987).

ACKNOWLEDGMENTS

We take this opportunity to express our since thanks to the Secretary, University Grants Commission, New Delhi for the financial support to a major research project entitled on “Ecology and Management of Indian Sea Turtles” sanctioned to Dr. M.V. Subba Rao, Professor and Head of the Department of Environmental Sciences, Andhra University. We would like to take this opportunity acknowledging the assistance of Research Scholars, Dr. K. Kameswara Rao and Dr. V.V. Subba Rao who helped us for intensive field studies during the sea turtles survey work. Our thanks are due to the principal Wildlife Warden, Government of Andhra Pradesh, Hyderabad for giving permission to collect the eggs of sea turtles and for captive rearing of hatchlings.

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Table 1. Details of hatching and hatching success in Olive Ridley clutches "*IN SITU*"

Parameters	Minimum	Maximum	Average
Clutch size (no. of eggs)	80	145	118
Egg diameter (mm)	37	46	40.08
Weight of the egg (g)	22.4	37.0	32.28
Infertile eggs (%)	7.50	15.15	10.54
Fertile eggs (%)	84.86	92.50	89.46
Eggs spoiled before			
Day 15 (n/clutch)	2	18	9
Day 30 (n/clutch)	12	34	24
Day 45 (n/clutch)	0	12	7
Unhatched eggs with discernable embryos (n/clutch)	3	27	12
Hatched eggs and dead in nest (n/clutch)	5	24	13
Hatched eggs and escaped from nest (%)	23.81	47.31	34.24
Hatching period (days)	51	62	57

Table 2: Details of hatching and hatching success of 7 nests incubated in Central Hatchery during 1984-86.

Year	Total eggs hatched	Infertile eggs	Fertile eggs	Spoiled eggs	Eggs developed & unhatched	Hatched eggs	Hatched dead	Hatched success
	(n)	(n)	(n)	(n)	(n)	(n)	(n)	(%)
1984-85	128	18	110	12	6	82	6	83.8
1984-85	100	14	86	8	7	71	7	82.5
1985-86	112	19	93	10	6	77	4	82.7
1985-86	132	16	116	13	8	95	8	81.8
1985-86	136	18	118	14	7	97	7	82.0
1985-86	141	20	121	15	8	98	8	81.0
1985-86	142	22	120	14	10	96	9	80.0
Total	891	127	764	86	52	626	47	81.94

Table 3: Morphometry of the one day old hatchlings of the Olive Ridley sea turtles.

Parameters	Range	Mean
Carapace length (mm)	36-41	39.46
Carapace width (mm)	34-40	38.62
Plastron length (mm)	25-29	27.43
Plastron width (mm)	22-26	24.14
Head length (mm)	16-19	17.66
Tail length (mm)	3-4	3.27
Weight (g)	15-18	16.72

Table 4: Food types offered to the Olive Ridley hatchling in captive and its preferences.

Food types offered	Preference	Food types offered	Preferences
A. Marine algae			
a. Gracillaria sp.	+++	D. Mollusca	
b. Ulva sp.	++	a. Cellana radiata (limpets)	+++
c. Spongomorpha sp.	+	b. Nerita albicella	++
d. Chaetomorpha sp.	o	c. Sepia sp.	++
B. Polychaeta		E. Marine Fishes	
a. Nereis sp.	++	a. Stolephorus sp. (While bait)	+++
b. Sebella sp.	+	b. Sardinella longicaps	++
		c. S. gibbosa	++
C. Crustacea		d. Dussumieria sp.	+
a. Metapenaeus monoceros	+++		
b. Penaeus indicus	++		
c. Scylla sp.	+		

+++: high preference; ++ common food; +: low preference; o: rejected

REGULATION OF SALT GLAND ACTIVITY IN *CHELONIA MYDAS*

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The salt gland is a highly efficient extra-renal salt secreting tissue which permits sea turtles to maintain water balance when excreting large quantities of salt. The mechanisms which regulate the activity of the salt gland were investigated and a model is proposed to explain its control. Blood flow was identified as a primary site of regulation, with blood flow through salt gland capillaries increasing nearly 200 fold when the gland was active. The secretory modifiers adrenalin and methacholine appear to exert their influence on gland activity by regulating blood flow, thereby controlling the availability of oxygen and salt to secretory cells. It is speculated that the activity of the secretory cells is dependent on the available oxygen concentration, based on results of oxygen consumption experiments. The proposed model identifies control of blood flow by adrenergic and cholinergic nerves as being the means by which salt gland activity is regulated.

AN UPDATE OF THE STATUS OF MARINE TURTLES AND THEIR CONSERVATION IN SRI LANKA

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During 1995 and 1996, the Turtle Conservation Project (TCP) conducted rookery surveys and interviews with beach dwellers at 49 of 51 rookeries identified along the West and Southwest coast of Sri Lanka. The results of the survey show that the populations of all five species of marine turtle that nest on the island are in decline, with the Olive Ridley turtle (*Lepidochelys olivacea*) apparently showing the most dramatic decline. This paper also discusses the historical and current marine turtle conservation activities in Sri Lanka.

ESTIMATIONS OF THE NESTING POPULATION SIZE OF LOGGERHEAD SEA TURTLES, CARETTA CARETTA, MASIRAH ISLAND, SULTANATE OF OMAN

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The population of loggerhead sea turtles *Caretta caretta* nesting at Masirah Island, Sultanate of Oman. (21° N x 59° E) was reported to be the largest in the world with more than 30,000 female turtles nesting annually (Ross and Barwani, 1982). This estimate was based on a two year study conducted between 1977 - 1978 (Ross, 1979) and has been confirmed by additional monitoring of the nesting beach by personnel of the Oman Ministry of Fisheries (reported in Ross, 1987). Nesting occurs on approximately 20 km of beach on Masirah island, which is located off the southeast Arabian coast in the Indian Ocean. At the time of these estimates the full extent of nesting of *Caretta caretta* on the U.S. east coast was just becoming known, and recent evaluations indicate the U.S. population is of comparable size, although nesting is dispersed along several hundred km of coast (Dodd, 1988). Since 1987, intermittent monitoring of the Masirah population is reported (A. Kiyumi, pers. comm.) but detailed information on the current levels of nesting and conservation status of the population is not published. Whether the U.S. or Oman population of this species is larger is immaterial, but it does appear that together these two populations constitute a very large majority of the species and such concentration leaves the species vulnerable to threats (Ross, 1982). Evaluation of the current status of the Oman population is important information for evaluating the world conservation status and directing conservation resources toward the survival of the species.

An intensive tagging program, regular counts of tracks and density of nesting turtles and monthly aerial surveys conducted between 1977 and 1979 were used to generate the first estimates of the size of the nesting population. A series of different estimates were generated under different assumptions and using independent elements of the available data. Using aerial surveys of nesting distribution, counts of tracks of nesting sea turtles, mark and recapture calculations of tagged turtles, and two standard population estimators, estimates of from 19,000 to 89,000 females per year were obtained. The estimates form two clusters around 80,000 and around 30,000. The higher estimates are associated with a very low value of observed renesting frequency and are probably too high. The lower estimates are based on calculated renesting frequencies of 4.0 nest per female, which fall into the currently accepted range for this important variable. The lower median estimate of around 30,000 per year was published in Ross and Barwani (1982). The raw data and calculations are given in Tables 1-3.

Like all sea turtle nesting populations, the Oman population shows quite large variation in nesting from year to year. Based on the 1977 - 1979 data set it appeared that weekly or monthly counts of the tracks of nesting turtles from a single night gave an adequate index of turtle abundance and had the additional merit of being simple and within the capacity of local staff to collect unassisted. These data are available for the ten year period 1977 - 1986 and confirm the very large size of the Masirah nesting group. The number of turtles nesting in a single night, averaged for 9 km of the most intensively used beach and for weekly or monthly counts, ranges from 27- 102 km/night with an average value of around 65/km/night (Ross, 1987, Fig.1). This value extrapolated for the total nesting beach length of 20 km and length of the nesting season of 120 days, and corrected with best estimates of multiple nesting and false crawls, remains the basis for estimates of this population in the range of 20,000 - 40,000 nesting females per year. Like all such estimates the correction factors can exert a strong influence on the final figure. Confirmation of the present size and status of this population is recommended.

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Table 1. Raw data for the estimation of numbers of nesting turtles at Masirah Island, Oman.

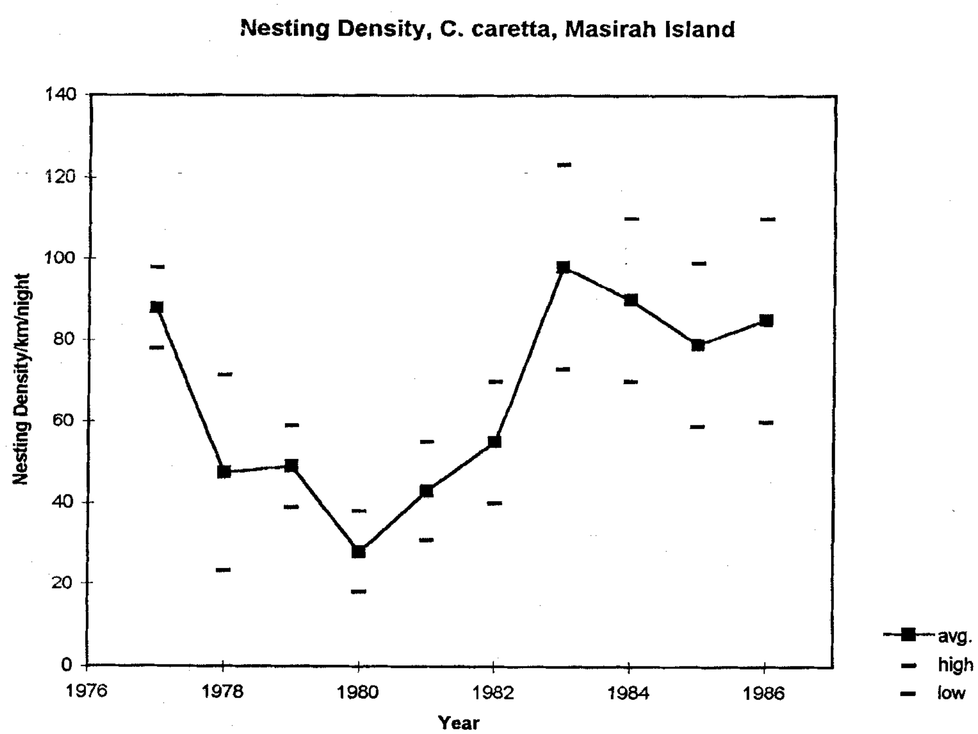
		Year		
		1977	1978	1979
A	New Tags on 3 km Study section	1830	2031	1640
B	Returns "	5	57	141
C	Days worked	123/147	82/128	74/115
D	% turtles seen on days worked	75%	60%	25%
E	Efficiency (C x D)	0.63	0.38	0.16
F	Renesting frequency counted (min)	1.33	-	-
G	Renesting frequency calculated (max)	4.00	-	-
H	Nesting Density Daily avg. 3 km	49.7 SE =8	46.2 SE=16	42.8SE=10
I	Nesting Density Weekly avg 9 km	87.8 SE=10	47.4 SE=24	49.0 SE=10
J	Dead turtles	78	122	144
K	Dead turtles with tags same year	6	?	11
L	Highest weekly avg. tagged/seen	0.36	0.35	0.27
M	Turtles tagged in 2 weeks preceding L	152	268	381

Table 2. Methods for the calculation of turtle population numbers. Symbols from Table 1. Total nesting beach on Masirah is approximately 20 km, Total effective days of the nesting season, May-August is 120 Days

I	Tagging	$N = \frac{A+B}{E} \times \frac{20km}{3}$
ii.	Tracks corrected for multiple nesting	N=H/F x 20 km x 120 nights
iii		N = H/G x 20 km x 120 nights
iv		N = I/F x 20 km x 120 nights
v		N = I/G x 20 km x 120 nights
vi	Tagged Dead Turtles	N=A x J/K
vii	Proportion of tagged Turtles	$N = \frac{A-M}{L} \times \frac{20}{3}$

Table 3. Estimated numbers of nesting female *Caretta caretta* on Masirah Island using methods from Table 2.

		Population estimate females/season nearest 100		
	Method	1977	1978	1979
I	Tagging	19,400	36,300	74,200
ii	Tracks corrected for	89,600	83,400	77,200
iii	multiple nesting	29,800	27,700	25,700
iv		158,400	85,500	88,400
v		52,680	28,400	29,400
vi	Tagged dead Turtles	23,800	-	21,500
vii	Proportion of tagged turtles	31,000	33,600	31,100
	Ford's method 1953	31,500	-	-
	Regression of A/A+B	-	-	
	After Richardson *et al*., 1978			48,600 (r =0.97)
	Average of Estimates	47,900	49,200	49,500
	Minimum Estimate	19,400	27,000	21,500



PATHOLOGIES, TREATMENT AND PREVENTION IN CAPTIVE GREEN TURTLES, *CHELONIA MYDAS*, IN THE MEXICAN CARIBBEAN

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Since February 1994 we have observed many pathologies in green sea turtles of different ages, causes by bacteria's, protozoa, physical factors, stress, nutritional or behaviour problems. The morbidity and mortality goes from particular cases to a big number of affected turtles. We have been working on the identification of the cause agent, the best treatment, the normal blood cell count, necropsy, identification of normal flora and the most important thing, the prevention of the illness.

ESTIMATION OF THE NESTING POPULATION SIZE OF THE LEATHERBACK TURTLE *DERMOCHELYS CORIACEA* IN THE MEXICAN PACIFIC DURING 1995-96 NESTING SEASON

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The leatherback is considered an endangered species, yet there is little quantitative information on global population size or status. In this study we utilized an aerial survey and ground patrols to achieve the first census of leatherback nesting colonies on the Pacific coast of México. From the total area of coast covered (4,186 km), nesting occurred in 1,690 km. Only 4 beaches, one of which was previously undescribed, supported nesting densities larger than 50 nests/km. We estimated that 1,093 females nested this season in the Mexican Pacific, this number representing a drastic decline from that reported in the early 80's.

INTERNESTING INTERVALS OF LOGGERHEAD TURTLES, *CARETTA CARETTA*, AFFECTED BY THEIR BODY TEMPERATURES

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To investigate the influence of temperatures on the length of internesting periods of loggerhead turtles (*Caretta caretta*) and green turtles (*Chelonia mydas*), body temperature, water temperature and depth of free-ranging turtles were monitored during internesting periods using micro data loggers. The data loggers were attached on turtles at nesting beaches after they finished nesting, and were retrieved when they re-landed on the same beach. The experiments were conducted at nesting beaches in the Japanese archipelago from 1989 through 1994, and body mass and clutch size were also measured. Internesting intervals of some turtles exceeded 21 days when they experienced low water temperatures. Internesting interval was significantly negatively correlated with mean body temperature or mean water temperature. There was no significant relationship between clutch size and internesting interval, or between body mass and internesting interval. The body temperatures were kept higher than water temperatures throughout their internesting periods, and larger turtles had a greater mean thermal difference between body temperature and water temperature. The rate of preovipositional development of eggs during the internesting period seemed to be accelerated by high body temperature within an appropriate range of temperatures and visa versa.

DIET COMPOSITION OF THE BLACK SEA TURTLE, *CHELONIA MYDAS AGASSIZII*, IN THE CENTRAL GULF OF CALIFORNIA, MÉXICO

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The Gulf of California is an important area for development and feeding of black sea turtles originating from nesting beaches of more southern portions of the eastern Pacific Ocean (Cliffton *et al*., 1982; Alvarado and Figueroa, 1992). As these animals move into the Gulf, they enter an enclosed body of water that is considered a dynamic and productive ecosystem (Brusca, 1980; Pacheco and Zertuche, 1996). Supported by seasonal upwelling of nutrient rich waters, coastal areas of this sea host diverse assemblages of fish (Thomson *et al*., 1979), invertebrates (Brusca, 1980), marine alga (Norris, 1975), and seagrasses (Felger *et al*., 1980). Though it is clear that the Gulf of California ecosystem provides a wide variety of potential food resources for black sea turtles, the dietary preferences of this species are poorly understood.

Studies of the closely related green sea turtle (*Chelonia mydas*) have shown that they are primarily herbivorous, feeding on seagrass and/or marine algae (Hirth, 1971; Bjorndal, 1980). Regarding black sea turtles, Felger and Moser (1985) noted that black turtles captured by the Seri Indians regularly had marine algae and sea grass remnants in and around the mouth region. Furthermore, after dissection of the stomachs of many of these turtles it was noticed that all were filled with sea grass and/or marine algae (Felger, pers.comm.). However, due to the limited distribution of seagrasses in the Gulf of California, it is likely that black sea turtles more commonly utilize non-seagrass food resources. Information presented here was collected during studies in the Bahia de Los Angeles region of the Gulf of California, an area at which seagrasses are absent.

This research required the open-water capture of black sea turtles in the Gulf with the use of entanglement nets. This has been proven a safe and effective method for capturing sea turtles (Mendonça and Ehrhart, 1982). Two entanglement nets (100 m x 8 m) were employed and continually monitored during each netting trial to prevent mortality due to drowning. Upon capture of each turtle physical data was collected and diet analysis was performed. Oral examination was used to recover residual food particles for identification. However, the most effective method was lavage, the esophageal flushing of food components (Forbes and Limpus, 1993). Through gentle injection of clean sea water, recently ingested stomach contents were flushed out. These food particles were then preserved and identified.

A total of 40 turtles were captured from the wild using entanglement nets during June - August, 1996. The average straight carapace length for these turtles was 78.4cm with an average weight of 69.5kg (153 lbs). Lavage samples were recovered from 31 captured turtles. Preliminary analysis suggests that the turtles in Bahia de Los Angeles are primarily herbivorous, with marine algae accounting for 92% of the average volume of lavage samples. Red algae of the genus
Gracillaria was most prevalent (69% average lavage sample volume). The following marine algae species were also recovered: *Gigartina* sp. (9%), *Codium* sp. (5%), *Sargassum* sp (3%), *Chaetomorpha* sp. (3%), and *Ulva* sp. (3%). In addition to consuming marine algae, turtles also ingested a variety of marine invertebrate organisms including sponges (4%), squid parts (<1%), tube worms (<1%), hydroids (<1%), and small snails (<1%). Lastly, small amounts of substrate particles (sand, shell fragments, small rocks) were recovered in virtually every sample.

This analysis of diet composition is the first step towards understanding the feeding ecology of the black turtle. Future study will include the analysis of local movement and food availability within individual home ranges. When this information is coupled with diet composition, a more thorough understanding of black sea turtle behavior and feeding ecology will be gained. Furthermore, by learning what resources they are most commonly using and where they are moving on a daily basis, we can begin to make educated management decisions regarding this endangered species.

ACKNOWLEDGMENTS

We wish to thank SEMARNAP (México), Earthwatch, PADI Foundation, Lerner-Gray Foundation, and Wallace Genetic Foundation for their financial and logistical support.

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KEMP'S RIDLEY TURTLE NESTING ON THE TEXAS COAST, 1979-1996

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Kemp's ridley (*Lepidochelys kempii*) is the most critically endangered sea turtle species in the world. Most Kemp's ridley nesting occurs in the vicinity of Rancho Nuevo, Tamaulipas, México (Marquez M., 1994). An international, multi-agency, experimental project was conducted from 1978-1988 to aid in the recovery of Kemp's ridley turtles by establishing a secondary nesting colony of them at Padre Island National Seashore (PAIS), located on North Padre Island, Texas (Shaver, 1989). A few Kemp's ridley nests were documented at PAIS prior to 1978 (Werler, 1951). Attempts were made to imprint Kemp's ridley turtles to PAIS so that they would return there to nest and establish a secondary nesting colony (Shaver, 1987). Between 1978 and 1988, 22,507 eggs were collected in Rancho Nuevo, packed in PAIS sand, and shipped to PAIS for incubation (Shaver, 1989, 1990). National Park Service (NPS) staff at PAIS provided care for the incubating eggs. After the eggs hatched the hatchlings were released on the beach at PAIS, allowed to enter the surf, and recaptured using aquarium dip nets. The hatchlings were raised in captivity (head-started) at the National Marine Fisheries Service laboratory in Galveston, Texas where most were held for 9-11 months but some for longer time periods (Fontaine *et al*., 1990; Caillouet *et al*., 1995). Prior to release, the turtles were marked with up to four types of external and internal tags (Fontaine *et al*., 1993). Turtles were released at a variety of locations but primarily into the Gulf of Mexico, approximately 30 km offshore from Mustang and North Padre islands (Fontaine *et al*., 1990; Caillouet *et al*., 1995).

METHODS

Because of the large number of Kemp's ridley turtles that were experimentally imprinted at PAIS, detection and protection of nesting Kemp's ridley turtles and their eggs on North Padre Island are priority items in the Kemp's Ridley Sea Turtle Recovery Plan (U.S. Fish and Wildlife Service and National Marine Fisheries Service, 1992). In 1986, NPS staff began a detection and protection program (Shaver, 1990). Critical components of the detection and protection program have been public education regarding sea turtles and patrols for nesting turtles and tracks. These daytime patrols have been conducted by PAIS staff members and volunteers, along the Gulf of Mexico shoreline on North Padre Island (125 kilometers in length), from April through August, during each year since 1986. The most comprehensive patrol efforts have occurred since 1990. The number of hours spent patrolling in 1996 (2,387 hours) was similar to the number spent during most of the previous six years but the distance patrolled in 1996 (46,234 kilometers) was greater in 1995 and 1996 than during all previous years. Patrols specifically to detect nesting sea turtles are not conducted elsewhere in Texas. However, Sea Turtle Stranding and Salvage Network personnel search for stranded turtles along several specific areas of the Texas coast from one to four times a week and also look for nesting turtles and tracks during that time.

RESULTS AND DISCUSSION

Seventeen confirmed Kemp's ridley clutches were found along the Texas coast from 1979-1996 (Shaver, 1995, 1996a). Twelve of the 17 were located at PAIS, more than found at any other single location in the United States during that time. Of the other five detected in Texas from 1979-1996, one was found at North Padre Island just north of PAIS, three at Mustang Island, and one at Boca Chica Beach. Three of the 17 were found by PAIS patrollers and the other 14 by beach visitors. Ten of the 17 nests were detected during 1995 and 1996.

The six Kemp's ridley nests found on the Texas coast during 1996 were more than found during any previous year since consistent nesting records have been maintained, beginning in 1979. The increase in nesting detected along the Texas coast during 1996 was at least partially the result of the experimental effort to establish a secondary nesting colony. Two of the five clutches found at PAIS in 1996 were from the first documented nestings by returnees from the experimental project to establish a secondary nesting colony. None of the turtles from the project had previously been confirmed to have nested at PAIS or anywhere else outside of captivity. The observations of the two returnees mark the first documentation of any sea turtle species nesting at an experimental imprinting site and outside of captivity after being head-started and direct evidence in support of the theory of imprinting.

One of the returnees was identified by the living tag on the 4th left costal scute as having been incubated and hatched at PAIS in 1983 and released into the Gulf of Mexico, off Mustang Island, Texas on 5 June 1984 (Fontaine *et al*., 1993; Caillouet *et al*., 1995; Shaver, 1996a, 1996b). The other had a tag scar on the right front flipper and was identified by the living tag on the 4th vertebral scute as having been incubated and hatched at PAIS in 1986 and probably released offshore from Mustang Island, Texas on 17 April 1987 but possibly released elsewhere after 22-39 months in captivity (Fontaine *et al*., 1990; Shaver, 1996*a*, 1996*b*). The turtles that laid the other four clutches during 1996 were observed and reported by the public and thus could not be conclusively linked to the experimental project. The two clutches of eggs from the returnees, and 14 of the other 15 confirmed Kemp's ridley clutches detected along the Texas coast since 1979, were retrieved and transferred to the PAIS incubation facility for protected care. One hundred eleven of the 177 eggs laid by the two returnees hatched. Hatchlings from the two clutches, and from 13 of the other 15 clutches, were released on the beach at PAIS and allowed to enter the surf without retrieval.

Possible factors influencing why more turtles from the experimental project have not been documented nesting on North Padre Island include: release location, marking and identification, detection, age of sexual maturity, sex ratio, and mortality in the marine environment. It is possible that the locations where the turtles were released after head-starting influenced their future nesting sites. At least one (and probably both) of the two returnees documented nesting at PAIS in 1996 and most of the other project turtles were released offshore from Mustang and North Padre islands after head-starting (Caillouet *et al*., 1995). However, hundreds of others were released elsewhere in Texas and the oldest turtles from the project were released off the west coast of Florida (Caillouet *et al*., 1995). Turtles that were released in those other areas may have nested somewhere other than the south Texas coast. Some of the turtles from the project may have nested but were not recognized as being from the project. Of the external markings that could have been observed, metal tags could have been shed and living tags were used to mark most or all individuals in only the 1983-1988 year classes (Fontaine *et al*., 1993). Also, these markings could have been obscured on nesting turtles covered with sand and epibiota. Turtles from the project may have nested but not been found. Due to a lack of funding, detection efforts on North Padre Island have been inadequate, particularly in comparison to those conducted at Rancho Nuevo. Based on the age of the two returnees, the age of sexual maturity for these turtles is at least 10 years and the turtles from the last few project years may not be sexually mature yet. Also, since mostly males were produced prior to the 1985 year class (Shaver, *et al*., 1988), it is likely that fewer of the older, mature turtles are females. Lastly, it is possible that more observations have not been made because relatively few of the turtles may still be alive. Virtually all of the turtles imprinted to PAIS were released before mandatory usage of Turtle Excluder Devices. Caillouet *et al*. (1995) reported tag returns for these turtles and predicted that few would probably survive to adulthood.

It is unknown how many turtles from the experimental project will return to nest at PAIS in the future. Long-term monitoring of beaches for nesting, observations of nesting turtles by trained biologists, and evaluation of hatching success for located clutches are necessary to accurately assess project results. Even if a secondary nesting colony becomes established at PAIS, it is still imperative that Kemp's ridley turtles continue to be protected at the nesting beaches in México and in the marine environment.

ACKNOWLEDGMENTS

Agencies in México, including the Instituto Nacional de la Pesca, are thanked for their assistance with this program. Canon U.S.A., Inc., Gladys Porter Zoo, H.E.A.R.T., National Marine Fisheries Service, National Park Foundation, National Park Service, Texas Parks and Wildlife Department, U.S. Coast Guard, U.S. Fish and Wildlife Service, U.S. Geological Survey, and others in the United States are gratefully acknowledged for their contributions to various aspects of the project.

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HEART RATE AND DIVE BEHAVIOUR OF THE LEATHERBACK SEA TURTLE DURING THE INTERNESTING INTERVAL

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The leatherback sea turtle (*Dermochelys coriacea*) is one of the deepest divers in the ocean, with records existing for dives exceeding 1000 meters of seawater (Eckert *et al.*, 1988). The leatherback dives continually and spends short periods of time at the surface in between dives (Eckert, *et al*.; 1986, Southwood *et al*.; current study). This diving pattern suggests that the turtle metabolizes aerobically while submerged. By measuring the leatherback's heart rate during dives and at the surface we may gain insight as to what oxygen-conserving measures, if any, the animal is utilizing in order to maintain aerobic metabolism. Some species of diving vertebrates display a decrease in heart rate while diving (diving bradycardia) which may result in a decrease in oxygen consumption. The goal of this study was to determine if the leatherback displayed a diving bradycardia while freely diving during the internesting interval.

Studies were conducted at Playa Grande, Costa Rica during the 1995-1996 and 1996-1997 nesting seasons. We attached data loggers capable of recording ECG (electrocardiogram), as well as dive depth and dive duration, to five leatherback females as they laid eggs on the beach. In order to record ECG, we also implanted two stainless steel thin-wire electrodes subcutaneously. Radio transmitters were attached to the data loggers to locate the turtles when they returned to the beach at the end of the internesting interval. When the turtles returned, we removed the data loggers and electrodes and downloaded the data onto a laptop computer.

So far, data from three of the five turtles has been analyzed. We found that the average heart rate while diving was 16.7 beats per minute (bpm), whereas the average heart rate during surface intervals was 26.3 bpm. This represents a significant decrease in heart rate from the surface level to the dive level ($P < 0.01$). On average, dive heart rates were 35% lower than surface heart rates. We also observed that heart rate began to increase during the ascent portion of dives before the turtle reached the surface. The at-sea heart rates we observed, whether the turtle was at the surface or diving, were lower than heart rates observed for turtles depositing eggs on the beach (average beach heart rate = 40 bpm).

We conclude that leatherback sea turtles display a diving bradycardia which may assist in conserving oxygen during diving. However, unlike large diving mammals, bradycardia develops slowly and diving heart rate is higher as a proportion of the surface heart rate. Further research in leatherback cardiovascular dynamics and metabolism is necessary to determine the exact nature and function of the diving bradycardia in this animal.

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COOPERATIVE EFFORTS BETWEEN VETERINARY DIAGNOSTIC FACILITIES AND GOVERNMENT AGENCIES IN ASSESSING TWO SEA TURTLE STRANDING EPISODES

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Aquatic epidemiological investigations are extremely difficult to conduct and require specialty group collaborations to achieve successful outcomes. During the summer of 1996, two large sea turtle stranding events occurred in North Carolina. The first was characterized by freshly-dead turtles lacking external lesions; the second by live and freshly-dead turtles with skin necrosis. Throughout the investigation specialty groups including National Marine Fisheries Service (NMFS) fishery biologists, veterinary aquatic specialists, pathologists, epidemiologists, virologists, microbiologists, dermatologists, geological survey specialists, and NMFS forensic and toxicology specialists provided cooperative input. Bacterial cultures, viral isolation, and toxicological screens were performed on appropriate samples. Complete blood counts and serum chemistries were performed on blood samples of live turtles. The cause of death is not definitively determined for either group of turtles. Septicemia was a common focus in many of the "necrotic skin turtles" and could have been due to a breech in the integument. Heavy spirorchid infestations were noted in many turtles, but their significance is unknown. The epidemiologists from North Carolina State University School of Veterinary Medicine compared the previous ten years of stranding data provided by the North Carolina Wildlife Commission and felt there was a true elevation of sea turtle deaths during these time periods. Fishing impacts were minimal in these areas during the stranding events. Many sampling difficulties affected the accuracy of diagnosis, including: carcass condition, sample collection technique, storage and cataloging procedures which impacted the ability to achieve a proper diagnosis. Disease investigation techniques between the NMFS, Beaufort Lab, NMFS, Charleston Lab, and North Carolina State University School of Veterinary Medicine were reviewed and included education and training of the field biologists and select volunteers. The goals of the review were to refine sample collections to the appropriate stranding class and design a detailed necropsy form for code 1 turtles only, prompting field personnel to collect all pertinent tissues and describe abnormalities of each tissue. Another need is for a prospective toxicological analysis study of healthy turtles (drowning victims) for control comparisons. The exact causes of the mortalities were not determined demonstrating the need for a preestablished systematic response protocol involving many agency specialists.

TURTLE-SAFE SHRIMP™: CAN IT HELP SAVE THE SEA TURTLES?

Todd Steiner and Randall Arauz

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The sea turtle - shrimp fishing issue has dragged on for a very long time: in fact we are approaching 25 years of work on this very issue. This history has been summarized in the excellent report by Center for Marine Conservation (CMC) called Delay and Denial: A Political History of Sea Turtles and Shrimp Fishing.

It begins at least 24 years ago, in 1973, when shrimp fishing was identified as the major threat to the Kemp's ridley sea turtle in a report by Pritchard and Marquez.

* 16 years ago-- in 1981, the National Marine Fisheries Service (NMFS) designed a turtle excluder device (TED) that was reported to be at least 97% percent effective at releasing turtles alive.

Since that time, environmentalists have been working to ensure TED use on shrimp vessels -- and some elements of the shrimp industry have worked to block TED rules. During this period, lawsuits have been filed by conservationists and the fishing industry.

* By 1991, TEDs were required year-round in 8 states. Stranding rates decreased approximately 25% from pre-TED years in those regions. Media reports suggested that shrimpers were learning to live with TEDs, and that some even found them to be advantageous, excluding unwanted debris and bycatch.

With this welcome news, Earth Island Institute (EII) began concentrating its effort to get TEDs in use on the approximately 70 other nations that shrimp trawl in waters shared with sea turtles. We are happy to report that our 1996 court victory now requires TEDs on ALL vessels from nations who choose to sell their wild-caught shrimp into the US. seventeen nations have now passed TED laws.

Unfortunately, sea turtles strandings in US waters sky-rocketed in 1994 -- with the death count exceeding all previous years -- even before TEDs became mandatory. By year's end, 2,149 turtles had washed ashore. Two new lawsuits were filed, one by EII and HEART and a separate suit by CMC.

NMFS concluded in a section 7 consultation under the ESA that if the continued take level did not decrease, it was likely to jeopardize the continued existence of the critically endangered Kemp's ridley and the recovery of the threatened loggerhead. Once a jeopardy opinion is issued NMFS had two choices--

1. Revoke the fishing industry permit which allows them to kill an "acceptable" number of sea turtles in the course of shrimp fishing or
2. Develop a new plan to reduce shrimp fishing mortality rates. A "new plan" was announced, including stepped-up enforcement, new training programs for shrimpers, float rules, and a host of additional things NMFS would do to get the mortality rates down.

Unfortunately, sea turtle strandings have not decreased. In 1995, 2,175 turtles washed ashore, slightly higher than 1994. And in 1996, 2,725 turtles washed ashore, a 25% increase over the mortality figures of 1994 or 1995.

Even as moralities have risen, government agencies continue to talk about a 95 to 99% compliance with TED regulations. In 1996 the professional investigation division of the Humane Society of the U.S., working with Earth Island Institute, began an undercover investigation of TED compliance in Texas. HSUS investigators visited 5 ports and randomly inspected vessels, mostly at dockside, but also at sea. They found that 41% of all shrimp boats inspected had disabled TEDs, suggesting a major disregard for the law.

The results of this investigation were presented to Rolland Schmitten, the top administrator of NMFS in early March 1977, and a final report will be released to the public by the end of March, 1977.

NEW SOLUTION

EII believes a new solution to this ongoing tragedy is needed. To date, the courts have failed to give the sea turtles the relief they need. The political strength of the shrimp industry has fought conservationists to a political stalemate... we have TED regulations, but we do not have adequate compliance.

In light of this history, EII concluded that a new strategy to protect sea turtles was in order... and that new strategy became the Turtle-Safe Shrimp Campaign.

EII certified Turtle Safe Shrimp Program is a broad-based, mass educational program to reach millions of U.S. seafood consumers -- alert them to the impacts of shrimp fishing on endangered sea turtles and the marine environment-- and mobilize them to take action. The plan stretches from the media to the market place -- and full page newspaper and magazine ads, billboards, chef endorsements, public service announcements, and other materials have already been developed.
The first simple message of the campaign is-- "Eat ONLY EII certified TURTLE-SAFE™ shrimp."

The Turtle-Safe shrimp program is designed to REWARD conscientious shrimp fishers who are abiding by ESA regulations through POSITIVE publicity and through a marketing strategy --making EII certified TURTLE-SAFE™ shrimp a value-added specialty niche product that will bring the fishers a higher price for their shrimp through participation in the program.

This creates an incentive for more fishers to join the program. More importantly, it also creates an incentive for TURTLE-SAFE™ shrimpers to ensure that not only their shrimp is Turtle Safe, but that of the other TURTLE-SAFE™ participants, as well.

Why? if the product loses its credibility, it will also lose its price advantage. Thus, if successful, shrimpers will begin to monitor each other. This is more than just idle speculation. This is in fact what has happened with certified organic produce, with one organic farmer making sure that his or her neighbor is not cheating and jeopardizing the program. Our program is modeled after the California Certified Organic Farmers program.

What is Turtle-Safe™ shrimp?

It is shrimp caught by fishers that:

1. Sign a legal contract agreeing to properly and consistently use NMFS approved TEDs; and

2. Agree to participate in an independent monitoring program. Farm Raised shrimp is not being certified Turtle-Safe™ because of the ecological damage to mangrove forests and wetlands, which harms sea turtles and the marine environment.

We are also investigating adding shrimp that is harvested in areas where there are no turtles (and where fishers are using the best available technology to reduce bycatch).

After a little over a year, we have created a test market for certified TURTLE-SAFE™ shrimp amounting to 2.5 million lbs. of certified shrimp per year. More than 100 shrimpers are participating.

Two natural foods supermarket chains, one in Oregon and Washington, and another in Boston have carried TURTLE-SAFE™ shrimp

And restaurants in California, Georgia, Colorado are buying TURTLE-SAFE™ shrimp. One of the most recent participants, which is a very exciting development in terms of public education, is that the Monterey Bay Aquarium Restaurant is now exclusively offering TURTLE-SAFE™ shrimp to its patrons. The media has picked up on the program and stories have appeared on CNN and local television stations in several states, on National Public Radio, and in several national magazines and newspapers. But this has to only be the beginning, if we are to succeed.

To date, we have created a coalition of 85 organizations and businesses whose memberships represent more than 5 million Americans. The Sierra Club endorsed the campaign this month-- adding approximately 600,000 more members who will learn about the program through their publications, and unleashing several thousand more activists around the country. Sea turtles NEED a stronger, larger and more active constituency of Americans. We believe the best way to organize that constituency is through the Turtle-Safe™ shrimp campaign.

The status quo, 2,000 - 3,000 dead sea turtles washing ashore each year, is unlikely to be sustainable.

I am asking all of you to join the Turtle-Safe Campaign.

* Educate your colleagues and friends.

* Drop off the TURTLE-SAFE™ brochure where you food shop and at your favorite restaurant.

* Get your local TV stations to run the Turtle-Safe™ public service announcement

* Meet with your local newspaper editorial board and ask them to run a opinion-editorial on TURTLE-SAFE™ shrimp

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GREEN TURTLE PROGRAM AT TORTUGUERO, COSTA RICA

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The Tortuguero green sea turtle nesting colony is the largest extant sea turtle population in the Greater Caribbean (Carr, 1979) and one of the largest in the world for this species. Although protection to the population is afforded by the Tortuguero Conservation Area (ACTo, for its acronym is Spanish) poaching of adults and eggs continues to be a problem, particularly since Park personnel are insufficient to protect the entire area. The community of Tortuguero was established (approximately at mile 31/8 of the study area) in the early '20s. Thus, interaction between turtles and humans precedes the foundation of the green turtle program by the Caribbean Conservation Corporation (CCC) in the mid '50s. Growth of the tourism industry in recent years, concomitantly with the growth in the population of the adjacent village, may pose an added threat to the long term survival of the population. The objective of this paper is to assess the impact of human activity on the nesting of the green sea turtle colony at Tortuguero. For this, historic records on the nesting activity of green turtles were analyzed with the help of a newly designed interface, which allows the synthesis of the extensive database that the CCC has accumulated for over 40 years of work at Tortuguero. The historic analysis shows that the nesting of green turtles is significantly affected by human activity in the beach area adjacent to the Tortuguero village.

METHODS

Tortuguero beach (22 miles long) was surveyed for green turtle tracks at least once a week throughout the 1996 green turtle nesting season. Tracks were divided into nesting, non-nesting, and total emergences. Data analysis was concentrated on the northernmost five mile section of beach, which is the area where human activity is highest. Track surveys were conducted here every three days. Because the database does not contain track survey records from previous years, historic analysis of the nesting activity of the green turtles was performed by looking at sighting records. A sighting is defined as a turtle intercepted on the beach from which tag information is recorded. Information associated with the tag includes, but is not limited to, the nesting section of beach where the animal was intercepted. For the purpose of this paper, the term "nesting activity" will refer to both nesting, non-nesting, and total number of emergences on the beach. Sighting records were summarized for the entire length of the program (1954-1996; with the exception of 1994-95, as these data have not been entered in the database yet). In addition, sighting records were summarized for the periods of 1954-1986 (1986 was the year electricity was introduced in the village) and 1955-1981 (1981 was the year a generator was introduced in the village).

RESULTS AND DISCUSSION

Track survey data for the 22 mile beach (Fig. 1) for the 1996 green turtle nesting season indicate that the section with the highest sea turtle activity is located inside the Tortuguero National Park, between the mouth of the Jalova lagoon (mile 18) and the border of the Park at mile 33/8. The beach section to the south of Tortuguero may have been influenced negatively by the runoff from the Jalova lagoon. It would be interesting to determine if the same phenomenon (*i.e.*, low nesting activity when the mouth of the lagoon is open) is found in the historic record. It seems likely that human activity in the northernmost five miles of the beach has caused an impact on the green turtle nesting population in this section of beach, unless the lower number of emergences here is coincidental or determined by unknown environmental constraints (*e.g.*, underwater topography or local currents that make this section of beach less visited by the turtles). Track survey data for the northernmost five mile beach for the 1996 green turtle nesting season indicate that the nesting activity was lowest in front of the village and by the mouth of the river (Fig. 2). The section of beach adjacent to the mouth of the Tortuguero river is believed to present suboptimal conditions for nesting due to the influence of the river and the lack of background vegetation. The area in front of the village is the section of beach that presents the most human activity, and includes community lighting. These results prompted the testing of the hypothesis that community lighting was responsible for the significantly lower nesting activity in front of the village. The hypothesis was evaluated by looking at the number of sightings along the northernmost five mile beach.

Fig. 3 shows the cumulative number of sightings along the northernmost five miles section of beach for three different periods. Since the trend observed for the period 1954-1996 is nearly identical to that in Fig. 1, we believed it was appropriate to use the sighting data to evaluate the proposed hypothesis. As observed in Fig. 3, the area in front of the village presents the lowest nesting activity of the section of beach studied, including the periods when community lighting was not significant. This observation suggests that community lighting may not be responsible for deterring the turtles from nesting in this area. We suggest that overall human activity is the factor responsible for the lower number of nesting animals in front of the village.

It is possible that the nesting of green turtles has been negatively impacted by the legal and illegal take of eggs and adults from the beach. Green turtles are well known for their tendency to nest subsequently in the same section of beach (Carr *et al*., 1978). Thus, it is possible that the more extensive poaching of eggs and adults has eliminated from the population those animals that historically have nested in this section of beach. The more frequent presence of humans in the north section of beach alone cannot be ruled out as a deterrent to the nesting of green turtles. With increasing pressure from the quickly growing, seemingly unregulated tourism industry, the pressure and impact over the nesting population may be even higher than suspected. To address the most immediate needs of the endangered sea turtle nesting population at Tortuguero, we propose the creation of a Sea Turtle Management Plan (STMP). The STMP should be designed in collaboration with the CCC, the natural resource management staff of ACTo, the Tortuguero villagers and local tourism industry. The main goal of the comprehensive document would be to define the actions needed to make the protection of the nesting population and its habitat more effective. The document should also serve to facilitate regulation of the growth of the tourism industry, as well as that of the village, by enabling the implementation of existing zoning laws and regulations.

ACKNOWLEDGMENTS

The authors would like to acknowledge the contribution to the Tortuguero Sea Turtle program by the Archie Carr Center for Sea Turtle Research through the work of Drs. Karen Bjorndal and Allan Bolten.

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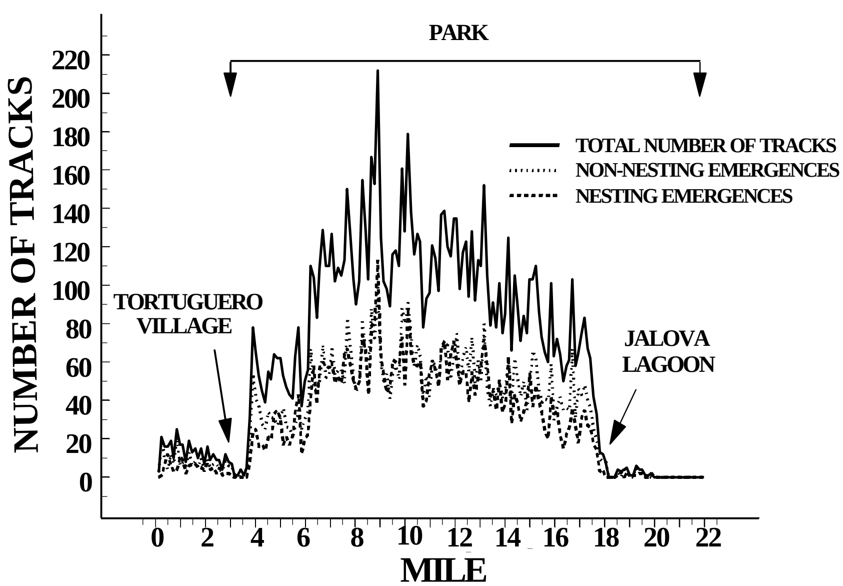

Figure 1. Number of tracks along the 22 mile Tortuguero beach for the 1996 green turtle nesting season. Tracks include nesting, non-nesting, and total number of emergences.

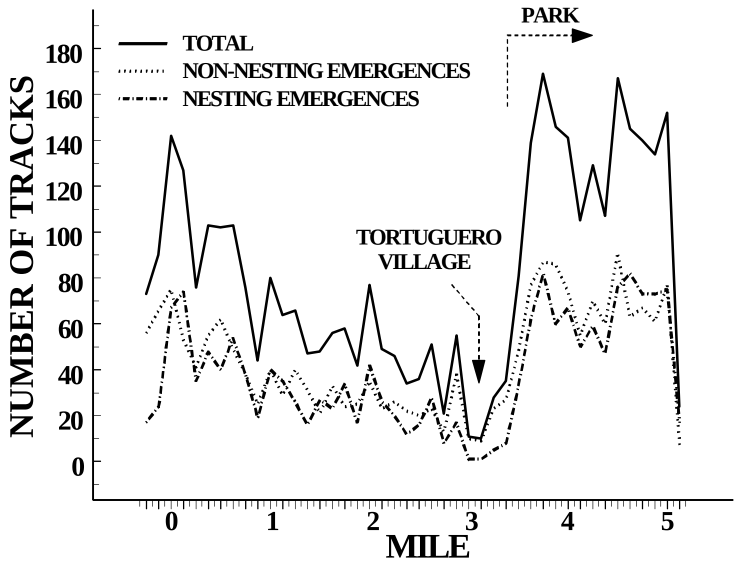

Figure 2. Number of tracks along the northernmost five mile beach of Tortuguero during the 1996 green turtle nesting season. Tracks include nesting, non-nesting, and total number of emergences.

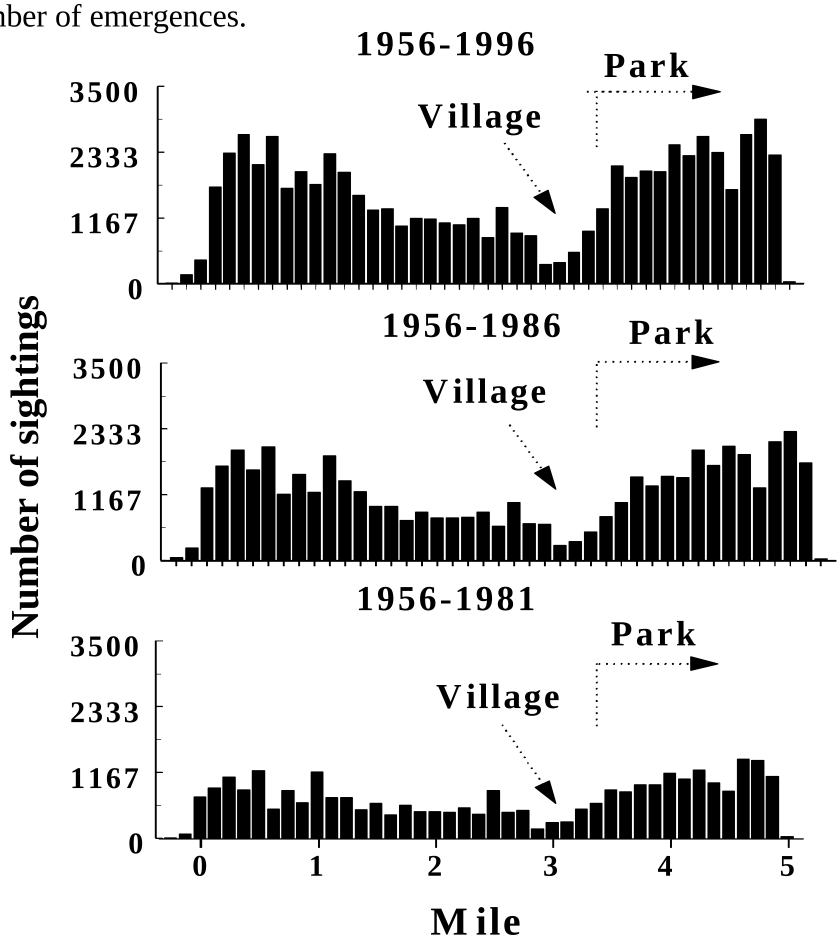

Figure 3. Cumulative number of sightings along the northernmost five mile beach of Tortuguero during three different time periods.

THE CELL-MEDIATED IMMUNOLOGY OF GREEN TURTLE FIBROPAPILLOMATOSIS

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Little is known about the sea turtle's cell-mediated immune system, much less its response to the debilitating disease green turtle fibropapillomatosis (GTFP). This investigation developed immunological profiles for healthy and diseased animals, establishing a clear contrast. This was achieved through the use of complete blood count, packed cell volume, serum protein electrophoresis, blood chemistry, and blastogenic analyses. Evidence indicates a distinct immune stimulation pattern associated with GTFP.

NESTING BIOLOGY OF HAWKSBILL TURTLES ON HOLBOX ISLAND, MÉXICO

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INTRODUCTION

The Yucatán Peninsula provides excellent nesting habitat for sea turtles, with more than 260 km of sandy beaches. It has been known for more than a decade that three species of sea turtles regularly nest on the Peninsula, including relatively large numbers of hawksbills (*Eretmochelys imbricata*). Recently, as many as 3,000 hawksbill nests have been registered in one year, just in the three Mexican states of Campeche, Yucatán and Quintana Roo.

One of the most important nesting areas is Holbox Island, in the northeast corner of the Peninsula. Studies began here in 1988, and since 1991 there has been relatively complete coverage of the beach. Holbox is a low-lying barrier island, and the principal nesting beach is about 24 km long, on the eastern side. Each year a turtle camp is set up in April or May, and the beach is patrolled nightly until September. The purpose of the present study is to compare information on nesting biology over the period from 1990 to 1996. Unfortunately, the data for 1993 were purloined by the technician in charge, and much of the data for 1994 are not reliable, so these two years are absent from this analysis.

RESULTS

The nesting season regularly extends from late April until late August, and the peak in nesting occurs in May or early June. The number of nests with eggs recorded each year during this 7-year period has risen from 97 in 1990 to 403 in 1996. Although an important part of this increase is due to greater effort in patrolling the beach, there was a remarkable increase in nesting activity during 1995 and 1996. An increase in annual nesting has also been found at other Hawksbill nesting beaches on the Yucatán Peninsula during the same period.

Over the years there has been a tendency for nesting on Holbox to peak between kilometers 2 and 6, at the western end of the beach. There is also a recurring tendency for the least nesting to occur between kilometers 8 and 10. The peak in activity at the eastern end of the beach does not occur at a regular position from year to year.

There was a positive relationship between clutch size and the curved carapace length (CCL) of the female for all 5 years. In 1991 and 1995 this relationship was significant. There is a tendency for clutch size to decrease in relation to the date of nesting. This relationship was negative and significant in 1990, 1995 and 1996; but it was positive and not significant in 1991 and 1992.

The period between oviposition and emergence of hatchlings from the nest - the period of incubation and emergence - is called "PIE." This period shows an inverse relation with date of laying, and it was significant in 1990, 1991, 1992, and 1996. In 1995 the relationship was positive, but not significant. PIE was negatively related to clutch size in 4 years: 1991, 1992, 1995 and 1996; although the correlation was statistically significant only in 1996.

DISCUSSION

The results show different levels of consistency in trends from year to year (Table 1). The relationship between clutch size and carapace length was constant; it was always positively related, although not always statistically significant. The significant negative relationship between clutch size and date of laying was reversed in 1991 and 1992. There is no simple explanation for either the negative relationship or for the reversal in the trend.

PIE and date of laying showed a significant negative relationship in 4 out of 5 years. In 1995, when two hurricanes hit the northern Yucatán Peninsula, there was a reversal in this trend. It is tempting to suggest that the hurricanes caused the reversal; however, since both of them arrived weeks after the last nest hatched, it is unclear how these climatic anomalies may have affected reproductive biology. It is also remarkable that reversals in other trends occurred in years when there were no hurricanes.

PIE and clutch size showed weak and variable trends. Given that there were regularly strong correlations between clutch size and date of laying on the one hand, and PIE and date of laying on the other, it is curious that there was no consistent relationship between PIE and clutch size.

What is clear is that sea turtle biology often defies simple explanations. The variation in basic biological trends from year to year should be taken as a warning not to rush to conclusions with a few year's of data. The variability shows the importance of using data collected over the long-term to derive generalities about sea turtle biology.

ACKNOWLEDGMENTS

We thank the following people and organizations for the assistance and support: Darwin Acevedo, Victor García, Reina Gil, Alfredo Jiménez, Martín Pérez, Raúl Rodríguez, Gordon Seyfarth, Ligia Uk, Tom van Eijck, Alfredo Villegas; Calica, Chelonia Institute, CINVESTAV IPN, Pronatura Península Yucatán, A.C., Sistema Nacional de Investigadores, U.S. Fish and Wildlife Service; for permits we thank Instituto Nacional de Ecología.

Table 1. Regression analysis of reproductive variables from Isla Holbox, over the period 1990 to 1996 (no data are available for 1993, and data for 1994 were not reliable).

VARIABLE		**YEAR**						
DEPENDENT	**INDEPENDENT**	**'90**	**'91**	**'92**	**'93**	**'94**	**'95**	**'96**
CLUTCH SIZE	**MAXIMUM CCL**	+	+*	+			+**	+
CLUTCH SIZE	**DATE OF LAYING**	-*	+	+			-***	-**
PIE	**DATE OF LAYING**	-***	-*	-**			+	-***
PIE	**CLUTCH SIZE**	+	-	-			-	-*

CCL = curved carapace length; PIE = period of incubation and emergence; "+" = positive regression; "-" = negative regression; * = $p < 0.05$; ** = $p < 0.01$; *** = $p < 0.001$

INTESTINAL SHELL DEBRIS ASSOCIATED WITH CHRONIC DEBILITATION IN LOGGERHEAD TURTLES, DIAGNOSIS AND TREATMENT

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Loggerhead turtles (*Caretta caretta*) may present in thin to emaciated body condition, depressed, lethargic and sometimes covered with parasitic leeches. Initial diagnostic techniques include a blood sample which should include an immediate serum glucose determination. Typical blood abnormalities include hypoglycemia, moderate to severe anemia, and hypoproteinemia. Radiographs reveal sections of bowel filled with shell debris. To facilitate recovery, surgical and medical treatment techniques have been used. Surgical removal has been only partially successful with the lone survivor of four attempts requiring a blood transfusion during surgery.

Successful medical management has included intestinal stimulants used in conjunction with mineral oil to lubricate the tract. Metoclopramide has been used most often at 0.5 mg/kg orally every 24-48 hours, orally alternated with mineral oil.

A LARGE POPULATION OF SLOW GROWING HAWKSBILLS: PRELIMINARY RESULTS FROM A WILD FORAGING POPULATION IN FOG BAY, NORTHERN TERRITORY

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INTRODUCTION

Unlike the green turtle, there are few studies which have examined the population dynamics of hawksbill turtles in the wild. Stage-based population models have been constructed for some other sea turtle species (Crouse *et al.*, 1987; Heppell *et al.*, 1996), however, data on habitat-specific size distributions are lacking for *E. imbricata*. Basic biological is important to determine size structures, growth rates, recruitment size, and rates and population sizes. These data will help to identify at what stage in the life cycle conservation methods will be most effective. This is especially important because of the recent discussion of sustainable harvest of hawksbill turtles. This paper presents preliminary results of a study of a natural assemblage of sub-adult *E. imbricata* residing on a rocky reef in tropical Australia.

STUDY AREA

Fog Bay (12°41' S x 130°21' E) is situated approximately 150 km by road west of Darwin, Northern Territory, Australia. An archipelago of 8 islands extends 20 km north from the mainland. Green and hawksbill turtles feed on a thin veneer of intertidal algae which covers the 23km-2 of intertidal reef. The area experiences a maximum tide range of 8 m.

METHODS

Turtles were captured using rodeo and beach jump methods between 1991 and 1996. From 1991 to 1994 feeding turtles were caught at irregular intervals but since 1995, sampling has occurred on a monthly basis. Each turtle was tagged and curved carapace length (CCL). Growth using CCL measurements was calculated for turtles with a recapture interval of greater than 11 months. An estimate of recruitment rate was determined by normalised plots of cumulative frequency of CCl measurements from a cross section of the population (1996 captures only). The population estimate and density/km^2 was calculated for the study site using Geometric Distribution Estimates
(Caughley, 1977; Chao, 1987; Krebs, 1989). This method is useful in large populations where the sample size is relatively small and the numbers of recaptures are low. The estimate from the study site was used to estimate the population of hawksbill turtles for the entire continuous feeding area.

RESULTS

Size Structure: A total of 190 captures of *E. imbricata* have been recorded from 156 individuals. The sample consisted of sub-adult turtles with a mean curved carapace length of 49.3 cm (SD = 11.4, range = 26.3 - 75.5, n=187). However, the size distribution is polymodal with some size classes being better represented than others.

Growth rates: Growth data were obtained during the last five years of research in Fog Bay. The mean growth period was 2.77 years (sd=1.21, n=19, range=0.93 - 4.79), the mean growth increment was 6.74 cm (sd=0.78, n19, range=1.6 - 12.3) and the mean growth rate was 2.3085 cm per year (sd=0.49, n=19, range=1.38-3.19). Growth rate in each size class range is presented in Table 1.

Table 1. Size class specific growth rates for *Eretmochelys imbricata* residents of Fog Bay Reefs

Size Class	**35.0-39.9**	**40.0-44.9**	**45.0-49.9**	**50.0-54.9**	**55.0-59.9**	**60.0-64.9**	**65.0-69.9**
mean growth rate	2.75	2.309	2.119	2.392	2.371		2.725
sd		0.687	0.272	0.865	0.585		
n	1	4	6	2	5	0	1
minimum		1.722	1.725	1.780	1.384		
maximum		3.187	2.538	3.003	2.887		

Recruitment: Young *E. imbricata* take up residence in the study site when in the 25 - 30 cm CCL size class. The smallest was 26.3 cm CCL. They are generally light in colour and carry commensal organisms (*e.g.*, Goose neck barnacle *Lepas*), which are uncommon amongst the other residents which are darker, covered with algae and carry the turtle barnacle, *Chelonibia*.

The size class distribution for *E. imbricata* sampled in 1996 using 2 cm size increments (approximate annual growth rate) reveals a polymodal distribution. A normalised plot of the cumulative percentage of the composition of each size class (Cassie, 1954;, Zar, 1984) revealed several normal distributions. The mean difference between the groups was 5.7 cm (sd = 1.6, n= 7) which is at least twice the maximum yearly growth rate for the feeding turtles. Differences in peaks ranged from 1-11 years.

Population size: Estimates of the size of the population of *E. imbricata* on the feeding area were made using frequency of capture models (Caughley, 1977; Krebs, 1989). Of the three distributions tested against the observed frequency of capture, the geometric distribution produced the most significant result ($\chi^2 = 2.35$, d.f = 3, $P < 0.05$) which indicated that individuals had an unequal probability of recapture (Caughley, 1977). The first moment estimator of the population (Chao, 1987) gave a conservative value of 414 with 95% confidence limits set at 277 and 669. This gave a population density of 81/km2.

DISCUSSION

Size Structure: Few areas have been described where *E. imbricata* occur in such abundance. The primary catch area comprises just 5.1 km^2 of reef flat, yet has provided 190 captures of 156 individual *E. imbricata*. The reason for the abundance of *E. imbricata* in the study site remains unclear. Inspection of the reef biota indicate a generally depauperate assemblage of algae and invertebrates. This, however, will be the focus of more intensive studies in the future. As almost 90 per cent of the sample are smaller than 65 cm (CCL), the data represent an assemblage of subadult feeding turtles.

Growth: *E. imbricata* in the study area grow on average 2.3 cm per year which is faster than growth rates for this species on the southern Great Barrier Reef (Limpus, 1992) yet slower than those reported from the Bahamas (Bjorndal and Bolten, 1988).

Recruitment: The smallest individual in the sample was 26.3 cm (CCL). This is smaller than new recruits reported from other feeding ground studies. In the Caribbean Sea, *E. imbricata* are thought to remain in their pelagic feeding areas until they reach the carapace lengths of 23-25 cm SCL (Meylan, 1988). No individual under 30 cm (SCL) was reported from the Bahamas (Bjorndal and Bolten, 1988). A minimum size of 30 cm (CCL) was reported form the southern Great Barrier Reef (Limpus, 1992). The smallest individual for the sample on Wuvulu Island, PGN was 31.8 cm (CCL) (Hirth *et al*., 1992). Recruits to the study area at Fog Bay appear at a smaller size than reported for other studies.

The polymodal size class distribution for 1996 may reflect periods of recruitment. In some years recruitment may be minimal, if any at all, while during other years the bulk of recruits may arrive from their pelagic habitats. Regular systematic catching of feeding turtles needs to continue for some years to explain the apparent dominance of some size classes.

Population Size: Relatively short term studies where the catch effort has varied from earlier opportunistic catching to regular monthly sampling later in the project does not lend itself to estimates of population size based on equal probability of recapture. As the low frequency of recaptures approximated a geometric distribution, the hypothesis of an unequal probability of recapture was validated (Chao, 1987). Caughley (1977) reminds us that unequal catchability is more often the case than the exception when dealing with wild populations. A conservative estimate of 414 individuals (Chao, 1987; Krebs, 1989) feeding over a reef flat of 5.1 km2 produces a density of 81.17 turtles km^{-2}. This is more than 24 times the density reported for Heron Island reef (Limpus, 1992) and is the highest yet reported. Based in the mean weight of the size classes and their respective presence in the 1996 survey of the feeding population, the estimated standing crop is 10.52 kg per ha^{-1}. This is twelve times greater than that reported for Heron Island (Limpus, 1993).

CONCLUSION

The rocky reef of Fog Bay represents a significant feeding habitat for *E. imbricata* as it supports a large population of subadult turtles in tropical Australia. The population contains smaller individuals than are found on the southern Great Barrier Reef. The estimated density is greater than that reported from any other study of *E. imbricata*. Growth rates are greater than those reported for this species on the Great Barrier Reef, but slower than those from the Caribbean Sea.

ACKNOWLEDGMENTS

We would like to thank Dr C. Limpus for his support and assistance with this study. Funds from JBA were gratefully received. Other support came from National Estates Grants Program, Queens Trust for Young Australians and Northern Territory University. Numerous volunteers assisted in field work. Our gratitude is extended to all. This work was conducted under permits from the Parks and Wildlife Commission of the Northern Territory (DASC 9558) and Northern Territory Animal Ethics Experimentation Committee (#950925).

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ENVIRONMENTAL CONSERVATION AND PROFESSIONALISM: A 21-YEAR PERSPECTIVE OF AN INDUSTRIAL ECOLOGIST

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In today's environment of corporate downsizing and less government where environmental concerns are becoming a low-priority item, the environmental professional needs to maintain an overall set of ethics and rules of engagement. The following points of guidance may be obvious to those who have practiced in the environmental field, but it is worthy to review what has worked for me as an environmental professional.

My rules of conduct or engagement are: 1) call an issue the way you see it based on your professional training and best judgment; 2) be truthful and forthright at all levels of your professional interactions; 3) insist on high professional standards from your peers, subordinates, and supervisors; 4) publish your data and release your reports; 5) go out of your way to keep people informed; 6) build partnerships and cooperative ventures with your constituencies; 7) listen to all points of view with patience and understanding; 8) success builds success: start small and build upon your success; 9) get involved to understand the issues: become part of the solution and not part of the problem.

These guidance points have helped me balance professionalism, conservation, and employment in a profit-making industry during my 21-year career as an ecologist and will continue to guide me in the future.

PART II. POSTER PRESENTATIONS

NESTING ACTIVITY OF SEA TURTLES ON ISHIGAKI ISLAND, RYUKYU ISLANDS, JAPAN

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Three species of sea turtles, *Caretta caretta*, *Chelonia mydas* and *Eretmochelys imbricata*, nest in the coast of Japan (Uchida and Nishiwaki, 1982). Ryukyu Islands, including Ishigaki Island, is utilized as a nesting site by all three species (Kamezaki, 1991). We have been monitoring the nesting activity of sea turtles on Ibaruma Beach, located on the northeast coast of Ishigaki Is., since 1993. Field surveys were done from April through August every two nights. On this beach, the nesting season extends from April through June for *C. caretta* and from May through August for *C. mydas*. The annual number of nests on the beach is 5-8 for *C. caretta* and 12-24 for *C. mydas*. No nest of *E. imbricata* was recorded in these 4 years. The nesting success rate was 48% for *C. caretta* and 37% for *C. mydas*. The annual average emergence rate of hatchlings for *C. caretta* and *C. mydas* were 69.2-87.9% and 46.3-92.1%, respectively. A field survey of nesting traces around the island in 1995-1996 revealed the sea turtle nesting sites have been restricted to the northeast peninsula of the island. The beaches which have restricted access for people, such as sandy beaches facing to pasture or short pocket beaches among rocky areas, were used as nesting sites in the peninsula. It is suggested that the reduction of human access to the sandy beaches correlated with the nesting activity of sea turtles in Ishigaki Is.

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INCIDENTAL CAPTURE OF SEA TURTLES IN THE SWORDFISH LONG LINE FISHERY

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Records of incidental capture of two species of sea turtle by longlines in the Southwest Atlantic Ocean are presented. That type of boat uses pelagic longline to capture swordfish, tunas and related species. The information was collected on board between 1994 and 1996. Data obtained by observers include initial and final geographic position (set and haul), surface water temperature, number of hooks, and total species captured. Hooks were baited with mackerel (*Scomber japonicus*) and mainly with squid (*Illex argentinus*). Total number of turtles captured was 106, composed by *Caretta caretta* (69.8%) and *Dermochelys coriacea* (30.2%). The average presence was 1.23 ind/1,000 hooks; 1.9% was found dead, and 98.1% was released alive but with the hook still in the body, mainly in the mouth.

SEASONAL EFFECTS OF TROPICAL STORMS ON THE HATCHING SUCCESS OF LOGGERHEAD TURTLE NESTS IN COLLIER COUNTY, FLORIDA

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In Florida, the loggerhead turtle (*Caretta caretta*) nesting season (May 1-October. 31) closely coincides with the Atlantic hurricane season (June 1- November 1). Storm surge, repeated over wash, and the resulting erosion and/or accretion associated with tropical weather systems can have profound impacts on nest hatching success (Milton *et al*., 1994). Rainfall events associated with storms can also influence nest success (Ragotzkie, 1959; Kraemer and Bell, 1979). An active 1995 Atlantic hurricane season caused abnormally low hatching success in Collier County, Florida. In contrast, the storm seasons of 1994 and 1996 were more typical for the Atlantic region. This report compares the hatching success of these three seasons.

METHODS

The nests evaluated were divided into three categories: completely washed away by storms, inundated but not washed away, and those not flooded during the incubation period. Nests that were washed away were not included with those evaluated for hatching success. To eliminate variables not related to inundation, nests that were depredated or invaded by roots were not included in the evaluated nests. Rainfall totals were documented from May 1 to October 31 for each year. Rainfall amounts were also recorded for a five day period centered around the date the storms impacted local beaches. Hatching success for non- inundated, inundated, and total combined nests was compared using analysis of variance.

RESULTS

The total number of live hatchlings recorded each season was 47,940, 19,590, and 45,616 in 1994, 1995, and 1996, respectively. The average hatching success of all evaluated nests was lower in 1995 than in 1994 and 1996 (Table 1). Significant differences were evident in the mean hatching success between these years ($F_{2,1681}$=81.44; $p_{0.05}$=3.00). For all three years there was a significant difference in the mean hatching success of inundated nests ($F_{2,511}$= 10.42; $p_{0.05}$= 3.01). However, there was no significant difference found for non-inundated nests ($F_{2,1167}$= 1.84; $p_{0.05}$= 3.00)(Fig. 1). The 1995 nesting season had the greatest percentage of both inundated (83%) and washed out (27%) nests (Table 2). In comparison, the 1994 and 1996 nesting season had only 23% and 11% of the nests inundated and 1% and 2% washed away, respectively. Four named storms affected the coast of Collier County during the 1995 nesting season. Collectively, they resulted in 32 in. of rain (Table 3). Two storms impacted southwest Florida in 1994 while only one occurred in 1996. Rainfall totals for all three nesting seasons varied considerably. During the sea turtle season rainfall totaled 45, 71, and 32 in. for 1994, 1995, and 1996, respectively. A large percentage of the monthly rainfall occurred while the tropical storms were influencing local weather conditions (Table 3).

DISCUSSION

The comparison between the hatching percentage of non-inundated versus inundated nests is indicative of the impacts tidal flooding can have on nest success. This is reflected in the overall hatching success of 1995, which was significantly lower than in both 1994 and 1996. The hatching success of nests that were not inundated did not vary between the three nesting seasons. Therefore, the increased rainfall caused by the storms does not appear to independently lower hatching success of the nests. The decreased hatching success in 1995 is attributable to the repeated wave and tidal flooding of many nests. The associated rainfall events may also have exacerbated the effects of waves and tides. The number of named tropical weather systems of 1994, 1995, and 1996 that influenced southwest Florida are listed in Table 2. Although a number of them passed close to Collier County, none made actual landfall in the immediate vicinity. However, the numerous storms still caused frequent changes in beach topography, nest inundation, and resulted in nests being washed out or buried. These factors had a profound impact on the number of hatchlings that were produced during the 1995 nesting season. Fifty-eight percent fewer hatchlings emerged in 1995 than were produced on average in 1994 and 1996. Major storms that make direct landfall are more dramatic in their immediate effects on nesting beaches, however, tropical storms and minor hurricanes passing offshore can also have profound impacts on nesting success, particularly if they occur repeatedly as was the case in 1995. While sea turtles are not r selected in an absolute definition of the term, the 1995 Atlantic hurricane season serves as a reminder of the enduring survival value of a reproductive strategy that involves repeated nesting and the deposition of hundreds of eggs by individual turtles each season.

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Table 1. Hatching Success of Evaluated Nests.

Year	1994	1995	1996
Total Nests Evaluated	564	594	710
Total Hatching Success	78%	56%	77%
Success of Inundated	67%	49%	58%
Success of Non-inundated	81%	77%	79%

Table 2. Number of Nests Inundated or Washed Away.

	1994	1995	1996
Total Nests Evaluated	564	594	710
Tropical Weather Systems Affecting Collier County	2	4	1
Number of Nests Inundated	132	492	75
Percentage of Nests Inundated	23%	83%	11%
Number of Nests Washed Away	7	162	16
Percentage of Nests Washed Away	1%	27%	2%

Table 3. Rainfall Associated With the Storm Events of 1995[1].

Storm Name and Date	Inches of Rain	Percentage of Total Monthly Rainfall
Hurricane Allison (06/02 to 06/06)	4.06	39%
Unnamed Storm Event (06/11 to 06/15)	0.45	4%
Hurricane Erin (07/31 to 08/04)	2.31	11%
Tropical Depression Jerry (08/22 to 08/26)	17.00	84%
Hurricane Opal (10/05 to 10/09)	8.26	52%

[1]Data for 1994 to 1996 storms events not available.

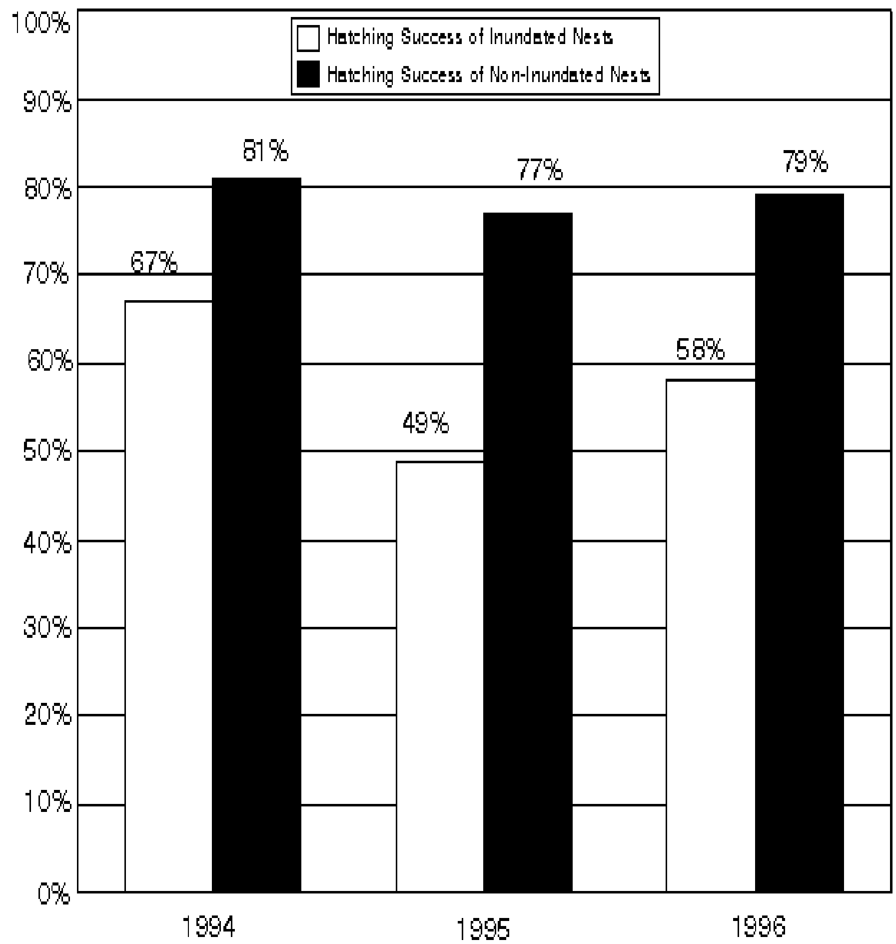

Fig. 1. Hatching Success of Inundated and Non-Inundated Nests.

OROPHARYNGEAL FIBROPAPILLOMAS IN HAWAIIAN GREEN TURTLES (*CHELONIA MYDAS*): PATHOLOGIC AND EPIDEMIOLOGIC PERSPECTIVES

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Pathologic examination of the oropharynx and adjacent tissues in five green turtles (*Chelonia mydas*) demonstrated fibropapillomas (FP). Size, appearance, and anatomic site of tumors confirmed that turtles presented total or partial inability to feed and breathe normally. A retrospective epidemiologic study based on 222 stranded green turtles necropsied from different locations in the Hawaiian Islands between 1991 and 1995, demonstrated that over 61% of the turtles with FP presented tumors in the oropharynx and adjacent tissues. Turtles with oropharyngeal tumors were larger than turtles with no oropharyngeal FP and turtles free of the disease. Female-biased sex ratios were also identified in turtles with oropharyngeal FP. During 1991 to 1995, 561 green turtles were captured live in Kaneohe Bay, Oahu. Of these, 42% had cutaneous FP, and 40% of the turtles with FP had oropharyngeal involvement. Fibropapillomas of the oropharynx in Hawaiian green turtles were invasive and seriously reduced survival and increased susceptibility to stranding.

ARE RED IMPORTED FIRE ANTS A THREAT TO HATCHING SEA TURTLES?

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Red imported fire ants (*Solenopsis invicta*) have been observed foraging in loggerhead (*Caretta caretta*) and green turtle (*Chelonia mydas*) nests in Florida. *Solenopsis invicta* are attracted to mucous and moisture, and may establish foraging tunnels into sea turtle nests shortly after egg-laying, making pipping turtles vulnerable to predation. To test the potential impact of *S. invicta* on pipping sea turtles, we conducted experiments on a surrogate species (*Pseudomys nelsoni*). Over 70% of the viable hatchlings were killed by *S. invicta* during pipping or shortly after hatching. Initial beach surveys indicate that *S. invicta* are abundant on beaches and dunes throughout Florida.

EVALUATION OF THE SUPER SHOOTER AND SEYMOUR TURTLE EXCLUDER DEVICES WITH DIFFERENT DEFLECTOR BAR SPACING IN THE SHRIMP FISHERY OF PACIFIC COSTA RICA

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As of May 1, 1996, the United States Government has enforced Public Law No. 101-162, which imposes an embargo on shrimp imports from countries that do not take measures to protect sea turtles from being caught and drowned during commercial shrimp fishing operations. Commercial shrimp fishing operations have been determined to be the main human induced cause of adult sea turtle mortality, and the expected measure to be taken is the implementation of the Turtle Excluder Devices (TED) in the shrimp fleets of nations where sea turtle/shrimp fishing interactions may prove to threaten survival of sea turtles. Despite the fact that TED technology is now being required worldwide for nations wishing to export shrimp products to the United States, all regulations (size and model of TED, deflector bar distance) are based on fisheries and sea turtle species in the Gulf of Mexico and the Atlantic coast of the United States. This may adverse acceptance by local central American shrimpers due to several reasons, mainly concerns regarding reduced shrimp and commercialized fin-fish caused by the imposition of TED regulations that are not based on local specific fishing conditions.

OBJECTIVES

1) Evaluate the performance of Super Shooter and Seymour TEDs regarding shrimp retention using different spacing between the deflector bars of the grid. 2) Evaluate the performance of Super Shooter and Seymour TEDs regarding retention of commercialized by-catch using different spacing between the deflector bars of the grid. 3) Evaluate the performance of Super Shooter and Seymour TEDs regarding the reduction of discarded by-catch, using different spacing between the deflector bars of the grid. 4) Evaluate the performance of Super Shooter and Seymour TEDs regarding sea turtle exclusion using different spacing between the deflector bars of the grid. 5) Advise the Costa Rican shrimp fishing sector on the modifications necessary to develop a TED adapted to our own fishing demands and conditions.

METHODOLOGY

Super Shooter and Seymour TED designs were used during the development of the project and bottom shooters were tested. After being calibrated, paired tows were carried out with a TED equipped net and a standard net as a control. Shrimp catch, fish catch, and discarded bycatch are separately weighed, and compared by means of a t test to determine if significant differences exist among the catch rates ($p < 0.05$). The shrimp fishery of Pacific Costa Rica was divided into six specific zones, depending on species of shrimp captured, depth and geographic location, and the performance of TEDs was evaluated independently in each fishing zone.

RESULTS

In Fig. 1 results of each trip are shown with vessel, fishing area, date, type of TED, total hours and percentage of efficiency of the TED (capture rate of shrimp, commercial by-catch and discarded by-catch. In total, 712.95 observer hours were recorded during 165 commercial drags.

CONCLUSION

In the white shrimp fisheries of Costa Rica (zones 1 to 3), the amount of logs and organic debris inhibit proper TED function and may cause significant shrimp and fish loss up to 37.73% and 43% respectively. Bottom shooting 8" Seymour TEDs with enlarged escape holes apparently improve performance because the wider bar spacing permits small debris to collect in the cod end, and by excluding larger logs and debris more efficiently. However, their performance regarding fish and bycatch is still uncertain. In the deeper waters where organic debris is not a problem (zones 4 to 6), 4" bottom shooting Super Shooter TEDs work efficiently regarding the shrimp and fish catch, but do not reduce the bycatch to a significant extent. Turtles in Costa Rican waters are not caught when 8" deflector bar spacing is used, contrary to 10" deflector bar spacing which allows turtles through the grid into the cod end of the net. To implement the use of TEDs in Costa Rica, and other Central American countries, TEDs must have few economic costs to the fishermen and must have some benefits. The continuation of research into performance of Super Shooter and Seymour TEDs with 6" and 8" deflector bar spacing in the problem fishing areas (zones 1 to 3), is necessary to advise the Costa Rican shrimping industry on models and modifications of TEDs that suit the industry best, without endangering the sea turtles.

ACKNOWLEDGMENTS

I gratefully acknowledge Dr. Solon Chavarría and Frank Gutierrez for their initial support of this project since 1991, Enrique Barrau and Arturo Villalobos of USAID-Costa Rica Mission and Arturo Vicente of National Commission for Scientific and Technological Research of Costa Rica (CONICIT), and Alexis Gutierrez, President of the Puntarenas Fishing Chamber, who made arrangements with the fishermen of the chamber for us to use their vessels. This study was funded by CONICIT and USAID-Costa Rica, with extra support from the Puntarenas Fishing Chamber, the Costa Rican Fishery Institute (INCOPESCA)and the Sea Turtle Restoration Project of Earth Island Institute.

Table 1. Performance of top and bottom shooting Super Shooter (SS) and Seymour (Sey) Turtle Excluder Devices (TEDs) using different deflector bar spacing in the shrimp fishery of Pacific Costa Rica (1995-1996).

Vessel	Date	TED type	# drags	hours	shrimp	p	Fish	p	bycatch	p
Performance of TEDs in the Gulf of Nicoya white shrimp fishery										
Nautilius II	22/8-2/9/95	SS, 4", bottom	4	21.41	-19.53	0.346	-24.29	0.489	-19.698	0.276
Don Beto	18-21/2/96	SS, 5.5", bottom	9	43.55	-1.8	0.586	-8.62	0.347	-	-
Don Manolo	6-10/3/96	SS, 5.5", bottom	11	56.1	-37.37	0.004	-20.31	0.327	-26.6	0.027
Andi	10-15/4/96	SS, 5.5", bottom	4	16.25	-28.57	0.13	9.2	0.63	-9.9	0.124
Ana Lourdes	3-11/9/96	SS, 8", bottom	23	87.48	-30.97	0.004	-7	0.351	-22.6	0.2
Karla G	18-25/11/96	SS, 8", top	9	38.67	-16	0.15	-22.78	0.157	-14.66	0.133
Performance of TEDs in the south Pacific white shrimp fishery										
Río Grande	7-16/11/95	SS, 4", top	4	14.95	-16.23	0.195	-33.73	0.479	-	-
Edjorka	26/11-7/12/96	Sey, 8", bottom	10	44.58	-12.47	0.185	-30.57	0.024	-21.94	0.002
Capt Lostalo	30/10-3/11/96	Sey, 8", bottom	10	44.56	-4.92	0.444	8.06	0.639	-14.41	0.353
Edjorka	24/9-6/10/96	SS, 10", bottom	7	31.06	-19.88	0.056	-18.04	0.326	-34.86	0.03
Monarka	24-29/10/96	SS, 10", bottom	13	38.79	-32.55	0.01	-31.32	0.367	-10.72	0.04
Edjorka	24/10-6/11/96	SS, 8", bottom	8	30	-9.81	0.081	-11.41	0.255	-28.01	0.003
Edjorka	24/10-6/11/96	SS, 8", bottom	9	37.3	-34	0.016	-22.77	0.049	-31.65	0.004
Karla G	18-25/11/96	SS, 8", top	4	22.5	-24.7	0.008	-8.34		-24	0.004
Performance of TEDs in the Golfo Dulce white shrimp fishery										
Joshua	16-21/5/96	Sey, 4", bottom	6	31.6	-27.78	0.171	-34.04	0.109	-	-
Performance of TEDs in the north Pacific pink shrimp fishery										
Andi	10-15/4/96	SS, 4", top	4	29.5	-14.51	0.237	-24.53	0.79	-22.45	0.095
Performance of TEDs in the south Pacific pink shrimp fishery										
Karla G	14-25/5/95	SS, 4", bottom	6	43.25	-3.32	0.016	-36.02	0.013	1.95	0.785
Joshua	24/4-4/5/96	SS, 4", bottom	3	16.75	2.13	0.263	52.18	0.283	-7.89	0.176
Joshua	24/4-4/5/96	SS, 4", top	1	5.25	-28.57	-	-61.54	-	-	-
Performance of TEDs in the deep fidel shrimp fishery										
Joshua	16-21/5/96	Sey, 4", bottom	11	33	-2.67	0.081	-	-	-	-
Joshua	24/4-4/5/96	SS, 4", bottom	7	17.45	-5.7	0.214	42.86	0.206	-13.85	0.195
Joshua	24/4-4/5/96	SS, 4", top	2	8.95	-34.97	-	-100	-	-	-
Total			**165**	**712.95**						

Table 2. Sea Turtle Exclusion using top and bottom shooting Super Shooter (SS) and Seymour (Sey) Turtle Excluder Devices (TEDs) with different deflector bar spacing (4”, 5.5”, and 10”) in the shrimp fishery of Pacific Costa Rica (1995-1996).

Vessel	Date	TED TYPE	Hours	Fishing Zone	# turtles TED net	# turtles control net
Edjorka	3-15/10/95	SS, 4", bottom	14.5	2	0	1
Karla G	5-21/5/95	SS, 4", bottom	43.25	5	0	2
Nautilius	22/8-2/9/95	SS, 4", bottom	21.41	1	0	5
Joshua	24/4-4/5/96	SS, 4", bottom	17.45	6	0	0
Joshua	24/4-4/5/96	SS, 4", bottom	16.75	5	0	0
Río Grande	2-7/11/95	SS, 4", top	14.95	2	0	1
Andi	10-15/4/96	SS, 4", top	29.5	4	0	3
Joshua	24/4-4/5/96	SS, 4", top	5.25	5	0	0
Joshua	24/4-4/5/96	SS, 4", top	8.95	6	0	0
Ma. Aurelia	3-11/1/96	SS, 4", bottom	17	2	0	0
Joshua	16-22/5/96	SS, 4", bottom	33	6	0	0
Joshua	16-22/5/96	Sey, 4", bottom	31.6	3	0	1
Total			**253.61**		**0**	**13**
Don Manolo	6-19/3/96	SS, 5.5", bottom	56.1	1	0	0
Don Beto	18-21/2/96	SS, 5.5", bottom	43.55	1	0	0
Andi	10-15/4/96	SS, 5.5", bottom	16.25	1	0	4
Total			**115.9**		**0**	**4**
Capt. Lostalo	30/10-3/11/96	Sey, 8", bottom	44.56	2	0	1
Edjorka V3	26/11-7/12/96	Sey, 8", bottom	44.58	2	0	0
Ana Lourdes	3-11/9/96	SS, 8", bottom	87.48	1	2*	9
Edjorka V2	24/10-6/11/96	SS, 8", bottom	67	2	0	1
Karla G	18-25/11/96	SS, 8", top	61.17	2	0	3
Total			**304.79**		**2**	**14**
Edjorka	24/9-6/10/96	SS, 10", bottom	31.06	2	1	2
Monarka	24-29/10/96	SS, 10", bottom	38.79	2	0	0
Total			**69.85**		**1**	**2**

* The TED was clogged with debris, thus the turtles didn’t even make it to the escape hole of the TED.

THE SEA TURTLE PROGRAM OF XCARET, THE ECO- ARCHEOLOGICAL PARK IN QUINTANA ROO, MÉXICO

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INTRODUCTION

On the coasts of the state of Quintana Roo are found the principle nesting areas for loggerhead (*Caretta caretta*) and green (*Chelonia mydas*) turtles (with 2,166 and 481-2,296 nests respectively) in México (Zurita *et al*., 1993), (Fig. 1). Since 1991, Xcaret has participated in various sea turtle conservation activities in the Mexican Caribbean. In 1996, we continued a sea turtle conservation program on the central coast of Quintana Roo, carrying on the work that the defunct "Centro de Investigaciones de Quintana Roo" (CIQRO) started. This presentation is a description and the results of our work during 1996. Including a review of the living tag program in the Eco-Archeological Park.

METHODS

We protected 13 beaches in coordination with SEMARNAP, approximately 19.5 miles of beach in total, from May to October. Some nests were left in situ and others were taken to hatcheries. Two methods were used to evaluate the success among inventoried nests: 1. hatching success - the number of hatchlings that successfully pipped free of the shell divided by the total number of eggs in the nest and 2. emergence success - the number of hatchlings that successfully emerged from the nest (in the hatcheries, some of the hatchlings were helped) divided by the total number of eggs in the nest. Using Hendrickson's (1981, 1986) technique, we tagged some of the green and loggerhead hatchlings from Xcacel beach. The hatchlings were taken to Xcaret where they were tagged and kept for 15 days, then returned to Xcacel where they were released.

RESULTS AND DISCUSSION

Loggerhead nesting occurs from May to September, with a peak in July; the green turtle nesting season starts in June and ends in September, with a peak in late July or early August. This year we recorded a total of 1717 loggerhead nests and 758 green nests (Table 1). The major cause of loss among the nests was poaching (9% of the loggerhead nests and 5.41% of the green nests). The area most effected by poaching was the beaches in the Sian Ka'an (Kanzul, Cahpechen and Tankah). The major loss of nests by flooding was 8.4% of the green nests. This was because of morphologic changes in the beaches due to erosion caused by Hurricane Roxanna in 1995. The main predator of turtle eggs on the beaches were dogs and racoons, who destroyed about 2% for both species (Table 1).

The data of hatching success and emergence success for nests left in situ for both species does not include losses due to abiotic and biotic factors. The reproductive data for both species is included in Table 2. The emergence success for the loggerheads ranges from 81.59 % to 92.91 % for nests left in situ; and for translocated nests ranges from 63 % to 90 % (Fig. 2). For the green turtle, emergence success ranges from 79.15 % to 92.78 % for nests left in situ; and for translocated nests ranges from 63.50 % to 92.33 % (Fig. 3). Emergence success was either the same or slightly lower than hatching success for each nest, the difference being the number of hatchlings that died in the nest. The mean emergence success value for all nests was 81.97 % for green and 82 % for loggerhead turtles. The hatching success for green turtles was 85.95 % and 85.65 for loggerhead turtles.

A total of 131,955 loggerhead and 62,467 green hatchlings reached the ocean at the end of the season. Of these, 4,025 loggerhead and 7,429 green sea turtles were tagged using the "living tag" technique (Fig. 4). It represents a important effort or conservation which have begun in 1990 on the Quintana Roo coast by CIQRO and has been continued at

Xcaret for the past three years. Utilizing 200 green sea turtle hatchlings kept in captivity since 1995 in the park we have conducted educational activities for more than 300,000 visitors (Mexican and foreign). The participation of other institutions is necessary to continue the conservation program on the main loggerhead and green nesting beaches, and more environmental education is needed to try to reduce the level of poaching in the study area.

ACKNOWLEDGMENTS

This program was authorized by SEMARNAP. El Colegio de la Frontera Sur (ECOSUR) provided advice. We thank the many volunteers and field workers especially to Eligio Guzman, special thanks to Julio Zurita for all the help to make this work.

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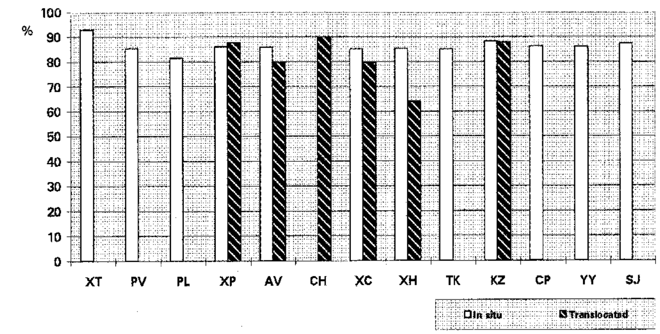
Table 1. Nesting season 1996: Outcome of loggerhead and green sea turtle nest.

	Chelonia mydas	*Caretta caretta*
Nests total	758	1717
Nests surviving to term	605	1418
Nests poaching	41 (5.41)	155 (9.03)
Nests predation	16 (2.11)	76 (4.43)
Nests erosion	64 (8.44)	48 (2.80)
Unknown	31 (4.09)	19 (1.11)

* 2 nests were not included; one loggerhead and one green turtle that were destroyed by the nesting activity of other turtles.
The numbers in parentheses ( ) indicate %

Figure 2. Emergence success of *Caretta caretta* on the various beaches



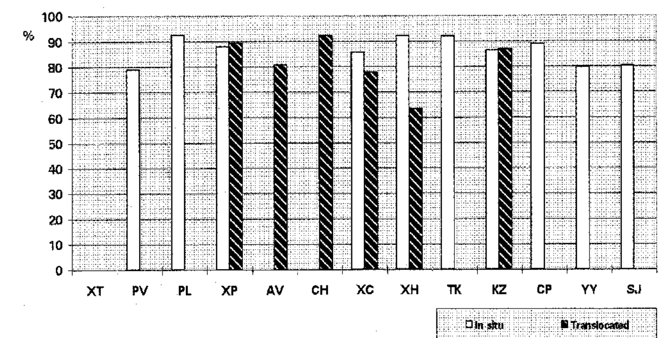
Playas XT = Xcaret, PV = Punta Venado, PL = Pamul, XP = Xpuha, AV = Aventuras DIF, CH = Chemuyil, XC = Xcacel, XH = Xelha, TK = Tankah, KZ = Kanzul, CP = Caapechen-Linos, YY = Yum-Yum, SJ = San Juan

Table 2. Reproductive data for loggerhead and green sea turtles nesting in Qintana Roo

	Chelonia mydas	
	Translocated	in situ
Number of nests	335	270
% emergence success	77.94	87.04
% hatching success	84.19	88.16
Hatching dead	2656	375
Hatching live	33123	29344
	Caretta caretta	
	Translocated	in situ
Number of nests	882	536
% emergence success	68.36	86.5
% hatching success	76.74	88.2
Hatching dead	6016	1026
Hatching live	79077	52878

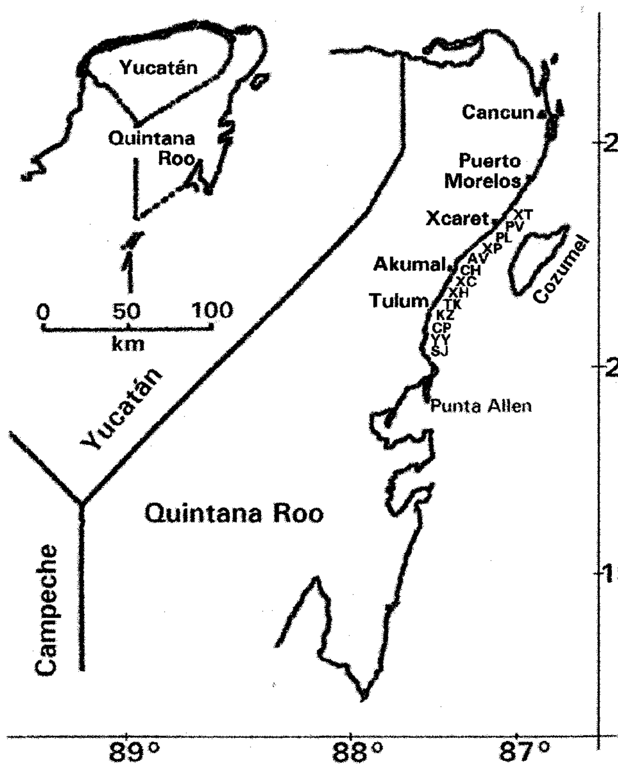
Total cluctch for C. Mydas 605, for C. caretta 1418

Figure 3. Emergence success of *Chelonia mydas* on the various beaches



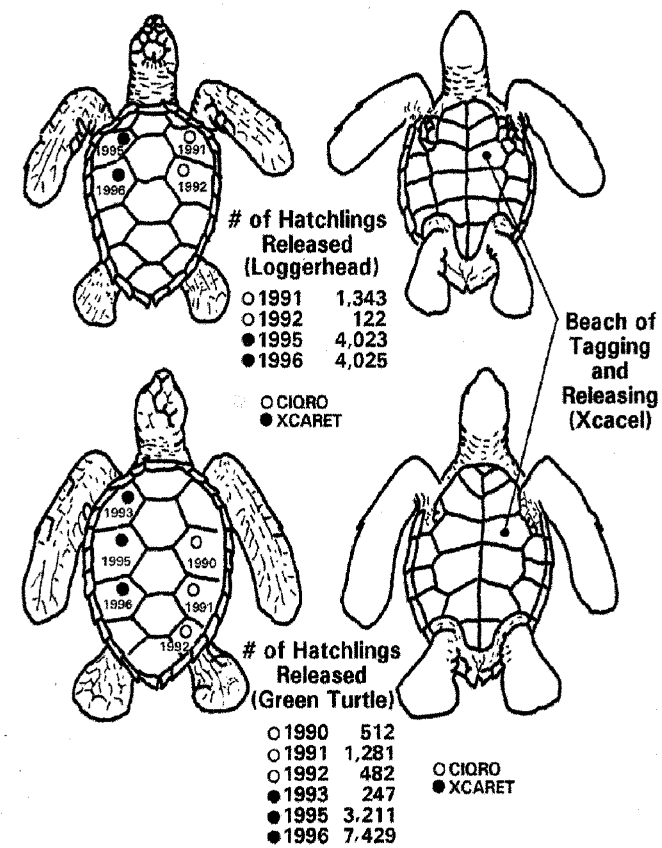
Playas XT = Xcaret, PV = Punta Venado, PL = Pamul, XP = Xpuha, AV = Aventuras DIF, CH = Chemuyil, XC = Xcacel, XH = Xelha, TK = Tankah, KZ = Kanzul, CP = Caapechen-Linos, YY = Yum-Yum, SJ = San Juan

Figure 1. Study Zone



Protected beaches: XT = Xcaret, PV = Punta Venado, PL = Pamul, XP = Xpuha, AV = Aventuras DIF, CH = Chemuyil, XC = Xcacel, XH = Xelha, TK = Tankah, KX = Kanzul, CP = Cahpechen, yy = Yu-Yum, SJ = San Juan.

Figure 4. Live Tagging Project



EQUILIBRIUM RESPONSES TO ROTATIONAL DISPLACEMENTS BY HATCHLING SEA TURTLES: A MIGRATORY HEADING IN A TURBULENT OCEAN

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During their offshore migration through the surf zone, sea turtle hatchlings experience many different types of wave action. These conditions may cause the hatchlings to "roll", or be swept vertically in a sideways, semicircular motion, which would displace them from the patch of migration. Hatchlings loggerheads and green turtles, when rolled, exhibited a stereotypic movement of the front flippers, which would serve to right the turtles with respect to the gravity vector. This behavior would keep hatchlings properly oriented and thus aid in keeping them on course during the migration into deeper water.

MARINE TURTLE NESTING IN THE ARCHIE CARR NATIONAL WILDLIFE REFUGE IN 1996: A NEW RECORD FOR LEATHERBACKS

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The summer of 1996 was the 15th consecutive season that the U.C.F. Marine Turtle Research group has studied marine turtle nest production and reproductive success in south Brevard County in the area now known as the Archie Carr National Wildlife Refuge, and the 8th consecutive summer that the group has worked in central Brevard County, between Patrick AFB and Melbourne Beach. All nesting and non-nesting marine turtle emergences were identified as to species and counted by trained biology students during morning surveys from 5 May through 23 September in 1996. A sample of 460 nests was marked for reproductive success.

In the Carr Refuge Study Area (CRSA), loggerhead (*Caretta caretta*) nest production at 14,305 exceeded the comprehensive (1982-1995) average by 28%; the 5,719 nests in the Central Brevard Study Area (CBSA) brought the 1996 total to 20,024 (Fig. 1 and 4). Green turtles (*Chelonia mydas*) adhere to a biennial pattern of highs and lows, and 1996 was expected to be a "high" year. Although it was 26% lower than the record-setting year of 1994, it was still the second highest number for this beach since we began studying it in 1982 (Fig. 2); an additional 169 nests in CBSA made a total of 990 (Fig. 5).

During the past decade expectation for the number of leatherback (*Dermochelys coriacea*) nests on South Brevard beaches has been minimal (Fig. 3). Surprisingly, this season, there were ten leatherback nests in CRSA and additional two in CBSA; three times as many as ever before! University of Florida students working in CRSA verified the return of a leatherback tagged by UCF in 1994; the first we had seen since 1983. The last one of the 1996 season was encountered, tagged and photographed by a crew member during the morning of 30 June.

The weather on the coast and conditions on the beach were rougher than expected and conditions for incubation were far from optimal. Four major hurricanes passed along the east Florida coast in the Atlantic, producing large swells and heavy surf that battered the beaches. Hurricane Bertha required evacuation of the barrier island. While the overall effect of the tropical weather was not as severe as in 1995, the 1996 season was the eighth most active on record, and taken together, the hurricane seasons of 1995 and 1996 constituted the most active two-year period since the beginning of the record-keeping era. Reproductive success (here defined as the percentage of total hatchlings that emerge from the nest) over the previous eleven years has ranged from 40.2% to 66.9% in loggerheads and from 46.6% to 75.2% in green turtles within the Carr Refuge Study Area. (The lowest reproductive success rates were from the turbulent 1995 nesting season). The negative impact on reproductive success was not quite as severe in 1996. A sample of 143 loggerhead nests was found to have an emerging success rate of 49.7%, while the 71 Florida green turtle nests analyzed yielded 62.6%.

For the past three years, the UCF group has been collaborating with Barbara Schroeder (NMFS) in a satellite telemetry study of on post-nesting green turtles. During the 1996 season, we installed four new transmitters and recaptured two of the three turtles fitted with transmitters in 1994, to remove their non-functional transmitters. Mating turtles are occasionally seen offshore, usually too far away to be photographed. This year mating green turtles were observed and photographed at least twice in CRSA, documenting that at least some males travel as far as the nesting beach. On 19 August, we found a Carr Refuge green turtle dead in the surf; a piece of discarded, shell-encrusted gill net wrapped around her flipper. As bad luck would have it, she was one of only nine greens encountered and tagged in 1986 by UCF and even then, had been previously tagged by another researcher; hence one of our longest tracked females. Although we were never able to obtain the original tagging data, she had been seen five times since our 1986 tag date and had been encountered once previously in 1996.

Nest production data continues to confirm the foresight and wisdom shown in the decision to create the Archie Carr National Wildlife Refuge in south Brevard County. Acquisition of refuge lands is only about 70% complete and commercial and residential development is booming within the refuge boundaries. Each new construction project contributes some degree of habitat deterioration. These results convey a sense of urgency to the Carr Refuge concept as a whole and should provide an impetus to the initiative for land acquisition by all levels of government and other institutions and organizations committed to wildlife and wilderness conservation.

ACKNOWLEDGMENTS

We would like to thank the U.S. Fish and Wildlife Service and especially Sandy McPherson for their continued support. We would also like to express our appreciation to Kathy Moore and her NMFS group as well as University of Florida students Sarah Bouchard, Kate Moran, Manjula Tiwari, and Dan Wood, who, while working on their own projects, collected data for us as well. This cooperative effort allowed for much more beach coverage than we alone could provide, and resulted in 350 new entries to our database, either as newly tagged turtles or valuable recaptures. Photo thanks to Dan Wood for his mating green turtles, Shigetomo Hirama for his leatherback, and to Boyd Blihovde for his green turtle. Thanks to the U.C.F. GAMES Lab (Geospatial Analysis and Modeling of Ecological Systems): Jeff Boutet for his hours of dedication to this poster project, and to Dr. John Weishampel for providing the necessary equipment. Thanks to Doc for keeping us all going, and to the rest of the UCF crew for their many long nights of searching for green turtles on top of many long days of netting.

INCREASING LOGGERHEAD NEST SUCCESS THROUGH PREDATOR CONTROL MEASURES ON A NORTHWEST FLORIDA BARRIER ISLAND

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INTRODUCTION

Franklin County is located on the Gulf of Mexico along the northwest coast of Florida (Fig. 1). The gulf beaches of Franklin County, most of which are located on the four barrier islands surrounding Apalachicola Bay, are important loggerhead (*Caretta caretta*) sea turtle nesting areas (Lewis *et al*., 1996). The two western most islands are St. Vincent Island, managed by the U. S. Fish and Wildlife Service as a National Wildlife Refuge (NWR), and Cape St. George Island, managed by the Florida Department of Environmental Protection (FDEP) through the Apalachicola National Estuarine Research Reserve (ANERR). Both of these islands are undeveloped and relatively pristine. Dog Island and St. George Island located at the east end of the bay are sparsely and highly developed respectively. It has been observed by Lewis *et al*. (1995) that depredation of sea turtle eggs by raccoons (*Procyon lotor*) and feral hogs (*Sus scrofa*) is only evident on the undeveloped barrier islands. Cape St. George Island is a narrow, 931 hectare island, providing approximately 15 km of relatively pristine nesting beach. This beach has been monitored for sea turtle nesting activity since 1983 (Meylan *et al*., 1995). Significant depredation (25% to 100%) of sea turtle nests by raccoons has been documented from 1990-1995 on Cape St. George. A rigorous predator control program was approved by the FDEP and implemented by ANERR staff during the 1996 season.

NEST MONITORING AND PROTECTION METHODS

Cape St. George Island, accessible only by boat, is monitored for nesting activity as often as staff time and weather permit, usually averaging 2 to 3 times per week. A four-wheel all terrain vehicle (ATV) is used to patrol the entire length of the gulf beach. General data, such as date, observer, crawl width, and location including detailed directions, landmarks, and position in latitude and longitude coordinates via a hand-held Loran-C unit, are recorded for all crawls. Crawls that result in a successful nest (eggs present) are covered by a 1.2 m x 1.2 m self-releasing screen. Ten centimeters around the perimeter, the screen is bent down, inserted into the sand, and then the entire screen is buried approximately 2-3 cm beneath the sand's surface. This screen, if deployed in time, can effectively prevent raccoons from entering the nest without inhibiting the exodus of the hatchlings. The nests are marked with a PVC stake and three blue flags which together form a square around the nest cavity. The nest I.D. number and a "Do Not Disturb" sign, which states the presence of a sea turtle nest and quotes the Florida Law (Chapter 370) and the portion of the Federal Endangered Species Act pertaining to sea turtles and their nests, are located on the stake. Another blue flag is placed at the seaward base of the primary dune line. After 75 days or determination of hatching, all nests are revisited and excavated to determine hatch success. Hatch success is determined by counting eggshells (hatched), unhatched eggs, and dead turtles found buried in the nest.

PREDATOR CONTROL METHODS

The two methods of raccoon removal used on Cape St. George Island are live traps and night time "spotting" with a spot light and a small caliber rifle. Only raccoons on the gulf beach are targeted since it is believed that the raccoons do not traverse the island except on the narrow overwash areas. This theory is supported by a tag and recapture experiment (unpublished) that was performed in the fall of 1996 and revealed that 80% of the recaptured raccoons moved 0.8 km or less over the four week study period. Feral hogs are eliminated using the spotting method only since the traps are too small to accommodate them. Tomahawk single-door live traps were set in areas of the beach where high densities of raccoon tracks were observed, usually near the primary dune line. Traps were baited with a half can of sardines packed in fish oil and left overnight. Traps were set year round on the beach on a irregular basis as staff time allowed.

The spotting method consisted of staff patrolling the beach at night on a six-wheel all terrain vehicle while shining a 1,000,000 candle power spot light periodically to locate raccoons/hogs that were foraging on the beach near the water. By riding high on the beach near the dunes, staff were able to get between the raccoon/hogs and the coastal strand, thereby allowing more time for a kill shot with a 22-caliber rifle. This method of predator control is used only after the nesting season during the fall and winter months as not to interfere with nesting/hatching activity. All carcasses are disposed of in accordance with Resource Management Policy #1 of the FDEP, Division of Marine Resources, Bureau of Coastal and Aquatic Managed Areas. The policy states that the carcasses be left in the wild out of public view and in a manner so that they will not contaminate a waterway.

RESULTS

In the six year period from 1990 to 1995, a total of only 42 raccoons and 17 hogs were eliminated from the island, ranging from 1 to 18 raccoons and 3 to 7 hogs each year. Depredation of nests ranged from 51% to 100% during this same six year period. During 1996 with the increased predator control effort, a total of 69 raccoons and 8 hogs were eliminated. Corresponding with this increase in predator removal, the percent of nests depredated by raccoons and hogs decreased to 9% for the 1996 nesting season (Fig. 2).

FUTURE PLANS FOR PREDATOR CONTROL

ANERR will continue to remove raccoons and feral hogs from the island using the trapping and spotting methods mentioned in this paper. The U. S. Fish and Wildlife Service has expressed an interest in placing one or two red wolves (*Canis rufus*) on Cape St. George Island in 1997 as part of their Red Wolf Captive Breeding Program. This would enhance ANERR's predator control program since raccoons would provide the main prey base for red wolves on the island. Although there is some concern that red wolves may depredate turtle nests, the threat appears low since St. Vincent NWR has accommodated several pairs of wolves since 1990 and during the past six years, their staff have documented only 3 cases of wolves depredating turtle nests. In all three of these cases, the wolves appeared to be secondary or tertiary predators, following raccoons and/or feral hogs.

Cape St. George Island represents a unique opportunity to study sea turtle nesting in an area not impacted by developmental pressures and where human disturbance is minimal. The predator control program has allowed the Reserve to achieve higher rates of hatch success for sea turtle nests on this barrier island.

ACKNOWLEDGMENTS

The authors would like to thank the following people for their assistance in ANERR's marine turtle nest monitoring/protection program and in the preparation of this paper: Thomas E. Lewis (U.S. Fish and Wildlife Service, St. Vincent NWR), Erik Lovestrand (ANERR), Jimmy Moses (ANERR), Patrick Millender (ANERR), Dora McCarthy (ANERR), Misty Nabers (ANERR), and Wayne Vonada (ANERR).

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DIFFERENCES IN FLIPPER SIZE AND ESOPHAGUS MORPHOLOGY OF GREEN TURTLES FROM HAWAII AND FLORIDA

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Remarkable and significant differences exist in certain morphological features of green turtles (*Chelonia mydas*) originating from the Hawaiian Islands and Florida. These dichotomous characteristics have not been fully recognized, described, quantified, and appreciated in the manner that they deserve. The purpose of this paper is to focus attention on two features; the comparative sizes of the flippers and the morphology of the esophagus.

Side-by-side detailed examinations including the standardized tracing of flippers, recording of morphometrics and conduction of necropsies with photographic documentation were carried out on a 49.5 cm SCL (straight carapace length) green turtle from Puako, Hawaii and a 50.2 cm SCL green turtle from Brevard County, Florida. The turtle from Hawaii was found to have hind flippers 74% larger and front flippers 48% larger than the counterpart flippers of the Florida turtle (Fig. 1). The hind flippers were also traced and the area computed in nine other pairs of green turtles from Hawaii and Florida of nearly identical carapace lengths (ranging from 39 to 67 cm). A t-test analysis conducted for the mean of each pair of hind flippers showed a highly significant difference for all pairs (P>0.0001). The hind flippers of the Hawaiian turtles were larger than their counterparts from Florida (Fig. 2). These findings are consistent with our earlier work comparing the hind flipper sizes of newly hatched green turtles from Hawaii and Florida (Wyneken and Balazs, 1996).

The side-by-side necropsies revealed that the Hawaiian turtle had a well-developed crop filled with fresh algal food material located in the posterior region of the esophagus just prior to the stomach. In contrast, the turtle from Florida had no structure of this nature whatsoever. Prominent crops have been consistently observed in hundreds of post-pelagic Hawaiian green turtles ranging from 35 to 102 cm SCL necropsied over the past 24 years. Researchers in Florida with considerable experience conducting necropsies of green turtles have never documented the presence of a crop (K. Bjorndal, A. Foley, E. Jacobson, pers. comm.). Rainey's (1981) guide to sea turtle visceral anatomy makes no mention of a crop in green turtles. However, the apparently common presence of crops in green turtles from Australia has been documented and described in a little-known unpublished thesis (Thompson, 1980).

Why are the flippers larger in Hawaiian green turtles and why do they have a crop? A plausible explanation could be that Hawaiian turtles need to be stronger swimmers to succeed in their somewhat more hostile environment feeding along wind-swept rugged coastlines where large waves crash ashore. In addition, Hawaiian turtles undertake reproductive migrations in excess of 2000 km across rough pelagic waters, while Florida's green turtles appear to be mainly coastal voyagers when migrating to breed. A crop would permit more food to be ingested during each foraging event. Possibly the hardships of habitat conditions in Hawaii and Australia, including predators such as tiger sharks, make it advantageous to consume as much food as possible at one time. The possible role of a crop in the formation of oral fibropapillomas in Hawaiian green turtles needs to be examined since tumors of the mouth are absent in turtles from Florida. Differences in the sizes of flippers and presence or absence of a crop may involve all Pacific versus Atlantic populations of green turtles, rather than just the ones in Hawaii and Florida reported upon in this study. Additional work is in progress by the authors to clarify this point.

ACKNOWLEDGMENTS

We greatly appreciate the valuable assistance of Lew Ehrhart, Dean Bagley, Denise Ellis, Marc Rice, George Watson, Mike Salmon and the Hawaii Preparatory Academy in the conduction of this research.

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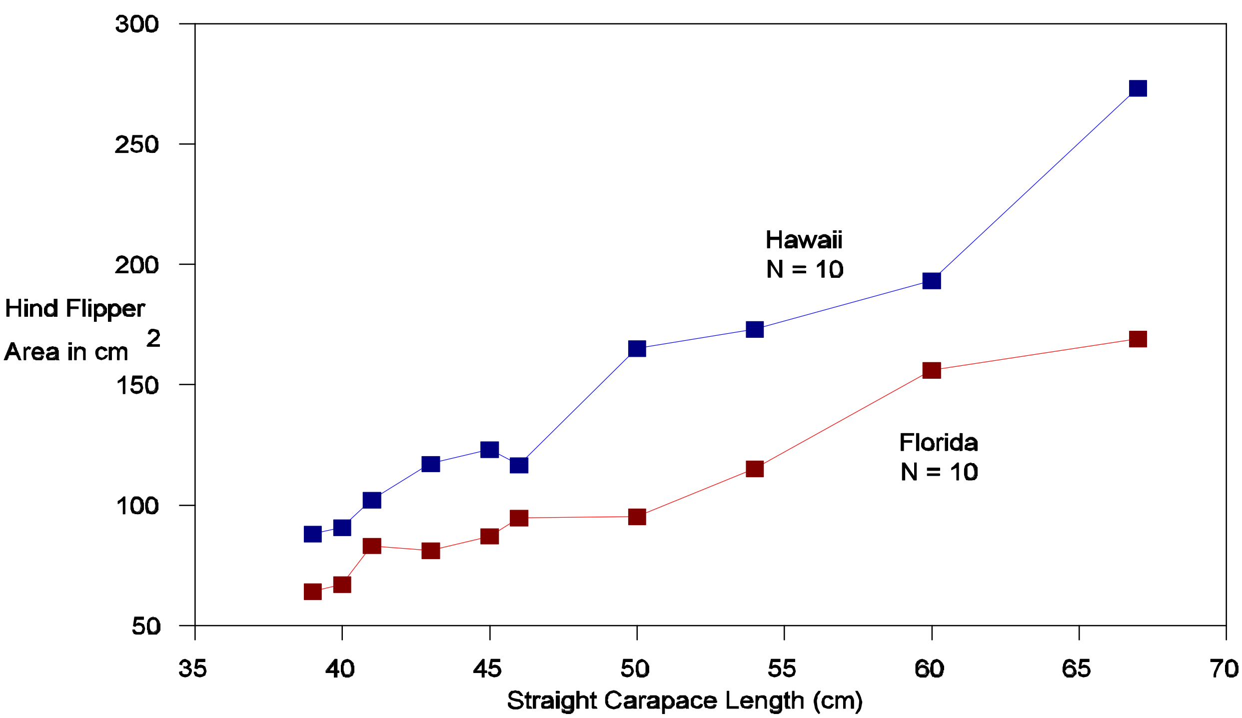

Figure 2. Paired comparisons of the hind flipper sizes of 10 Hawaiian and 10 Floridian green turtles with nearly indentical carapace lengths.

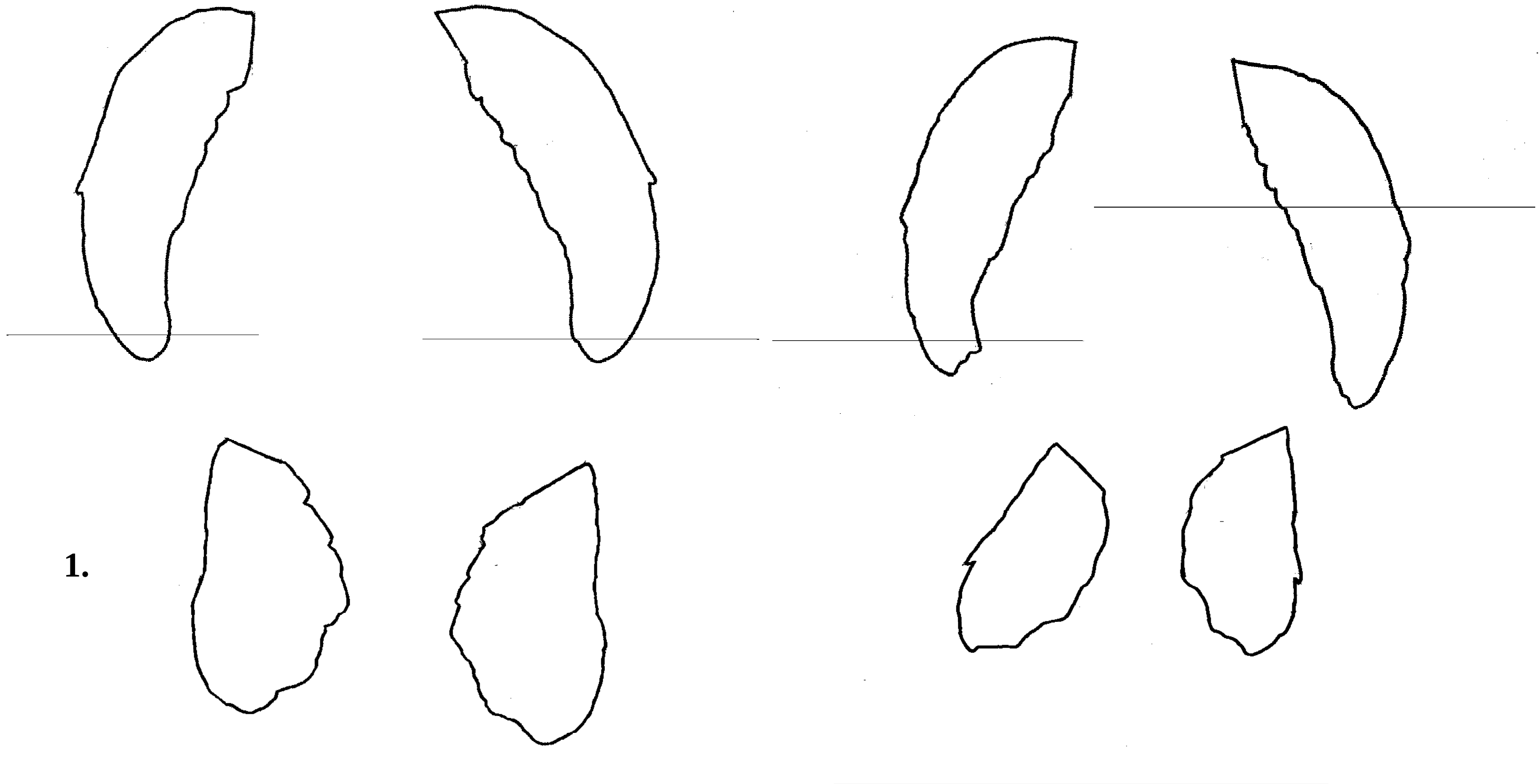

Figure 1.

Flipper tracings of a 49.5 cm green turtle from Hawaii

Flipper tracings of a 50.2 cm. green turtle from Florida

The area of each tracing was digitally measured using a Sigma-Scan Digitizer scanning program. Each flipper was scanned three times, the mean tabulated, and then the means computed for the front and hind flippers. Tracings shown here are proportionally scaled down.

GROWTH RATES AND INCIDENCE OF FIBROPAPILLOMATOSIS IN HAWAIIAN GREEN TURTLES UTILIZING COASTAL FORAGING PASTURES AT PALAAU, MOLOKAI

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Long-term studies of green turtles, *Chelonia mydas* (honu), in the Hawaiian Islands have been underway to obtain comprehensive data on growth rates, health status, population trends, food sources, habitat use, reproductive migrations, and underwater behaviors. Systematic monitoring for 24 consecutive seasons (1973-96) at the principal breeding site of French Frigate Shoals (FFS) has documented a significant increase in nesting females (Wetherall *et al*., 1997). However, fibropapillomatosis (FP), a debilitating and often fatal sea turtle disease, is currently an inhibiting factor to the full recovery of the Hawaiian green turtle population. The disease involves the formation of multiple fibrous tumors up to 25 cm in diameter on the eyes, in the mouth, and on all skin surfaces. Other sites affected less frequently include the carapace, plastron, and internal organs. The increase of FP and its epidemiological aspects in Hawaii have been documented in a major foraging aggregation at Palaau, Molokai. Some of the significant results of this work are summarized in this paper.

Green turtles were obtained alive and unharmed as by-catch in a bullpen, a fishing technique similar to the use of pound nets on the U.S. Atlantic coast and fish weirs in the South Pacific, Philippines and Taiwan. From 1982-96, 1,458 green turtles ranging from 34.4 to 89.3 cm in straight carapace length (SCL) were captured, tagged and released along the southern coast of Molokai. During this period a massive increase of FP was recorded, peaking at 61% prevalence in 1995 (Fig. 1). A similar increase of the disease also occurred elsewhere in Hawaii from 1982-96, based on data from strandings, in-water research, and other observations.

Two-hundred and three or 13.9% of the 1,458 turtles were recaptured one or more times, of which 171 turtles ranging from 38.0 to 84.6 cm yielded SCL remeasurement data useful for determining growth. A single growth increment was computed for each turtle based on the initial capture measurement and the measurement taken when last recaptured. The time intervals for the 171 growth increments ranged from 3 months to 12.3 years.

The overall mean growth rate was 2.1 ± 0.9 cm/yr. When each turtle was assigned to a 5 cm size category, ANOVA revealed a significant difference in growth for 10 different size classes (Fig. 2). Duncan-Waller analyses showed that growth rates were significantly faster in five of the size classes encompassing 40-65 cm, compared to the 75-80 cm size class (0.9 cm/yr). In addition, growth rates in the 45-50 cm and the 60-65 cm size classes (both 2.4 cm/yr) were also significantly faster than the 80-85 cm size class (1.1 cm/yr).

Tumored turtles comprised 46.2% of the 171 turtles recaptured and utilized to compute growth. A significantly slower ($P>0.05$) rate of growth took place in tumored turtles (1.9 cm/yr) than in non- tumored turtles (2.2 cm/yr). ANOVA showed a significant difference in the rates of growth between four levels of tumor severity (Fig. 3). The depression of growth, as identified by these data, should be considered as a minimal estimate of the impact of the disease. Growth rates computed for nearly all of the afflicted turtles in this study included unknown intervals of time, prior to the formation of tumors, that served to bias the growth data.

Only a few of the 1,458 tagged turtles have been resighted away from Molokai. Four adults were seen in the seasonal migrant breeding assemblage at FFS after being tagged at Molokai. In addition, two adults tagged at FFS were recaptured at Molokai. An adult male fitted with a satellite transmitter at FFS was tracked to Molokai on its post-breeding migration (Balazs and Ellis, in press). These data lend strong support to other findings that demonstrate a high degree of residency by Hawaiian green turtles for their foraging areas (Balazs *et al*., 1994).

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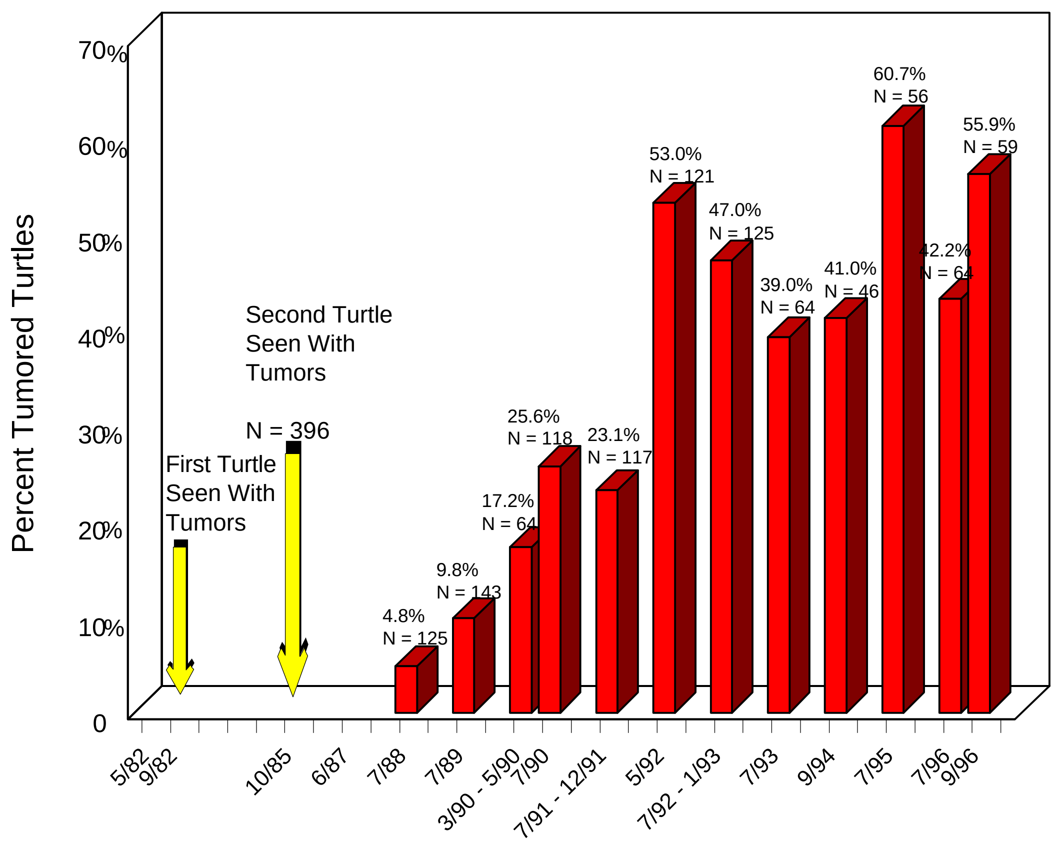
Figure 1. Incidence of fibropapillomatosis observed in green turtles captured from 1982-96 at the



Palaau foraging pasture along the southern coastline of Molokai.

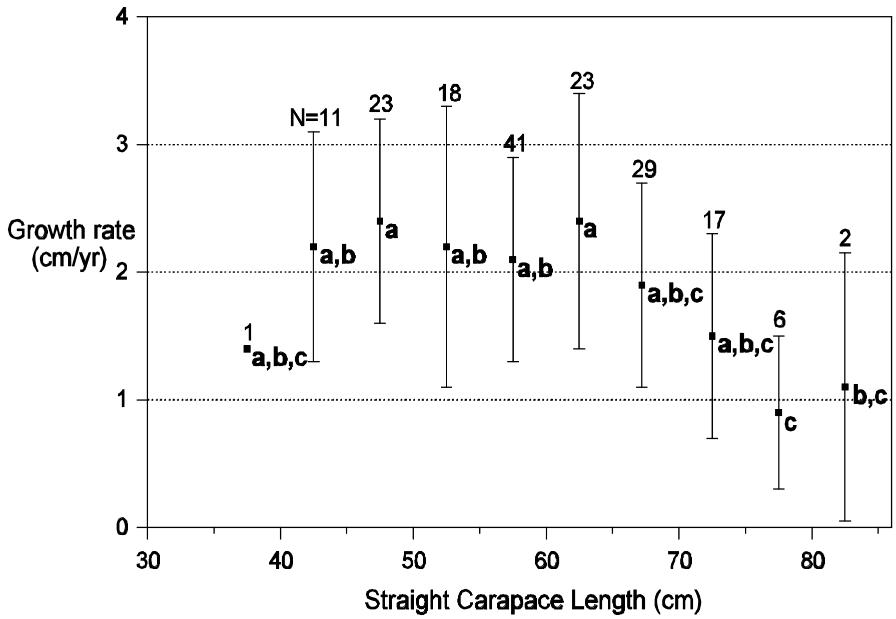


Figure 2. Mean and standard deviation for the rates of growth divided into 5 cm size classes exhibited by green turtles tagged and recaptured at Palaau, Molokai. Means bearing the same alphabet letter (a, b, c) are not significantly different (P>0.05).

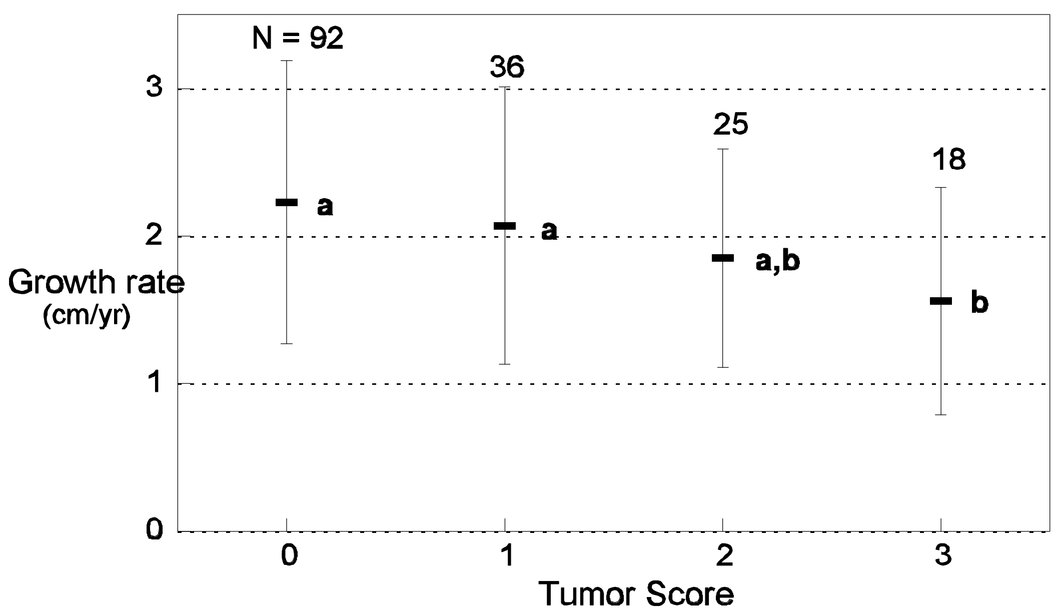


Figure 3. Mean and standard deviation for the rates of growth exhibited by four groups of green turtles tagged and recaptured at Palaau, Molokai. 0 = no visible tumors, 1 = lightly tumor afflicted, 2 = moderately tumor afflicted, and 3 = heavily tumor afflicted. Means bearing the same alphabet letter (a, b) are not significantly different.

ESTIMATION OF THE NUMBER OF SEA TURTLES NESTING ON A BEACH IN A SEASON

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A model for the estimation of the number of sea turtles nesting on a beach in a season is presented, based on data gathered by tagging the turtles on the nesting beach and counting the total number of nests laid on the beach in the season. The estimator classically used in this kind of problem calculates the number of females nesting in the season as the ratio between the estimated total number of nests laid on the beach in the season and the estimated mean number of nests laid per turtle in the season. The estimated mean number of nests laid per turtle in the season is usually calculated directly from the data gathered by tagging the turtles on the beach. Several researchers have already recognized that this estimate is generally smaller than the actual mean number of nests per turtle, if the beach tagging coverage is not complete.

In the procedure proposed here, the total number of nests laid on the beach in the season is assumed to be known exactly. The classical estimator is applied using, instead of the mean number of nests per turtle calculated directly from the data gathered through tagging, a mean number of nests estimated through a mathematical model of the sampling of the turtles on the beach. The essence of the model is the analysis, using the probability theory, of the transformation undergone by the actual probability distribution of the number of nests laid per turtle in the season whenever the beach tagging coverage is not complete.

The model has its statistical properties investigated through computer simulations. The results of these simulations show that the proposed estimator is essentially unbiased (it has a relatively small bias) and consistent. The simulations also allow an estimate of the beach tagging coverage necessary to obtain a specified precision in the estimation of the number of turtles nesting in the season. A procedure for the construction of a confidence interval for the estimated population, using the bootstrap method, is also proposed; this procedure has its validity checked through computer simulations. As an example, the model is applied to the loggerhead sea turtles (*Caretta caretta*) nesting on Praia do Forte, Bahia, Brazil, using data gathered by Projeto TAMAR / IBAMA, the Brazilian sea turtle conservation program. Finally, a possible extension of the model is proposed. A detailed technical report will be published elsewhere.

ACKNOWLEDGMENTS

This work is part of a doctoral thesis presented in 1996 to the State University of Campinas (Universidade Estadual de Campinas), Sao Paulo, Brazil. I would like to thank Ulisses Caramaschi, George Svetlichny and Neca Marcovaldi for their guidance and assistance. My thanks also to all people of Projeto TAMAR, past and present. This work was supported in part by the Brazilian National Research Council (Conselho Nacional de Desenvolvimento Cientifico e Tecnologico - CNPq). The main computer simulations were carried out at the Brazilian National Laboratory for Scientific Computing (Laboratorio Nacional de Computacao Cientifica - LNCC / CNPq), in Rio de Janeiro.

THE TURBULENT 1996 NESTING SEASON ON BALD HEAD ISLAND, NORTH CAROLINA

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Bald Head Island is located at the mouth of the Cape Fear River, just south of Wilmington, North Carolina. The island has the distinction of having the highest density of loggerhead sea turtle nesting in the state. Nesting green sea turtles (*Chelonia mydas*) also visit the island on occasion. The 14 km island has an east-facing beach ("east beach") bordered by a large area of hard bottom and reef structure. Bald Head island also has a south-facing beach ("south beach") with approximately 40 km of sandy shoals extending from the south-southeast corner of the island. Most turtle nesting occurs on south beach, probably due to navigational use of the shoals by the turtles. Ninety-five percent of the development on Bald Head is located on south beach due to low elevation of east beach, making this area unsuitable for building. During the spring of 1996, Bald Head Island underwent a major renourishment project including the addition of sixteen 90 m sand filled canvas groins on south beach. No physical parameter readings were taken prior-to or after the project, but past studies have shown that the quality of a nesting beach is normally reduced after renourishment. This reduction is due to alteration of beach compaction, gaseous and hydric environments, and changes in nutrient availability and thermal regime (Crain et al. 1995). Ambient temperatures may be affected by the color of the sand used for renourishment, possibly altering the sex ratio of hatchlings (Nelson and Dickerson, 1989; Moulding and Nelson, 1988). Alteration of the the physical parameters of a beach after renourishment can affect oxygen diffusion through the substrate which can rob embryos of necessary oxygen (Crain et al. 1995) Ackerman (1981) showed that in areas where gas exchange was less than on "natural beaches," mortality rates went up and growth rates slowed. Hydric environment is also affected as many studies have shown that renourished beaches retain more water than "natural beaches" (Parkinson et al. 1994, Broadwell 1991). On July 12, 1996, Hurricane Bertha made landfall in southeast North Carolina, with the eye passing directly over Bald Head Island. Then on September 5, Bald Head sustained another direct hit in the form of Hurricane Fran. Between these two devastating storms, the island felt the effects of Tropical Storm Eduoard, experiencing unusually high tides caused by storm surge. These three events led to significant overwash and beach erosion and subsequent loss of many turtle nests.

MATERIALS AND METHODS

Data on nest location and hatching success for the years 1984-1995 were compared to those from 1996, for south beach only. South beach was the area of renourishment and sustained by the hurricanes as they approached from the south. Since east beach is largely undeveloped, natural renewal of the beach is possible which does not normally affect sea turtle nesting. Bald Head Island is divided into 10 one-mile sections by the Wildlife Resources Commission, beginning at the north end of east beach and continuing along south beach, ending at the mouth of the Cape Fear River. Nest locations are recorded by section number to enhance data analysis in subsequent years. Zones 279-284 are on south beach and include the areas of renourishment and soft groins. South beach was broken down by zone, noting the number of nests per zone and hatching success. The 1984-1995 results were then averaged and compared to results from 1996.

RESULTS AND CONCLUSIONS

Overall nesting success showed only a slight decrease of 2.8% between 1996 and mean of previous years (Figure 1). However, there were noticeable differences when examining the zones independently. Decreases in the number of nests per zone were seen in the 1996 data in zones 279, 281 and 284. On the other hand, increases in nesting were seen in zones 280, 282, and 283 in 1996 (Figure 2). Increases in zones 280, 282, and 283 were most likely caused by increases in nesting habitat due to renourishment as some studies have shown (Witham, 1990). These areas had been sites of some of the worst erosion on the island previously. Unfortunately, hatching success decreased by 18.1% in 1996

(Figure 3), at 49.0% compared to a mean of 67.1% for previous years. Therefore, it is assumed that the quality of the nesting habitat is questionable. The decrease in hatching success cannot be attributed solely to one cause as effects of renourishment and a season a fierce tropical weather combined to make the 1996 sea turtle nesting season on Bald Head Island a turbulent one.

ACKNOWLEDGMENTS

The authors would like to thank the Bald Head Island Conservancy and the University of North Carolina at Wilmington for financial and technical support. A special thanks to David A. Nelson at USAE Waterways Experiment Station, Vicksburg, MS, for providing background materials in mass.

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Figure 2. Data Comparison of Average Nests Per Zone on South Beach

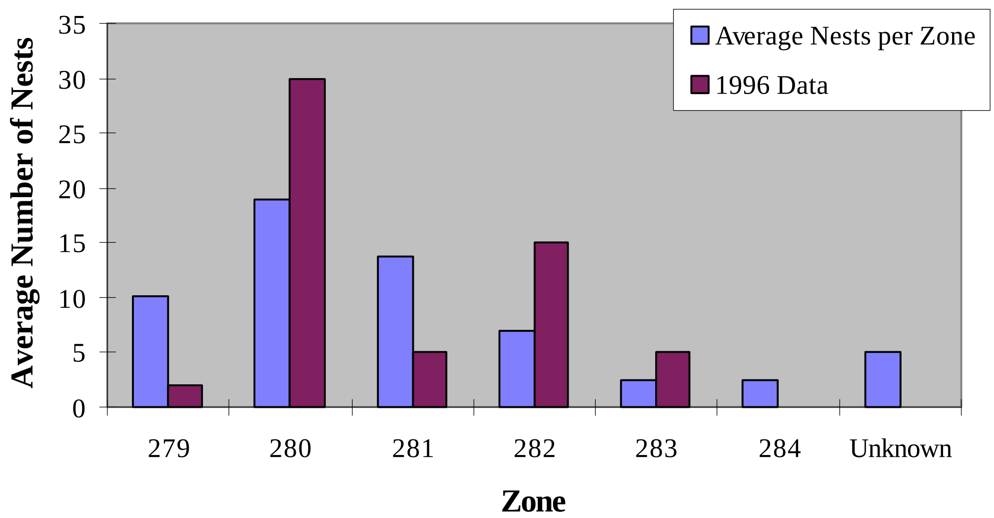
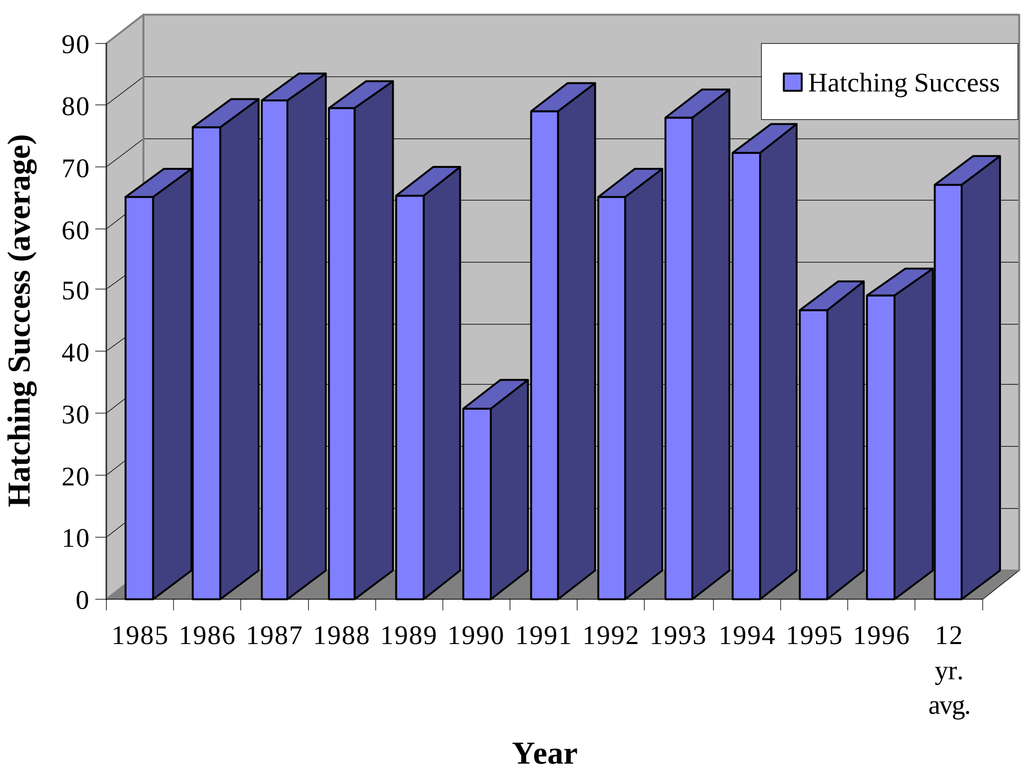


Figure 3. Hatching Success Data for South Beach



NATAL ORIGIN AND SEX RATIOS OF FORAGING SEA TURTLES IN THE PAMLICO-ALBEMARLE ESTUARINE COMPLEX

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The Pamlico-Albermarle Estuarine Complex, North Carolina, U.S.A., seasonally harbors a large population of foraging immature loggerhead, green, and Kemp's ridley sea turtles (Epperly *et al*., 1995*a*, 1995*b*). Rookery specific mtDNA polymorphisms (and related haplotype frequency shifts) in conjunction with maximum likelihood analysis was used to identify the natal origins and estimate the percent contribution of turtles on the foraging ground. Six haplotypes were identified in loggerheads (N=97). The majority of loggerheads carried haplotype A (57%) or B (38%) (Enclada *et al*., in press). Rare haplotypes among the North Carolina foraging ground animals included C, D, G, and J. Based on a maximum likelihood analysis, 32% of the juvenile loggerheads on the foraging ground originate from the North Carolina-Northeast Florida management unit. The South Florida management unit, which encompasses nesting on both the southeastern and southwestern sides of the Florida peninsula, was estimated to be the largest contributor, 64%. Contributions from the Northwest Florida, Mexican, and Brazilian management units were estimated at less than 5%. Maximum likelihood analyses were not conducted for green turtles due to the small sample size (N=27). However, the 5 haplotypes found have been identified in rookeries in Florida, México, Costa Rica, Venezuela, Surinam, Brazil, Ascension, and Guinea Bissau (Enclada *et al*., 1996).

A serum androgen sexing technique which followed a testosterone radioimmunoassay was used to determine the sex ratio of wild turtles in the Complex (Wibbels *et al*., 1987; Owens, 1996; Valverde, 1996). Females dominated in both species. Four loggerheads were predicted to be males (T<30 pg/ml), 129 were predicted to be female (T<20 pg/ml), and five could not be predicted (20<T<30 pg/ml). Seven green turtles were predicted to be males (T>20 pg/ml) and 39 were predicted to be female (T<10 pg/ml).

Approximately 90% of the nesting effort in the southeast U.S. is in southern Florida, and most of the remaining nesting effort is between North Carolina and Northeast Florida (Murphy and Hopkins, 1984). According to our genetic results, the smaller northern management unit contributes disproportionately to the North Carolina foraging grounds. Similar results have been reported for foraging animals in Georgia, South Carolina, and Virginia (Sears, 1994; Sears *et al*., 1995; Norrgard, 1995). These findings indicate that mortality of juveniles in waters off these states will have greatest consequence for the small NC-NEFL management unit.

The highly skewed sex ratio, consistent from 1995 to 1996, may be cause for concern. Either immature males are behaving differently such that they are not vulnerable to the North Carolina pound nets, or there is a dearth of males in the foraging population. The latter could be a result of fewer progeny from cooler northern beaches or from a bias towards females as a result of higher incubation temperatures in hatcheries throughout the range, especially on those beaches used by the large south Florida population. If these data can be verified by laparoscopy and/or necropsies, it will be important to determine (perhaps through nuclear DNA) which management units are producing the few males and whether there are adequate numbers of males entering the population.

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WHERE'S THE BEEF?... OR IS IT SEA TURTLE?

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All seven species of sea turtles are currently listed as threatened or endangered. While natural environmental conditions, predators and incidental take are major threats to their survival, the deliberate take of sea turtles is also significant. Sea turtle meats continue to be illegally served in some Puerto Rican restaurants. We describe here a DNA-based species identification method for cooked sea turtle meats. Total DNA is extracted from the cooked meat by a modified SDS-urea extraction. An approximately 800bp DNA fragment from the mitochondrial cytochrome b gene is polymerase chain reaction (PCR) amplified, then digested with restriction enzymes Msp I and Alu I. Msp I yields diagnostic RFLP banding patterns for leatherbacks, olive ridleys, Kemp's ridleys, and greens. Alu I yields diagnostic banding patterns for leatherbacks, flatbacks, Pacific and Atlantic greens, loggerheads, and hawksbills.

NON-INVASIVE TREATMENTS FOR RESCUE OF MARINE TURTLES DAMAGED BY ANTHROPOGENIC ACTIVITY

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The Aquarium of the Zoological Station of Naples cares for all the loggerhead (*Caretta caretta*) sea turtles, the most common species of marine turtle in Italian waters, that are reported wounded in the Gulf of Naples. These wounds, in general, are caused by either fishing hooks, fishing nets, marine vehicles or pollution. The Aquarium research group has developed procedures for the treatment and maintenance of these animals before they are released into the wild (Bentivegna *et al*., 1993). It recently used a video endoscope to develop a non-invasive procedure to remove polyethylene cord and metal hooks from loggerhead turtles (Bentivegna *et al*., 1995).

Last year, the group employed hyperbaric oxygen therapy (HBO) to save the fin of a turtle that was damaged in a type of accident which commonly occurs in the Gulf, namely, an encounter with a fishing net. If the fin had not been treated in this way, it would have had to have been amputated. This HBO technique was developed for the turtle on an empirical basis since the literature spoke only of HBO therapy for the treatment of human beings. (Jain, 1990; Thoms, 1992).

METHODS

On 1 November 1995, a juvenile loggerhead which had become entrapped in the net of a fisherman was brought to the Aquarium. It had a curved shell length of 65 cm. Moreover, it was totally inactive and refused food. Ten HBO therapy sessions were held between 16 December 1995 and 3 January 1996. The monoplace hyperbaric chamber used pressurized oxygen. Each session was limited to 30 minutes to avoid the toxic effects of oxygen in the lungs. The oxygen pressure during the course of the initial sessions was increased gradually from 1.3 ATA to a maximum of 3.0 ATA to avoid the toxic effects of oxygen on the nervous system (Table 1).

Prior to HBO therapy, an x-ray of the injured fin was taken, and the bacteria in the lesion were analyzed by tampon cultures. The turtle was kept in an aquatic tank (600 l) during and after the therapy period. The tank had a continuous flow of sea water pumped through it from the Gulf of Naples. However, since it was winter and the sea water temperature was 15°C, a decision was made to raise the tank water temperature to 20°C in order to hasten the scarring of the wound.

RESULTS AND DISCUSSION

The turtle tolerated the hyperbaric sessions very well: no toxic effects were noted. Its general condition improved immediately after the therapy period with a resumption of motor activity and appetite. The edema was reduced and new tissue began to form. This is consistent with the results of studies in human beings demonstrating the efficiency of HBO in improving local vascular circulation. (Shoemaker, 1991).

The tampon cultures which had resulted positive for *Pseudomonas aeruginosa* at the beginning of the therapy period resulted sterile at the end. This is consistent with the results done *in vitro* that have shown that HBO acts directly on the microorganisms of infected wounds. (Knighton, *et al*., 1984; Fredette, 1965).

X-rays taken four months after the therapy ended showed that a bone callus had formed at the fracture point of the humerus. Six months after the end of therapy, the wound had completely scarred over and the fin had recovered full mobility. Amputation was thus avoided.

One of the more common causes of death of marine turtles is infection due to wounds suffered when they are accidently caught by fishermen. Future studies regarding the use of HBO in the treatment of the Cheloniidae may play a significant role in the preservation of endangered species such as *Caretta caretta.*

ACKNOWLEDGMENTS

We would like to express our thanks and gratitude to the Servizio Di Terapia Iperbarica della Seconda Università degli Studi di Napoli for the use of their hyperbaric chamber and to Prof F. Portolano, Prof C. Luongo, and Dott. N. Salerno for their aid.

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Table. 1 Sessions of HBO Therapy

	Pure Oxygen	Duration
I° Session	1.3 ATA	30 Min.
II° Session	2.0 ATA	"
III° Session	2.0 ATA	"
IV° Session	2.5ATA	"
V° Session	2.8 ATA	"
VI° - X° Session	3.0 ATA	"

STATUS OF THE SEA TURTLES IN THE GULF OF NAPLES AND PRELIMINARY STUDY OF MIGRATION

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The present study was performed under the auspices of the Sea Turtle Conservation Program that has been conducted in the Gulf of Naples (Italy) since 1983 (Bentivegna *et al*., 1986, 1992, 1994). The Gulf of Naples, located on the western coast of Italy and opening directly to the Mediterranean Sea, is frequented by the loggerhead sea turtle (*Caretta caretta*). The data collected over the last four years includes the number and size of specimens recovered, the time and method of recovery, and the probable cause of injury. These data were used to evaluate the loggerhead turtle situation in the Gulf of Naples, an area of the Mediterranean Sea which has never before been considered in studies of this species. Loggerhead feeding habits in offshore waters and the impact of anthropogenic pollution were also studied in order to define the level of danger that the Gulf of Naples presents to this species. It was known from previous studies that loggerheads do not come into the Gulf to reproduce, but rather, to feed (Bentivegna *et al*., 1994). In all probability, they originate from the eastern Mediterranean basin where there are numerous egg deposition sites (Venizelos, 1991). In order to verify this hypothesis, we began to track a loggerhead sea turtle in the Mediterranean using satellite telemetry. The tracking study helped to better understand the life history of the loggerhead in the Mediterranean Sea.

METHODS

Data regarding the loggerhead turtle population in the Gulf of Naples have been collected from specimens recovered over a period of four consecutive years (1993-1996). Information pertaining to their number and size, and the type of injury suffered was based entirely on records of turtles found dead either on beaches or floating in coastal waters, or caught incidentally by fishermen. The feedings habits of the loggerhead turtle and the impact of anthropogenic pollution were investigated by analyzing the fecal content of live specimens and the stomach content of dead ones. Fecal content was divided into natural and anthropogenic material. The tracking program began on October 1, 1995 and continued to the end of May, 1996. The turtle tracked was originally found by a group of fishermen using a trawl net. The turtle, a female in good health, had a curved carapace 73 cm long and 63 cm wide, and weighed 43.7 kg. A Telonics model ST-6 platform transmitter terminal (PTT) with a salt water switch was fitted on her carapace. PTT transmissions were monitored by the ARGOS tracking system which uses NOAA satellites that guarantee complete coverage over the earth's surface. Each satellite was equipped with a data collection and location system (DCLS) that received and recorded signals from the PTT during an overpass.

RESULTS AND DISCUSSION

Most animal recoveries occurred from late spring to autumn (Fig. 1), the period when boat-traffic and fishing activity in the Gulf of Naples increase. The largest number of recoveries occurred in May, the month when human aquatic activities begin, and in November, which is the beginning of the winter season. Winter is hazardous for turtles because of the quick drops in water temperature, sometimes up to 5°C in a month, which tend to reduce their activity, and hence, render them vulnerable to the dangers of maritime traffic and fishing nets. The high level of danger that the Gulf of Naples represents to the loggerhead turtle has been described in a previous study (Bentivegna *et al*., 1994). Most of the animals recovered are affected by stress caused by maritime traffic or by pollution, or they have been wounded by hooks or nets. Overall, 70% of the injuries were due to fishing gear, 28% to maritime traffic, and 3% to pollution (Fig. 2). All specimens recovered in the Gulf of Naples have been defined as either juvenile or as sub-adult because their CCLs have been less than or equal to 70 cm. The majority of the specimens recovered have fallen within the CCL range from 50 to 70 cm (Fig. 3). (Margaritoulis, 1988). Most of the recovered specimens had swallowed either non- biodegradable material, such as plastic and tar, or little pieces of wood, or feathers. This indicates that there is a high level of anthropogenic pollution in the Gulf and that, as the loggerhead turtle approaches the coast to feed, it searches through the floating garbage for food. In addition, the presence of algae, sea-weed, squid parts, crustaceans (*Parthenope angulifrons, Squilla mantis*), gastropods and fish parts in the feces or stomachs of the recovered specimens indicates that the loggerhead feeds at all depths in the Gulf of Naples, from the surface to the bottom.

During the eight months that the tracking study lasted, the loggerhead traveled a route 2600 km long. Immediately after its release in Sicily, in October, the turtle turned southeast and swam continuously for two months (Oct-Nov) and maintained an average speed of one kilometer per hour. The animal crossed the straits of Messina and headed southeast to the Isle of Crete, and then turned southeast to Crete, and then to Lybia. It then returned to Crete and went southeast to Turkey. It is likely that during the winter season the loggerhead searches for warm water. The average surface temperatures (16°-18°C) on its route were higher than in other areas of the Mediterranean where an isolated yearly isotherm averages 20°C (Tortonese, 1951). The stopping points on the turtle's route may be explained in terms of a search for a nesting site. In fact the turtle approached known nesting sites, e.g., she stopped in Libya where a very large nesting site has recently been discovered (Venizelos, 1996). It is also likely that the loggerhead turtles which visit the Gulf of Naples come from the warmer eastern Mediterranean waters. Tagged female loggerheads nesting in Greece (Margaritoulis, 1988) have been shown to disperse over a very wide area of the central Mediterranean extending west to Sardinia. By taking advantage of the favorable currents off the coast of Naples from the southwest to the northeast (Ovchinnikov, 1966), the loggerhead comes into the Gulf of Naples in order to search for feeding grounds. The results of the studies of the loggerhead in the Gulf of Naples has contributed to our understanding of the function that the Gulf serves in the life history of the Mediterranean loggerhead turtle. The identification of the Gulf of Naples as one of its preferred habitats in the Mediterranean Sea should persuade the competent authorities to aid the development of, and to adopt, suitable programs and laws which eliminate, or at least reduce, the dangers that threaten the survival of the loggerhead.

ACKNOWLEDGMENTS

We would like to express our thanks and gratitude to Dr. Karen Eckert for the travel grant provided, to Dr. Scott Eckert for his generous aid and advice, and to the World Wildlife Fund for financial support.

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Fig. 1 Monthly capture rates of loggerhead sea turtles (*Caretta caretta*) in the Gulf of Naples.

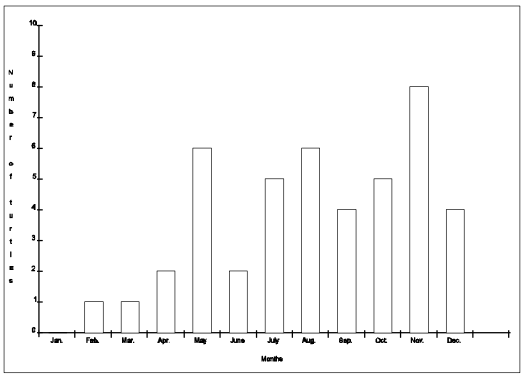


Fig. 3 Curved carapace length (CCL) of loggerheads in the Gulf of Naples (1993-1996)

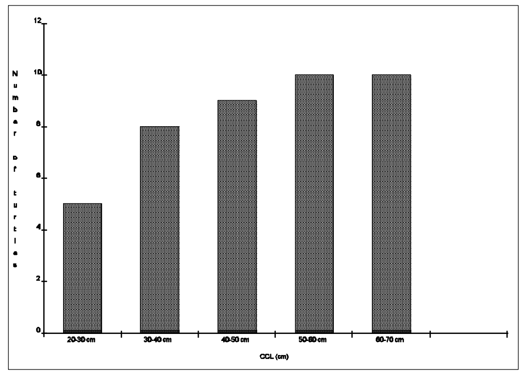
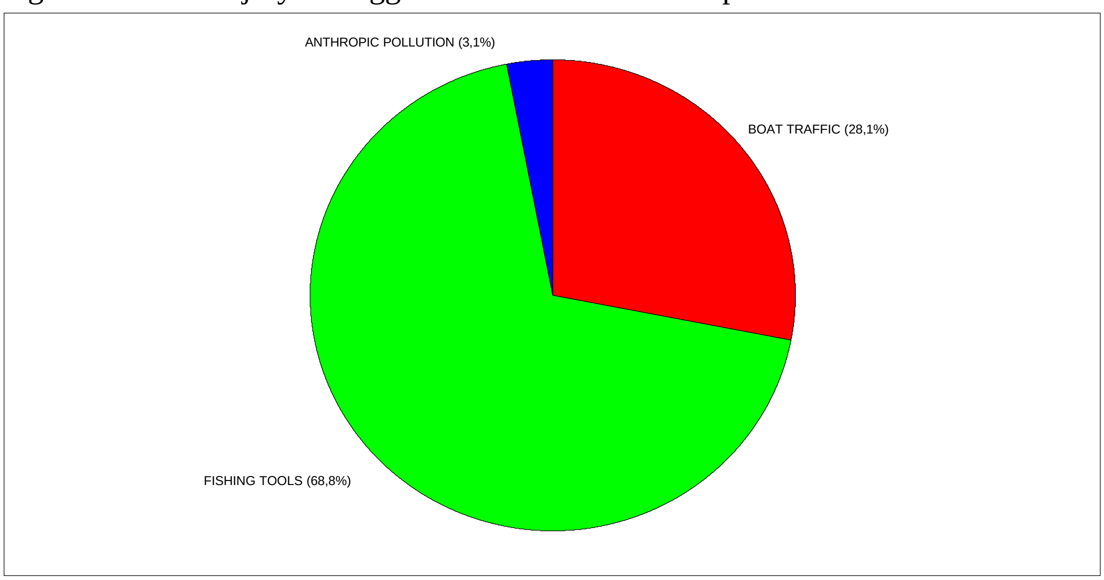


Fig. 2 Causes of Injury to Loggerheads in the Gulf of Naples.



DIFFERENTIAL GENE EXPRESSION IN GREEN TURTLE FIBROPAPILLOMATOSIS

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Green turtle fibropapillomatosis (GTFP) is a grossly disfiguring and potentially fatal disease which ha reached epidemic proportions in several populations of endangered green turtles (*Chelonia mydas*). We are investigating this problem by identifying genes whose expression is altered in diseased tissue by using mRNA differential display and two-dimensional polyacrylamide gel electrophoresis (2D-PAGE). Several candidate cDNA clones have been identified. These molecular probes will be valuable for both laboratory studies of how suspected environmental factors (*e.g.,* pesticides) affect gene expression as well as field studies to potentially identify apparently healthy animals that may be at risk.

EFFECTS OF EXPOSED PILINGS ON SEA TURTLE NESTING AT MELBOURNE BEACH, FLORIDA

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The STABLER(tm) Discs are a patented system developed to minimize beach erosion by dissipating wave energy during storms or unusually high waves. The system consists of a series of concrete discs anchored into the beach by pilings situated at regular intervals. When the system is functioning correctly, these discs are generally buried in the sand with only the pilings exposed. This study determined the effects of exposed pilings (25 cm in diameter, spaced 5.2 m apart, and 1 m above the ground) on sea turtle nesting activity at Melbourne Beach, Florida. Although nesting emergences still occurred in the presence of pilings, the number of nesting emergences in the experimental area was significantly lower on nights when pilings were present.

SEX ON THE BEACH?

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Many observational accounts of mating turtles have been given (see Ehrhart, 1982). All of these have been of turtles at sea. Studies suggest that mating in marine turtles occurs prior to the oviposition of a female's initial clutch and that sperm are then stored for the fertilisation of subsequent clutches (Galbraith, 1993; Gist *et al*., 1989). In this study we report observations of marine turtles mating in Cyprus where both green (*Chelonia mydas*) and loggerhead (*Caretta caretta*) turtles nest. Observations were made during June 1995, between 2 and 4 weeks after the onset of the nesting season, whilst conducting night time beach surveys at Alagadi Beach, a major marine turtle nesting site in Northern Cyprus.

OBSERVATIONS

Four separate observations of mating green turtles were made. On one occasion the pair were in the sea, approximately 5 metres from shore, whilst on another, a mating pair appeared to have been washed onto the beach in stormy weather. In both cases the pair were observed to remain attached for approximately 5 minutes. However, on two other occasions, the female crawled onto the beach with the male firmly attached. After ascending approximately 5-10 m up the beach, the male in each case detached, apparently disorientated, and returned to the water. Both females attempted nesting, one laying a clutch which successfully hatched. In this final instance, the male was measured. Curved carapace length was 85 cm. We suggest two hypotheses for the latter two observations: 1) Mate guarding; 2) Use of a 'sneaking' strategy.

MATE GUARDING?

Since these observations occurred during the first 2-4 weeks of the nesting season it might be suggested these were prior to the deposition of the first clutch by the females concerned. Two of these observations may have been a result of the pair being incidentally washed ashore as a result of stormy weather. However, on the other two occasions the females went on to attempt nesting or complete the process. This suggests that the females in question were making a concerted effort to reach the nesting beach. Mating at this late stage is unlikely to have any fitness benefit to either the male or female. Any sperm transferred to the female are likely to be flushed out at oviposition. There is a possibility that this male had previously mated with this female and was guarding his mate until she had reached the safety of the beach, reducing the chance of further copulations. However, if there is little chance of another male fertilizing her clutch at this late stage then why guard the female?

'SNEAKING' MALE?

It is possible that these observations involved the same 'rogue' male, who, unable to compete with other males for matings prior to the onset of the season, was using an unorthodox 'sneaking' strategy (Krebs and Davies, 1987). Thus he was seeking copulations with females as they approached the beach to nest. Whilst he would be expected to have a lesser chance of fertilizing clutches than males that had mated with females previously, he may still have stood some chance of fertilizing, at least some of the eggs, of future clutches. Nesting green turtles in Northern Cyprus range in curved carapace length from 79 -106 cm (Broderick and Godley, 1996). Thus, although no information is available on the size of male green turtles in this region, it is possible that this male is smaller (CCL 85 cm) than average, which might support the theory that he was 'sneaking' copulations.

OTHER OBSERVATIONS?

Additional observations of mating green turtles have been made off the coast of Northern Cyprus, although none have been made of loggerhead turtles mating. Possibly the mating grounds of the latter species are not within this vicinity or their mating behaviour is such that they are observed less frequently. We are not aware of such events having been previously recorded, however we would be very interested to hear any similar accounts and welcome any correspondence on such subjects.

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FEMALE SIZE, NOT LENGTH, AS A CORRELATE OF REPRODUCTIVE OUTPUT

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Some studies suggest that sea turtles do not show a direct correlation between clutch size and carapace length, whilst other findings support such a relationship (Chen and Cheng, 1995; Hays and Speakman, 1991; Loop *et al*., 1995). It might be expected that larger species would have a larger clutch size. This is generally true, exceptions being *Dermochelys coriacea* and *Natator depressa* (see Ehrhart, 1982). These two species have smaller clutches than would be expected for their relative sizes. The larger size of the eggs of *D. coriacea*, in comparison to other species, may explain some of this variation and it has been suggested that the small clutch size of *N. depressa* may be due to a limitation in the capacity to hold eggs due to its flattened body shape (Ehrhart, 1982). Population differences are to be expected, due to varying environmental conditions, however, one reason for the inconsistency of the findings with regard to this relationship may be due to the parameter used to represent female size, that is straight or curved carapace measurements. Pinckney (1990) found that, in *C. caretta* nesting in South Carolina, straight carapace length was a better correlate of clutch size than curved carapace length. This present study involved the use of a data reduction tool (Principal Components Analysis) to gain a measure of *C. mydas* and *C. caretta* female size which incorporated both length and width data.

METHODOLOGY

This study was conducted at Alagadi Beach, situated on the north coast of the island of Cyprus. During night time beach surveys, nesting females were tagged and their curved carapace length and width measured. When a female nested more than once in a season, and variation existed in the curved carapace measurements recorded, mean length and width were calculated to avoid pseudoreplication (Hurlbert, 1984). In an effort to gain one measure to represent female size, Principal Components Analysis (PCA) was used (Everitt and Dunn, 1991). This is a multivariate data reduction technique which combines related variables in order to gain a single score (in this case of female size). If variables are measured on the same scale principal components can be used directly, if not PCA must utilize values generated by a correlation matrix. In this instance, PCA was used to obtain one measure of female size, incorporating measurements of curved carapace length and width. In this study, only two variables were examined, however, PCA can incorporate as many as 20 variables into one score. The amount of variation accounted for by these new scores, however, is likely to decrease with the introduction of more variables. The measure obtained by PCA is referred to as $PCA_{adult\ size}$. Linear regression was used to examine relationships which might exist between $PCA_{adult\ size}$, curved carapace length, curved carapace width and mean clutch size of nesting *C. mydas* and *C. caretta* females.

RESULTS

Principal Components Analysis was found to account for 90.5% of the variance of *C. mydas* data and 93% of *C. caretta* data through the scores calculated for axis 1. Using linear regression analysis, it was found that all three indices of *C. mydas* and *C. caretta* female size ($PCA_{adult\ size}$, curved carapace length and width) were significantly related to mean clutch size. Female PCA_{adult} size was the most significant of the three relationships, for *C. mydas* females (Fig. 1) whereas curved carapace width, followed closely by $PCA_{adult\ size}$, was the best correlate for mean clutch size of *C. caretta* females (Fig. 2).

	Chelonia mydas			*Caretta caretta*		
Female size	F	p	n	F	p	n
$PCA_{adult\ size}$	33.01	<0.0005	48	14.53	<0.0005	41
Curved carapace length (cm)	32.14	<0.0005	48	11.3	<0.002	41
Curved carapace width (cm)	26.11	<0.0005	48	15.07	<0.0005	41

Table 1. Results of regression analysis to compare the three measures of female size with mean clutch size of *C. mydas* and *C. caretta*.

DISCUSSION

No recent papers have been published reporting on the use of Principal Components Analysis to gain one measure of marine turtle size. This study has shown that for *C. mydas* at least, the measure gained from this technique is a better correlate of mean clutch size than curved carapace length or width alone. However, in the case of *C. caretta*, curved carapace width was the best correlate of mean clutch size. This variation may be explained in part by the differing shapes of the two species. *C. mydas* has a relatively flatter shell that is more circular than the humped, tear-dropped shaped carapace of *C. caretta*. The relative cranial displacement of the apex of the dome on the shell of *C. caretta* females and the extension of the caudal carapace beyond the body proper may contribute to curved carapace width being a better indicator of body size and thus the ability to produce and store eggs.

Care must be taken when using such a technique as in some cases, data reduction may not be appropriate. For example, one might expect curved carapace length to be a better correlate of nest depth. Whilst the measure of straight, as opposed to curved, carapace length and width is commonly used it would seem appropriate that both be recorded as curved carapace measurements take into account the shape and possibly volume of the female. Females may adopt different strategies depending on their size and the prevailing environmental conditions, such as levels of nutrition and temperature, to which they are subjected. In addition, to satiate predators it may be better to lay a greater number of small clutches rather than fewer larger clutches. These different strategies may have evolved as a result of different selective pressures that exist in the form of egg or hatchling predation. In addition, every time a female leaves the sea she may herself face a threat from predation. This must also be taken into account when opting for the most efficient method of depositing her eggs. It is likely that there will be a constraint on the number of eggs, or weight of eggs that a female can carry without affecting her motility in water. A large proportion of the dry weight of turtle eggs is fat which is less dense than water and may thus restrict diving capability. In addition, it is highly possible that there will be a limit to the clutch volume which can be contained in the body cavity without negatively affecting physiological processes. Whilst it is acknowledged that a relationship may not exist between some marine turtle species and their mean clutch size, in others, PCA helps to elucidate relationships and is also a useful tool in reducing the amount of statistical analyses and hence the chance of producing spurious results.

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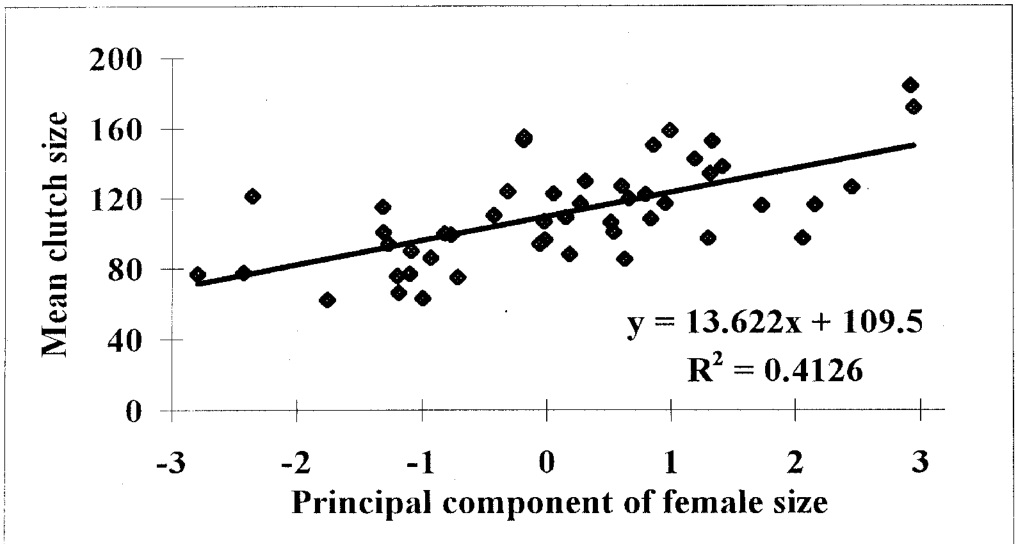

Figure 1. Relationship between *C.mydas* PCAadult size and mean clutch size.

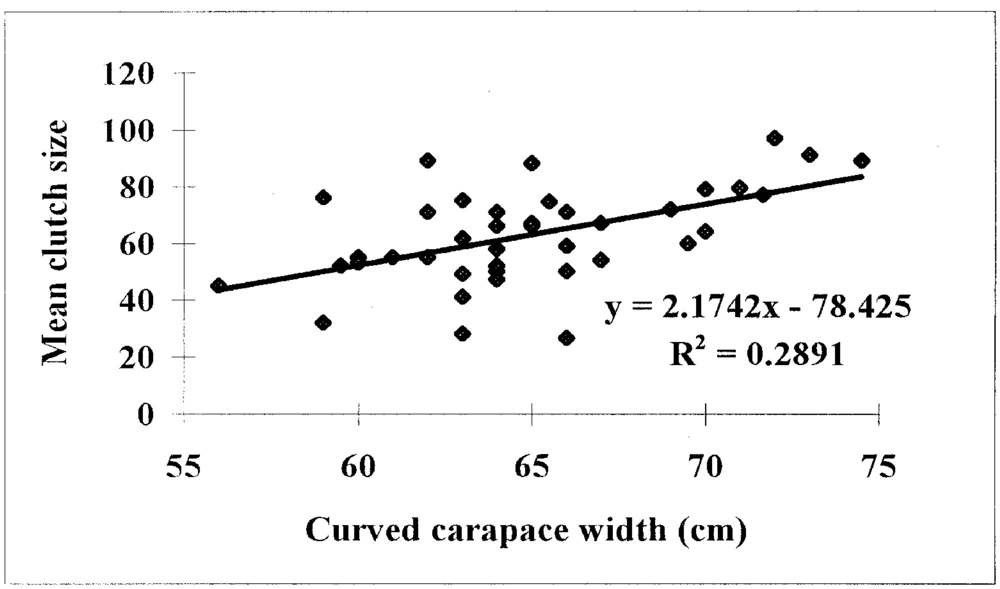

Figure 2. Relationship between *C.caretta* curved carapace width (cm) and mean clutch size

CONSIDERATIONS FOR MIXED STOCK ANALYSIS USING mtDNA MARKERS

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Many populations of marine turtle are endangered and currently declining. Efforts to manage this species are hampered by the lack of knowledge of the appropriate geographic units of management, and the relationship between breeding and foraging assemblages. Tagging studies are providing valuable information about the relationship among breeding populations and foraging assemblages, however these studies will take many years to establish detailed patterns of movements. Genetic studies however offer a means to infer broad patterns of gene flow and can complement ongoing tagging studies. Patterns of genetic variation can be used to determine the geographic scale of breeding populations (*i.e.*, define stocks), and to compare the genetic composition of turtles in feeding populations to those nesting at nearby rookeries (*i.e.*, mixed stock analysis [MSA] *e.g.*, Bowen *et al*.,1995, 1996; Broderick and Moritz, 1996, Meylan *et al*., 1990). The primary assumption of MSA is that all of the potentially contributing stocks are known and adequately characterised. When this assumption is violated the utility of the stock analysis is greatly reduced. Other factors such as sample sizes and degree of genetic differentiation of contributing stocks will effect the performance of MSA (*e.g.*, Chapman ,1996; Broderick and Moritz, 1996; Epifanio *et al*., 1995). Little can be done about the inherent nature and distribution of genetic variation, other than to select loci and techniques that maximise differentiation (*i.e.*, mtDNA sequence data). Ultimately, a good MSA should give an accurate estimate of the contribution of each of the breeding stocks to the mixed assemblage. Numerous populations of marine turtle have been successfully differentiated using mtDNA sequence data, however, this approach may be impractical due to time and budgetary constraints. To process large numbers of samples we developed a rapid, yet sensitive, screening protocol that uses denaturant gradient gel electrophoresis (DGGE) to detect DNA variants. This technique uses the melting behaviour of DNA fragments to detect genetic variants. The standard application of this technique detects some, but not all, single base pair changes. However, we were able to increase the sensitivity of this technique by using heteroduplex analysis. An advantage of this method over PCR-RFLP analysis (see Abreu-Grobois *et al*., 1996) lies in its ability to detect a larger proportion of both known and new alleles.

First, PCR products are run through DGGE and scored relative to the mobility of alleles in a size marker. This size marker includes all alleles known to the study and is continually updated as new alleles are discovered. Following the initial screening we determined whether two fragments of DNA, that have identical mobilities, also have the same sequence using a heteroduplexing technique. In this technique, the candidate DNA fragment is hybridised to control DNA through a process of heating and cooling. If the two DNA fragments have identical sequences, a single homoduplex band will be formed. If the sequences are different then slower migrating heteroduplex molecules are formed. This technique allows for candidate DNA fragments to be matched to known sequences, and, for the identification of novel alleles for sequencing. We were satisfied with the sensitivity of the DGGE technique when applied to the Indo-Pacific stocks of hawksbill turtle (detailed results will be presented elsewhere) but were somewhat alarmed by the results it generated! One third of the 327 individuals screened in the foraging and harvested populations had alleles that did not match those found in the any of the breeding stocks surveyed to date. The majority of new alleles were only single base pair mutations away from known alleles, however, the most abundant new allele (n=57) formed a new clade that is equally divergent from those previously described (see Broderick *et al*., 1994 and Broderick and Moritz, 1996). The high frequency of novel alleles in mixed populations strongly implies that there is one or more genetically divergent rookeries not yet analysed. Furthermore, it raises the possibility that there are undetected rookeries that have similar allele frequencies to those already examined. Clearly, the genetic data demonstrate a need for more intensive surveys of the distribution of hawksbill breeding populations in the SW Pacific. We therefore cannot attempt a MSA with this data until the source population(s) of these new variants are found.

These results have prompted us to re-evaluate the confidence that we place in estimates generated from MSA. What follows is a summary of ways to identify and quantify the errors that are encountered at each step of MSA.
i) To test for sufficiency of sample size, Epifanio *et al*. (1995) used re-sampling statistics to determine the sample size needed to detect 95% of the haplotypes in the contributing stocks. Similarly, sufficiency of sample size for foraging populations needs to be critically appraised. Tests of this nature are rarely used but are a vital first step in MSA to determine whether the sample sizes for both rookeries and foraging populations are sufficient to genetically characterise those populations accurately.
ii) A slightly different sample size consideration arises when we begin MSA proper. Given the distribution of genetic variation, are the sample sizes of the foraging populations sufficient to generate accurate estimates of stock contribution? Regardless of the algorithm used, the confidence intervals around an estimate can be used to determine if sample sizes are sufficient for a given level of accuracy. If they are unsatisfactory then it is possible to use simulation to estimate the number of samples required to generate accurate estimates of stock contribution (see Broderick and Moritz (1996) for methods).
iii) It is becoming apparent that whenever foraging populations are genetically assessed, new alleles are likely to be discovered. The number of new alleles that can be tolerated is study specific and depends on how well the original stocks have been characterised. If stocks are poorly characterised (*i.e.*, insufficient sample size) then a higher frequency of new haplotypes can be tolerated before this frequency becomes evidence of unsampled stocks. Conversely, there is evidence of unsampled contributors whenever the frequency of new alleles is greater than that expected compared to the errors calculated for the source stocks (see point (i)).

iv) For the purposes of MSA the pooling of new alleles with their closest genetic relatives previously known is a heinous sin that has no scientific basis given our current understanding of marine turtle phlyogeography. Numerous studies have shown that there is a poor relationship between geographic distance and genetic distance within regions (Bass, 1996; Bowen *et al*., 1992; Bowen *et al*., 1994; Broderick *et al*., 1994). Given that some stocks are differentiated by alleles with single mutations (Norman *et al*. 1994; Broderick and Moritz, 1996; FitzSimmons *et al*., 1996) we consider that there is no justification to pool new alleles with their closest genetic relatives.

Therefore, MSA is best viewed as an iterative process between sampling of breeding populations and foraging populations until the desired level of resolution is achieved. To do this it may be necessary to exhaustively sample within and between geographically distant locations (*i.e.*, entire ocean basins). Even though extensive sampling of marine turtle populations is difficult, it is imperative that conclusions drawn from MSA are made within the context of the source and magnitude of errors identified in each step of MSA. Regardless of the many limitations of MSA, this technique is providing valuable information for management. What changes when we strive to minimise errors is our ability to make quantitative rather than qualitative statements about stock contributions. This will be necessary if we want to incorporate these estimates into demographic models that make predictions about the impacts of different mortality sources on particular stocks.

ACKNOWLEDGMENTS

I am grateful for the contributions from Dr. Colin Limpus, Kamarudin Imbriham, The Director of Wildlife in Sabah, Dr. Jeff Miller, Dr. Robert Prince, Dr. Mick Guinea, Scott Whiting and Michelle Boyle for assistance with the provision of samples and Kathy Taylor for the layout of the original poster.

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ANALYSIS OF SURVIVAL AFFECTED BY TEMPERATURE AND HUMIDITY IN KEMP´S RIDLEY (*LEPIDOCHELYS KEMPII*) NESTS

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During the season of 1989, four "arribazones" of Kemp´s ridley at Rancho Nuevo, Tamaulipas, México, beaches occurred from April 23 to June 15. Because of the nests of each "arribada" showed different survival, a study on temperature and humidity to determine the likely effect on incubation was carried out. Two nests per group were selected to survey daily temperature during the whole incubation process and relate their variations with the rest of the nests. Simultaneously, samples of sand were taken every week to determine humidity content through the weight difference method. Survival of each nest considered in this analysis was also obtained.

A one-way analysis of variance using 4 treatments and 330 repetitions was carried out. A Newman-Keuls multiple rank test at a 95% confidence level was applied. Temperature curves were adjusted by means of the least squares method. In order to determine whether or not the trend of the recorded temperature was similar to the rest of the group, an Analysis of Covariance was also realized.

The analysis of variations of temperature and humidity along the incubation period showed that the greater fluctuation of temperature, the more severe changes affect survival. Such is the case of group IV, which had bigger temperature residuals than group I, while nests of groups II and III showed similar survival with a difference of almost 10 units in temperature residuals, although humidity in group II was lower. Group IV showed the lowest survival, since apparently this group was under the worse environmental conditions, having wide variations in temperature, as well as higher humidity conditions than the rest of the groups. This fact shows that during the incubation process, when these parameters have minimum oscillations and steady average values, nest survival tends to increase.

THE EFFECTS OF VARIOUS SAND TYPES ON THE TEMPERATURE, INCUBATION PERIOD AND HATCHING SUCCESS OF LOGGERHEAD SEA TURTLE NESTS: RESULTS OF A TWO YEAR STUDY

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Results of a two year study determined that, under hatchery conditions, the effects of different sand types on temperature, incubation length and hatching success could be ameliorated by manipulating sand type mixtures.

Sand types used in this study included native Miami Beach sand, renourish or off-shore borrow source sand and aragonite from Ocean Cay, Bahamas.

SEA TURTLE INTERACTIONS WITH NW ATLANTIC SWORDFISH LONGLINE FISHERIES

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U.S. swordfish longline fisheries were monitored north of 35°N latitude from 1990 through 1995 by fisheries observers. Observers were placed on the vessels primarily to collect information needed for fisheries management or to document marine mammal interactions. Observers also documented sea turtle interactions with the fishing gear. Preliminary analysis of the data indicates that leatherbacks and loggerheads are the primary species encountered and that as many as 2,000 sea turtles are entangled or hooked annually. Most are released alive; but, no estimates of post release mortality are available.

SEA TURTLES IN THE ARCHIPELAGO OF SAN ANDRÉS, OLD PROVIDENCE AND CATLEEN-CARIBBEAN, COLUMBIA

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Since middle April to November 30, with the collaboration of Columbian Navy Marine, we conducted diurnal and nocturnal surveys of the beaches in the Archipelago of San Andrés, Old Providence and Catleen. During the nesting season, 168 turtles were seen: 31 were loggerheads, 21 were hawksbills, and 6 were green turtles. The northern cay, Seranilla, registered the main nesting activity (67%) and the Bolivay cay, the lower one registered 1.19%. The most striking factor affecting turtle reproduction is the presence of hurricanes and tropical storms, that wash out 40% of the nests.

STOMACH AND GASTROINTESTINAL CONTENTS OF STRANDED KEMP'S RIDLEY (*LEPIDOCHELYS KEMPII*) SEA TURTLES IN GEORGIA.

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ABSTRACT

Stomach and gastrointestinal contents of twenty-six stranded Kemp's ridley *(Lepidochelys kempii)* sea turtles were examined. The sample size represents 14.5% of Kemp's ridley strandings in Georgia from 1992 through 1996, and focuses on waters surrounding Wassaw Island and Jekyll Island. Curved carapace length ranged from 25-69 cm. Percent occurrence showed moon snails (*Polinices duplicatus*) and blue crabs (*Callinectes sapidus*) to constitute 30.77% and 88.46% of the 26 animals, respectively. Other organisms found included horseshoe crabs, calico crabs, purse crabs, additional mollusks, fish, and comb jellies. The data supports the idea that the Kemp's ridley is a shallow water benthic carnivore.

INTRODUCTION

The Kemp's ridley (*Lepidochelys kempii*), the most endangered sea turtle, has been found along the Georgia coast during juvenile and sub-adult stages of life. However, by the adult stage, Kemp's ridleys are primarily found in the Gulf of Mexico, being seen rarely along the coast of Georgia. The food requirements for these stages is an important constituent in the conservation and protection of this species. By learning the diet of the Kemp's ridleys we can understand more about their feeding habits.

One of the first studies in Georgia concluded that the spotted lady crab was the main food source of the Kemp's ridley in that area (De Sola and Abrams, 1933). Other studies from the Chesapeake Bay region showed the blue crab and rock crab as the predominant stomach components (Hardy, 1962; Lutcavage, 1981; Belmund *et al*., 1987). Portunid crabs, barnacles, molluscs, plants, and mud have also been part of the diet according to research in the Gulf of Mexico (Liner, 1954; Dobie *et al*., 1961; Shaver, 1991).

This present study shows the stomach contents of Kemp's ridleys in the sub-adult and adult stages along the Georgia coast. The curved carapace length of the sub-adult is defined within the range of 20-60 cm and the adult is greater than 60 cm in length (Ogren, 1989).

MATERIALS AND METHODS

Fifteen stranded turtles were collected from the beaches of southeast Georgia in 1996. These carcasses were found on Jekyll Island (N=10), St. Simons Island (N=2), Sea Island (N=1), Quarantine Island (N=1), and a shrimp boat (N=1). From 1992 to 1996, eleven strandings were taken from the northern coast of Georgia. These turtles were found on Wassaw Island (N=10) and Little Tybee Island (N=1).

The curved carapace length was recorded for each turtle when possible. Due to damaged carapaces, some measurements could not be taken. A general necropsy was performed on each stranding in accordance to a sea turtle necropsy manual written by Wolke and George (1981). Necropsies were performed to determine the cause of death and to collect the digestive tract contents.

The contents were sieved through a 2 mm mesh net, rinsed with water, and placed into storage containers. The collected items were then separated and identified to the lowest taxon when possible. Samples under 5 mm that could not be identified were recorded as unknown. The individual categories were placed in 10% formalin and air dried for 24-48 hours. The dry weight of each food item was measured and recorded in grams. Calculations for the percent dry weight and percent of occurrence were made for each category.

RESULTS

Every Kemp's ridley sea turtle used in this study was separated according to size. Of the 26 individual strandings, 20 turtles were classified as sub-adults, 3 were adults, and 3 could not be determined. The curved carapace lengths of the sub-adults ranged from 25 cm to 57.7 cm (x= 23) with a mean of 37.77 cm. The adults ranged in length from 62 cm to 69 cm (x=3) with a mean of 64.83 cm. To collect the digestive tract contents, necropsies were performed on all 26 turtles. 3 turtles were completely void of any contents. Of the remaining 23 Kemp's ridleys, a total of 40 different food items were identified.

Eighteen of the 40 food types were found in the turtles from Wassaw Island and Little Tybee Island. Blue crabs (*Callinectes sapidus*) showed a 100% occurrence rate and accounted for 39.71% of the total dry weight in the turtles from Northern Georgia. The blue crab made up over 42% of the contents found in the 3 adult turtles and 38% in the sub-adults. Other crabs found included the stone crab (*Minippe mercenaria*), spider crab (*Libinia dubia*), and decorator crab (*Stenocionops furcata*) making up 15.08%, 9.77%, and 3.7% respectively. Mud snails (*Nassarius obsoletta*), which had a dry weight of 6.67%, appeared in 8 of 11 turtles. Other mollusks such as the great heart cockle (*Dinocardium robustum*), ribbed mussel (*Siliquacostata*), and cross hatched lucine (*Divaricella quadrisulcata*) had small dry weight percentages as well as small percentages of occurrence. Two additional prey items, fish and diamondback terrapins (*Malaclemys terrapin centrata*), were found with a high dry weight percentage but a low percent occurrence.

Twenty-six of the 40 food types were found in the turtles from Jekyll Island, St. Simons Island, Sea Island, Quarantine Island, and the shrimp boat. Moon snails (*Polinices duplicatus*) accounted for the majority of the contents by having the highest dry weight percentage (32.41%) and one of the highest percent occurrences (53.33%). The Atlantic clam, flat slipper, and mud snail were among various other mollusks which made up 1.74% of the total stomach contents. Appearing in 8 of 15 turtles, the purse crab (*Persephona punctata*) made up 22.37% of the dry weight. Additional crabs that had significant dry weight percentages were the spider crab (*Libinia emarginata*) and the calico crab (*Hepatus epheliticus*). A small vertebra was found but could not be identified. Fish and chicken necks were discarded as possibilities.

Crabs were a significant part of the Kemp's ridleys diet, occurring in 88.46% of the turtles used in this study. 69.23% of the turtles contained mollusks, of which 44.45% were moon snails. No foreign material was found in any of the turtles used in this study.

DISCUSSION

The diagnosis of the gut contents from stranded animals suggests that mollusks and crustaceans are a major food source for the Kemp's ridley along the coast of Georgia. A variety of mollusks were found among 18 of the 26 turtles and crabs were seen in 23 out of the 26 animals. The 3 turtles that were void of crabs had empty digestive tracts. Hildebrand (1981) and Ogren (1989) reported that the disbursement of Kemp's ridleys may be associated with areas of large populations of portunid crabs on which the turtle primarily feeds. (Dobie *et al*., 1961). Although portunid crabs were well represented with 34.44% dry weight, the combined dry weight of the spider crab, purse crab, and stone crab accounted for 17.72%.

Along with the crabs and mollusks, other benthic organisms were represented such as horseshoe crabs, echinoderms, and coral. Other food items such as fish, diamondback terrapins, and comb jellies may have been ingested in the water column.

Comparison of the contents taken from northern Georgia with that of southern Georgia shows contrast. Blue crabs made up 39.71% of the total dry weight from the north and moon snails made up 32.41% of the dry weight in the south. Although the primary constituent in the south was moon snails, blue crabs were found in 5 of the 11 turtles. Purse crabs were only represented in the southern waters, while stone crabs found only in northern waters. Because of the large representation of different benthic organisms found in the gastrointestinal tracts, it can be understood that the Kemp's ridley is feeding opportunistically in shallow benthic areas.

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MATING STRATEGIES OF THE LEATHERBACK TURTLE AS REVEALED THROUGH MOLECULAR MARKERS

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To describe the mating strategy of the leatherback turtle, we used polymorphic nDNA microsatellite markers to examine alleles within clutches of eggs. We investigated clutches laid by 10 females, from which 20 hatchlings were sampled, including several successive clutches throughout the season. Three primer sets are currently being screened, including Dutton's DC99, and FitzSimmons' E18 and CC117, for paternally derived alleles.

MONITO ISLAND - PRIME HABITAT FOR THE HAWKSBILL TURTLE

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Monito Island, which lies 6 km off Mona Island and between Puerto Rico and the Dominican Republic, provides an uncommon habitat for hawksbill turtles. In 1993 we began studying Monito's resident hawksbill population and have since tagged 49 turtles there. We report on our findings regarding growth rates, diving behavior, diet, juvenile recruitment rates and other observations.

A HISTORICAL REVIEW OF THE RESEARCH AND CONSERVATION OF MARINE TURTLES IN PUERTO RICO

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Hawksbill, green, leatherback and loggerhead sea turtles have been reported to inhabit Puerto Rico's territorial waters. However, only hawksbills and leatherbacks are common nesters. Since 1973, all the species of sea turtles have been protected by law. But, it was not until 1984 that continuous nesting surveys started for assessing the population status. These studies have shown that Mona Island is the most important nesting beach for hawksbills turtles, while Culebra Island for leatherback turtles. In-the-water studies have been also performed for both the green turtles (Culebra Island 1986-89) and the hawksbill sea turtles (mona Island 1992-present). To date the sea turtle research in Puerto Rico is heading toward the identification and quality assessment of new nesting beaches and specially foraging grounds.

RATE OF SURVIVAL DEPENDS UPON PROMPT ACTION AND TREATMENT

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One green sea turtle (*Chelonia mydas*) with a fishing hook inside the stomach, and two hawksbill turtles (*Eretmochelys imbricata*), with dehydration symptoms and a broken carapace, respectively, were found in 1996 in the north and east part of Puerto Rico. This poster presents rehabilitation efforts resulting in the successful release of two of these turtles, one of each species. Terinary medical findings from the treatments of these reptiles are presented, in order to share with the concerned scientific community, effective methods to prevent these species from becoming extinct.

EFFECTS OF THREE SOIL CEMENT STEP-FACED REVETMENTS ON THE SEA TURTLE NESTING HABIT AND HATCH SUCCESS ON CASEY KEY, FLORIDA

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INTRODUCTION

Beach armoring has been associated with the alteration of sea turtle nesting activity (Foote, 1995). The increasing development of beach armoring structures on the barrier islands of the west coast of central Florida has prompted the need to document the attributes of armored beaches that may alter the sea turtle nesting activity and hatch success. During the 1996 nesting season, a pilot study was conducted on the North half of Casey Key, Sarasota County, Florida, to establish a base line documentation of the effects of three soil cement step-faced revetments on the sea turtle nesting habit and hatch success. This type of erosion control device has never been used in an open coastal environment in Florida prior its development on Casey Key (Coastal Planning and Engineering, 1989).

METHODS

The 1996 pilot study was treated as a multidisciplinary study. The goal was to determine which aspects of armored beach environment were likely to impact the sea turtle nesting activity and the hatch success so that more detailed studies could be conducted in the future. The fields investigated included beach morphodynamics, hydrogeology of the beach shallow subsurface, analysis of five beach sediment characteristics, and the monitoring of the sea turtle nesting activity and hatch success. Three kilometers of beach, divided into 38 grids that were grouped into 11 beach segments were surveyed during the entire 1996 nesting season. Three of these beach segments included the soil cement step-faced revetments; five beach segments were immediately adjacent to the north and south end of the revetments; finally three beach segments were unconnected with the revetment and were used as controls. Two of these three controls were unarmored beaches located at the north and south ends of the study site. The third control was located between two stepped revetments and was armored with ripraps.

RESULTS

The occurrence of nests tended to vary with the average volume of sediment on the study site (see Fig. 1). The beach segments with large volumes of sediment and wide beaches tended to have more nests than armored beach segments with smaller sediment volume. The two highest level of subsurface water were recorded at the location of the two nests with the lowest success rate: nests 96CK03012, and 96CK03002. These two nest were placed within 10 meters from the swash zone. In areas where the soil cement step-faced revetments are adjacent to a paved road, discharges from overland flow during rain storm events have eroded the sediments of the upper beach. The buried slabs of soil cement step-faced revetments and the buried rocks of riraps have deterred sea turtle from nesting and in six documented cases resulted in false crawls. Out of these six documented false crawls, two showed signs of meandering upon the road pavement where soil cement step-faced revetments were adjacent to the road. One time measurements of the temperatures, the shear resistance and the compactness of the sediment, the moisture content as well as the grain size analysis proved to be insufficient to show any pattern that could be associated either with the armoring structure or with the nesting activity and the hatch success.

DISCUSSION

Three type of armoring devices were observed on the study site. Ripraps are the oldest and the most ubiquitous, soil-cement step revetments and bulkheads are the most recent. All three types deny sediments from the bluff to the sediment transport process and therefore tend to maintain low and narrow beaches (Pinet, 1992). If nesting occurs, the beach morphology of armored areas often does not allow sea turtle to place their nest far enough from the swash zone or high enough above the water table (see Fig. 2, 3, 4, and 5). Discharge from overland flow increases with the surface of impervious material (Fetter, 1994). Where road pavement meet the soil cement step-faced revetments, the input of overland flow onto the upper beach can be significant. This could result in the maintenance of a large volume of water within the sediment which in turn could increase the subsurface temperature by transferring more readily the thermal energy from the beach surface to the subsurface sediment (Harrison and Morrison, 1993).

CONCLUSION

In order to better document the effects of armoring the beach on the sea turtle nesting activity, further study should include constant monitoring of the temperature and moisture content in the sediment neighboring to the nests; analysis of the grain size and the vertical distribution of the sediment along with shear resistance measurements near the nests should be repeated regularly during the period of incubation. Survey of the beach morphodynamic and the subsurface water table should also be pursued. Future research is also needed to determine the effect on the hatch success of overland flow inputs onto the upper beach. The location of the nests, the false crawls, and the relevant features of the beach environment should be documented using Differential Global Positioning System and Geographic Information System.

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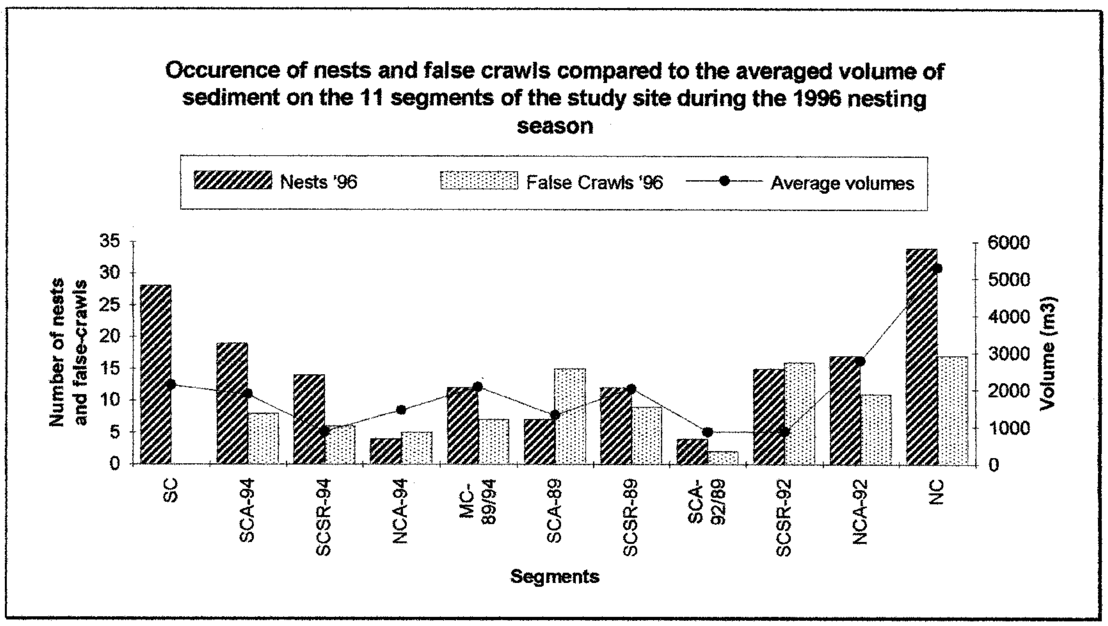

Figure 1. The number of nests tend to follow the volume of sediment. Areas showing number of false crawls greater than the number of nests are located on segments with narrow beach.

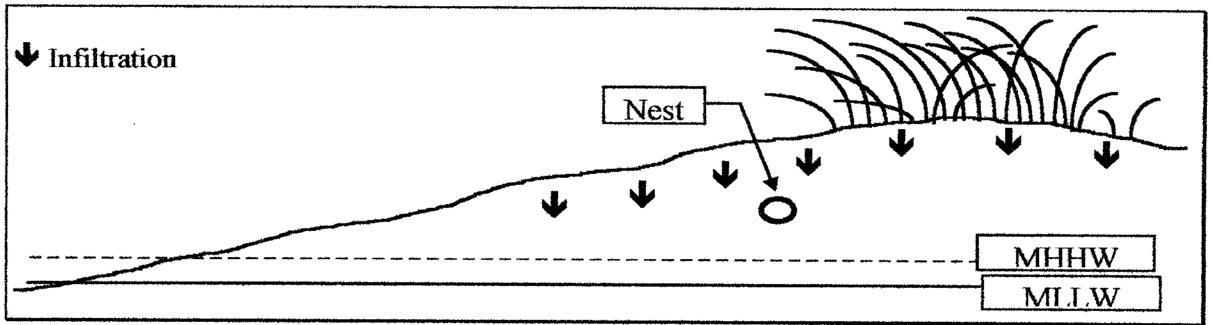

Figure 2. Diagram of an unarmored beach. The nest is well beyond the swash zone, deep in sand, and there is no discharge from oveland flow.

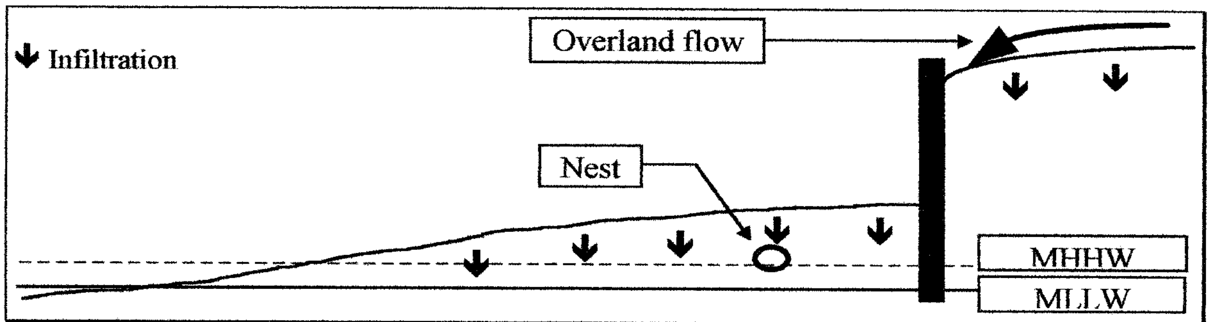

Figure 3. Diagram of a beach armored with a bulkhead. The nest is closer to the swash zone and to the water table. There is no discharge from overland flow.

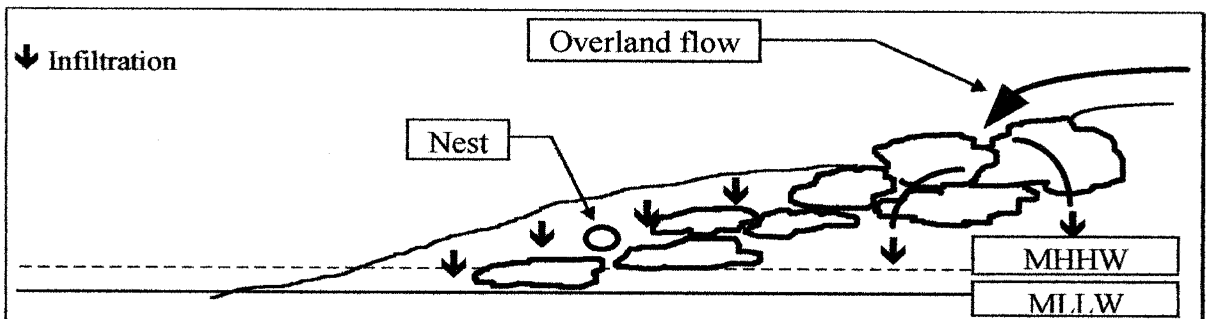

Figure 4. Diagram of a beach armored with ripraps. The nest is near the swash zone, the depth of sediment is limited by the ripraps. Discharge from overland flow is mostly absorbed between the voids of the ripraps.

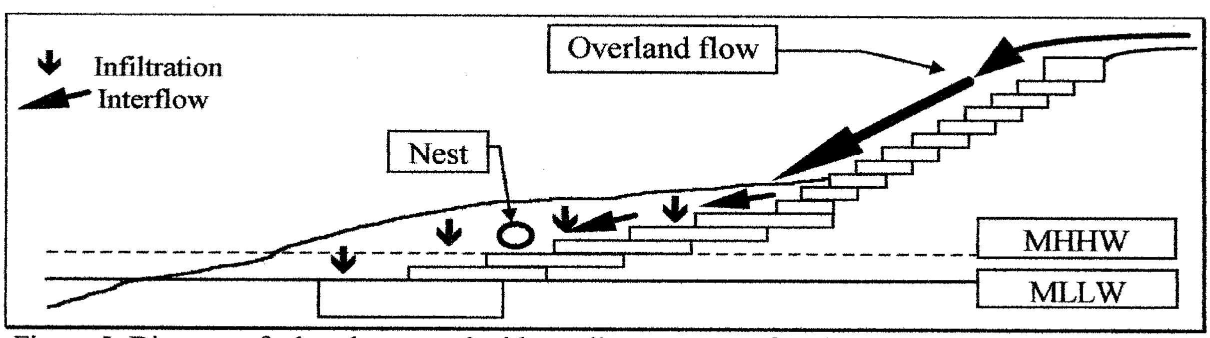

Figure 5. Diagram of a beach armored with a soil cement step-faced revetment. The nest is close to the swash zone, the depth is limited by the steps of the revetment. There is a significant discharge from overland flow and interflow.

ACCELERATED GROWTH IN SAN DIEGO BAY GREEN TURTLES?

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INTRODUCTION

San Diego Bay in San Diego, California is the only place on the west coast of the U.S. where sea turtles are known to aggregate. Since 1989, we have been conducting studies on the green turtles in the bay. Preliminary genetic analysis indicates that the majority are from Mexican nesting stock. Juveniles and adult males and females are present. The turtles are generally found in the south part of the bay in the vicinity of the San Diego Gas and Electric (SDG&E) power plant effluent channel, where the water is warmer than in the rest of the bay, and at least 20°F warmer than the adjacent ocean. Average daily effluent water temperatures normally range from 12.2°C in winter to 27.7°C in the summer.

MATERIALS AND METHODS

Turtles were caught in 150 ft tangle nets with 16 in. mesh, set across the effluent channel of the SDG&E power plant. Once caught, they were tagged, weighed, and measured, and a blood sample was taken for genetic analysis and sex determination. Standard straight carapace measurements were made with a tree caliper, from the precentral scute at the carapace midline to the posterior margin of the postcentrals. Plastron and curved carapace measurements were also taken.

RESULTS

Table 1 shows growth measurements for San Diego Bay green turtles. One turtle measured 54.4 cm SCL when captured in 1991. It was recaptured as an adult male in 1996, and measured 87.0 cm. Tail length was 34.5 cm (plastron to tip) and 12.8 cm (anus to tip). Based on a von Bertalanffy growth curve, Boulon and Frazer (1990) estimated a 50 cm SCL turtle in the Caribbean to be 8-10 years old. Applying this estimate to the San Diego Bay male, it may have reached sexual maturity in less than 15 years.

DISCUSSION

Growth rates for San Diego Bay turtles in the 40 - 60 cm size classes are higher than in most other areas. In the Bahamas, turtles took from 11 - 13 yrs to grow from 30 to 70 cm (Bjorndal *et al*., 1995). In the Galapagos Islands, growth rates in 50-60 cm SCL category were only 0.45 cm/yr for the black morphotype and 1.57 for the yellow (Green, 1993). Growth rates for Hawaiian greens in the 50 - 55 cm SCL size class average 2.0 cm/yr with slightly higher rates off Waikiki Beach of 3.7 and 3.0 cm/yr for 57.6 cm and 69.3 cm turtles, respectively (Balazs *et al*., 1994, in press). Immature greens in Puerto Rico averaged 3.8 cm/yr in the 50-60 cm SCL category, and 6.0 cm/yr in the 40-50 cm (Collazo *et al*. 1992). U.S. Virgin Islands growth rates were similar (Boulon and Frazer, 1990).

Growth rates for San Diego Bay greens more closely resemble Caribbean greens than those in the Pacific. This is likely due to a combination of high water temperatures and abundant food. The most predominantly used food source seems to be eelgrass (*Zostera* sp.), with different species of red and green algae also taken.

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Table 1. Growth of Green Turtles in San Diego Bay

NMFS Tag No	Date First Tagged	Sex	Wt. (kg)	SSC L (cm)	Recapture Date	Wt. (kg)	SSC L (cm)	Growth in cm/yr (SSCL)
X103-104	5/12/90	Male	100.0	85.5	11/10/91	91.5	85.7	0.1
X105-106	5/12/90	Juv	24.0	54.4	1/14/91	39.5	58.0	5.4
X122-123	1/28/91	Juv	13.0	46.7	2/1/92	19.0	51.8	5.1
X124-125	1/28/91	Fem	88.0	86.7	1/18/92		90.6	3.9
X127-128	2/16/91	Juv Male	18.0	54.4	11/17/96		87.0	5.7

USE OF THE GENERIC MAPPING TOOLS PROGRAM TO PLOT ARGOS TRACKING DATA FOR SEA TURTLES

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Satellite telemetry is used to track the movements of sea turtles and other animals worldwide. One challenge a scientist faces is how to present the numerical data received from transmitters as a publication-quality graphic. Presented here is one way to convert tracking data into such a format using a powerful system called the Generic Mapping Tools (GMT) program, created by Paul Wessel and Walter H. F. Smith. Many GIS integrated systems, such as Argos' ELSA, and ARC/INFO or MapInfo, are available, but can range upwards of US$4500 for the initial purchase. High resolution maps of locations worldwide can be created relatively easily using GMT, a free, public-domain collection of over 50 tools that run on UNIX, an operating system similar to DOS (Wessel and Smith, 1991; Smith and Wessel, 1990). GMT uses the WGS-84 ellipsoid as its default global projection and can be customized with personal preferences through the .gmtdefaults file. More information about GMT can be obtained over the Internet at: http://www.soest.hawaii.edu/wessel/gmt.html or by writing to: GMT c/o Paul Wessel, SOEST, 2525 Correa Road, Honolulu, Hawaii 96822 U.S.A. (Wessel and Smith, 1995).

The first step in making a map, such as shown in Fig. 1, is to create an executable ASCII file containing all the required command lines as follows: #!/bin/sh, where the pound sign (#) is used to "comment out" or exclude from execution that particular line, and simply notes 'this is a shell script.' The line, PSFILE=<filename>.ps, indicates the PostScript file where the output of all commands will be compiled. The map scale is created with: SCALE=X/Yd, where X and Y are the number of centimeters per degree for the corresponding axis; here, both the x and y-axes are 1.57 cm per degree. The line: gmtset DEGREE_FORMAT 3, sets the labeling so longitudes are displayed as 0 to 180 and latitudes as 0 to 90 degrees with the letters W, E, S and N appended as appropriate. Four basic commands are then used to create a map as follows:

1) psbasemap. This program creates a basic map frame for a selected area. A base map was created using the command, -R177/192.2/-21/-13, where each number specifies a corner (W/E/S/N). Map projection with the previously designated SCALE (20 available including Mercator, Hammer, etc.) was selected with the command, -Jx${SCALE}, where x specifies a linear projection. The position of the map was set at 2.5 cm from the left margin (-X2.5) and 3.8 cm from the bottom edge (-Y3.8). The tickmarks and their labels are situated every 5 degrees on the left and bottom of the frame by the command, -B5/5WeSn. For tick marks on the right and top of the frame, the 'e' and 'n' would be capitalized. The command, -K, allows you to append additional commands to the PostScript file. The line, > $PSFILE (or >> $PSFILE), at the end of each command line sends the results to the named PSFILE.

2) pscoast. This program includes land and water masses on the basic map. Each mass can be shaded (0-255, where 0 is black and 255 is white), colored (red/green/blue, where 0-255 provides intensity), or textured. The -G command sets the 'painting' for 'dry' areas with black as the default, -G155/240/90, colors land masses green. The -S command sets the 'painting' for 'wet' areas with white as the default, -S100/255/255 colors the water blue. GMT draws coastlines, rivers, and political boundaries with different commands. Coastlines were included as a black line with a pen size of 3 with the command, -W3/0/0/0. There are five resolutions (-D) of which the intermediate resolution (-Di) thats plots polygons greater than 20 km2, is probably sufficient for most maps or high resolution (-Dh, features > 1 km2) could be used. The -O command overlays output from this command line onto the previous map. Note -R and -J are not appended as no changes were made.

3) psxy. This program includes the database latitude and longitude files that were created and displays them as lines or symbols. Longitude values should be entered as 0 to 359.999. Latitude values should be entered as 0 to 90, positive in the northern hemisphere and negative in the southern hemisphere. Data files will be read into GMT as X, Y pairs (longitude, latitude). The command, -:, allows the data to be read as Y, X pairs (latitude, longitude). Database files for each turtle were inputted twice, once to create tracklines and the second time to create symbols. Various types of lines (-W) and symbols (-S) can be created. Here, three lines with a pen size of six were created. The command, -W6/255/0/255, created a solid, hot pink line, -W6/255/50/50ta, an orange, dashed line, and -W6to, a black, dotted line. Three black symbols were created by -Si0.15, an inverted triangle with a side length of 0.15 cm, -Ss0.13, a square with a side length of 0.13 cm, and -Sc0.15, a circle with a diameter of 0.15 cm. Again -R and -J are not appended and -O indicates commands are overlaid.

4) pstext. This program positions text such as labels, titles, and other text onto the map. Seven fields of information are needed to create the text: X, Y, size, angle, fontno, justify, and text. X and Y can be either longitude, latitude data, or x, y values in cm (position of text is relative to map position). The 'fontno' field contains the number for a particular font, the default, 0, is Helvetica. The 'justify' field indicates the part of text on the x, y position. Text files can be included with the command line or as a separate file. The positioning for the base map (-R) of the second pstext was changed to cm (-R0/27.9/0/21.6) from latitude, longitude and the scale was set at 1:1 (-Jx1). The command line, 7.62 7.62 12 00 1 25693, placed "25693" as a 12 point, Helvetica string at 0 angle, and justified on the lower left corner (1) of text 10.2 cm from the left margin and 11.4 cm from the bottom. No -K command was included in the last command line, which indicates the map is finished to GMT.

The final product is obtained by executing the program in UNIX and printing the output file on a PostScript compatible printer (Fig. 1, a black and white version). A high quality graphic is the reward for the time expended modifying the programs and is an excellent complement to manuscripts and presentations.

Our thanks to K. Bigelow and R. Uyeda for their time and assistance with GMT and UNIX, and to S. K. K. Murakawa, F. A. Parrish, J. Kendig, S. Beavers, and J. Nichols for providing review comments.

EXAMPLE OF A GMT COMMAND FILE

```
#!/bin/sh
PSFILE=Samoa_Fiji.ps
SCALE=1.57/1.57d
gmtset DEGREE_FORMAT 3
psbasemap -R177/192.2/-21/-13 -Jx${SCALE} -X2.5 -Y3.8 -B5/5WeSn -K > $PSFILE
pscoast -R  -Jx  -Di -G155/240/90 -S100/255/255 -W3/0/0/0 -O -K >> $PSFILE
psxy 25692_96.dat -Jx  -R  -W6/255/0/255 -O  -K  -: >> $PSFILE psxy 25694_96.dat -Jx  -R  -W6/255/50/50ta
-O  -K  -: >> $PSFILE psxy 25693_96.dat -Jx  -R  -W6to  -O  -K  -: >> $PSFILE
psxy 25693_96.dat -Jx  -R  -Si0.15 -G0 -O  -K  -: >> $PSFILE psxy 25694_96.dat -Jx  -R  -Ss0.13 -G0 -O -K -:
>> $PSFILE psxy 25692_96.dat -Jx  -R  -Sc0.15 -G0 -O -K -: >> $PSFILE
pstext -R177/192.2/-21/-13 -Jx  -O -K <<END>> $PSFILE
191.400 -14.000 12 0 0 1 Rose
191.400 -14.300 12 0 0 1 Atoll
178.500 -16.000 12 0 0 2 Fiji Islands
187.000 -13.300 12 0 0 1 W. Samoa
END
pstext -R0/27.9/0/21.6 -Jx1 -O <<@END>> $PSFILE
7.62 7.62 12 0 0 1 25693
7.62 5.84 12 0 0 1 25692
7.62 2.54 12 0 0 1 25694
20.62 2.41 12 0 0 1 Niue
0.5 13.97 16 0 0 1 Post-nesting Migrations of Green Turtles from Rose Atoll, American Samoa to Fiji, 1995-96
@END
```

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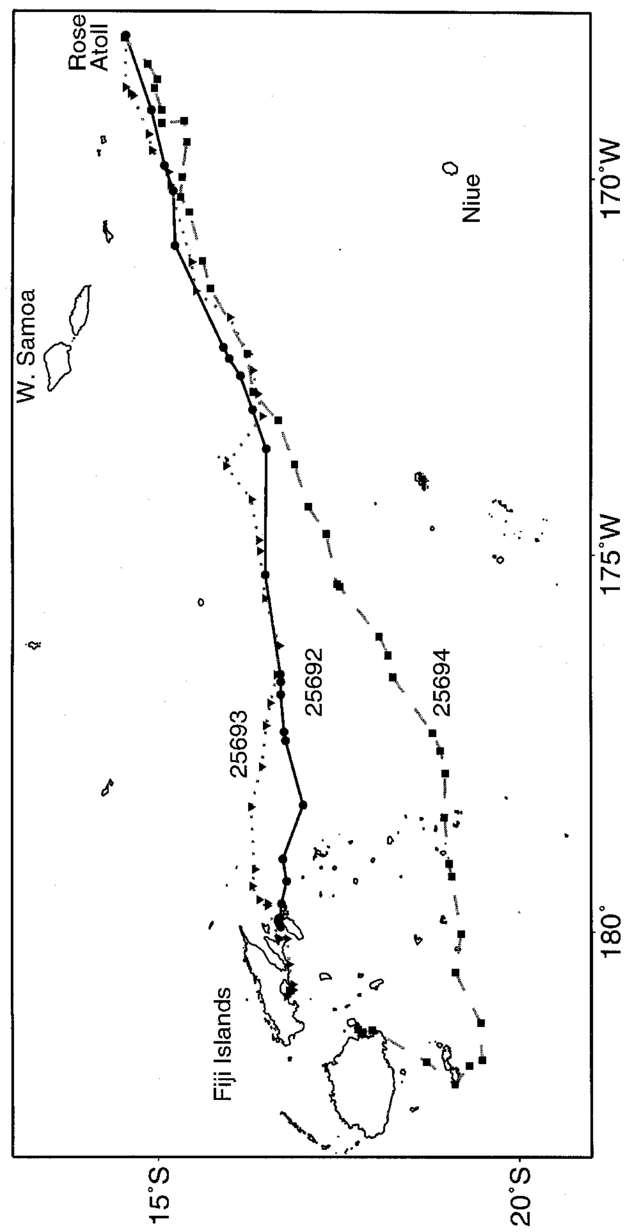

Figure 1. Graphic produced using the Generic Mapping Tools Program showing post-nesting migrations of three green turtles from Rose Atoll, American Samoa to Fiji, 1995-96

AN INCREASE IN MARINE TURTLE DEATHS ALONG THE WEST CENTRAL COAST OF FLORIDA (1995-1996): IS RED TIDE THE CULPRIT?

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One-hundred six marine turtles, including Kemp's ridley (*Lepidochelys kempi*), green (*Chelonia mydas*), hawksbill (*Eretmochelys imbricata*), and loggerhead (*Caretta caretta*), live or dead stranded along the Gulf of Mexico coastline of Sarasota County during 1995 and 1996. This number represents an increase over the previous high of 38 turtles in 1987. Fig. 1 shows the annual counts of stranded turtles from 1987 through 1996 for each species. Turtle strandings per week are shown for 1995 and 1996 in Fig. 2 where red tide (*Gymnodinium breve*) cell counts are also plotted. The red tide measurements were taken irregularly in the passes and Gulf of Mexico in the Sarasota area to monitor the severity of the outbreaks. The majority of the 1995 and 1996 stranding events occurred during prolonged periods of rapid spread or "bloom" of red tide. Circumstantial evidence indicates that red tide may be a cause in the deaths of some of these animals. It is important to note that no tissue assays for brevetoxin have yet been conducted. Historical information suggests red tide may be fatal to turtles. "The appearance of a red tide about November is an annual event according to Morobe harbor villagers who look forward to the associated fish and turtle kills. The meat from the dead animals is cooked and eaten without ill effects." (Maclean, 1975.)

A die-off of West Indian manatees was also observed in 1996. Although south of Sarasota County, manatee deaths along the Southwest Coast of Florida which began March 5 through April 27, 1996, showed a strong correlation between the appearance and disappearance of intense red tide blooms. Toxicity tests and bioassays were used to prove the relationship between the red tide blooms and the manatee deaths (Huff, unpublished).

Symptoms of red tide on marine turtles were observed in the live stranded turtles. The symptoms included respiratory difficulty, disorientation (swimming/pivoting in circles), head bobbing, extreme lethargy and lack of coordination. These symptoms were exhibited by five (4 loggerhead and 1 Kemp's ridley) out of the eight live stranded marine turtles during 1995/1996. The remaining three live stranded were green turtles infected with the fibropapilloma virus. These turtles did not exhibit the above listed symptoms.

Necropsy results from 32 of the 96 carcasses collected in 1995 and 1996 (26 Kemp's ridley, 3 green, 1 hawksbill, and 2 loggerhead) also add evidence of possible red tide involvement. Gross examination revealed that 17 of the carcasses including 12 Kemp's ridley, two loggerhead and 3 green were classified as fresh dead to moderately decomposed. These animals appeared robust with no obvious cause of death noted.

Twenty-seven necropsies involved examination of GI tract contents. Twenty of these, all Kemp's ridley, contained fish bones or other fish parts. Kemp's ridley is a benthic feeder that forages predominately on portunid crabs, other crabs and various mollusks. Fish constitute a small percentage of the dietary component and may be the result of scavenging on discarded bycatch or bait (Marquez-M., 1994; Shaver, 1991; Bjorndal, 1997).

The red tide cell counts averaged more than 100,000 cells/liter during the 1995/1996 red tide blooms in April 1995 through May 1996. This level was deemed an estimated reference point of toxicity for fish kill by the Florida Department of Environmental Protection (Huff, unpublished). There is a possibility that these turtles were consuming fishes debilitated by the accumulation of red tide (*Gymnodinium breve*).

Similar correlations between the marine turtle strandings and the red tide blooms during 1995/1996 warrant further investigation into the possible influence of red tide on marine turtle strandings.

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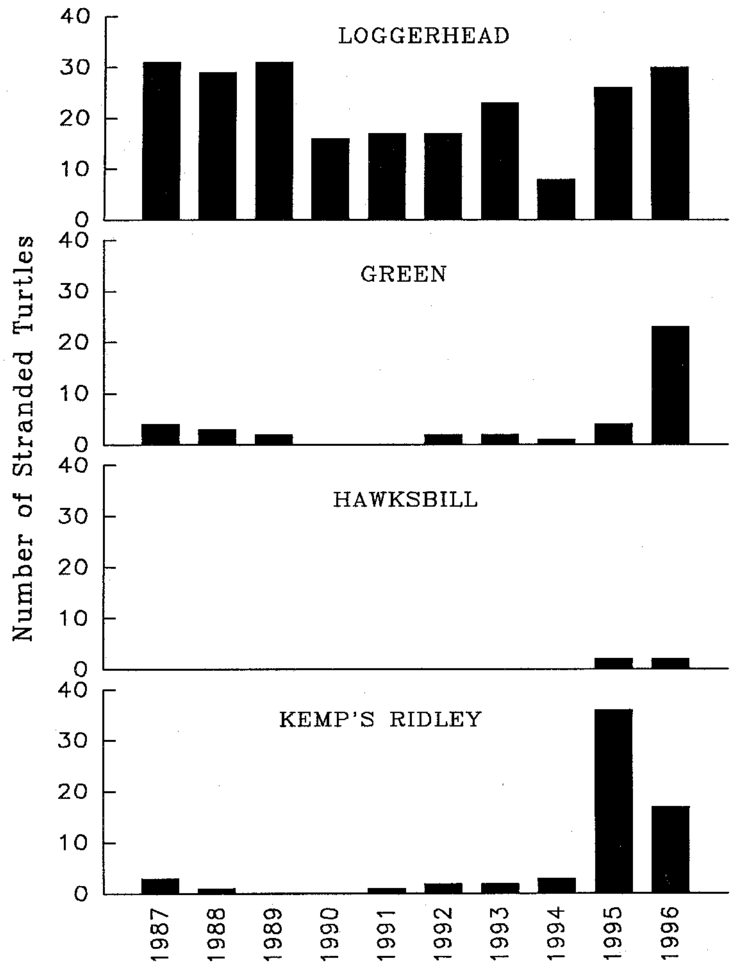

Figure 1. Number of stranded turtles from 1987 to 1996 in Sarasota County, Florida. Mote Marine Laboratory.

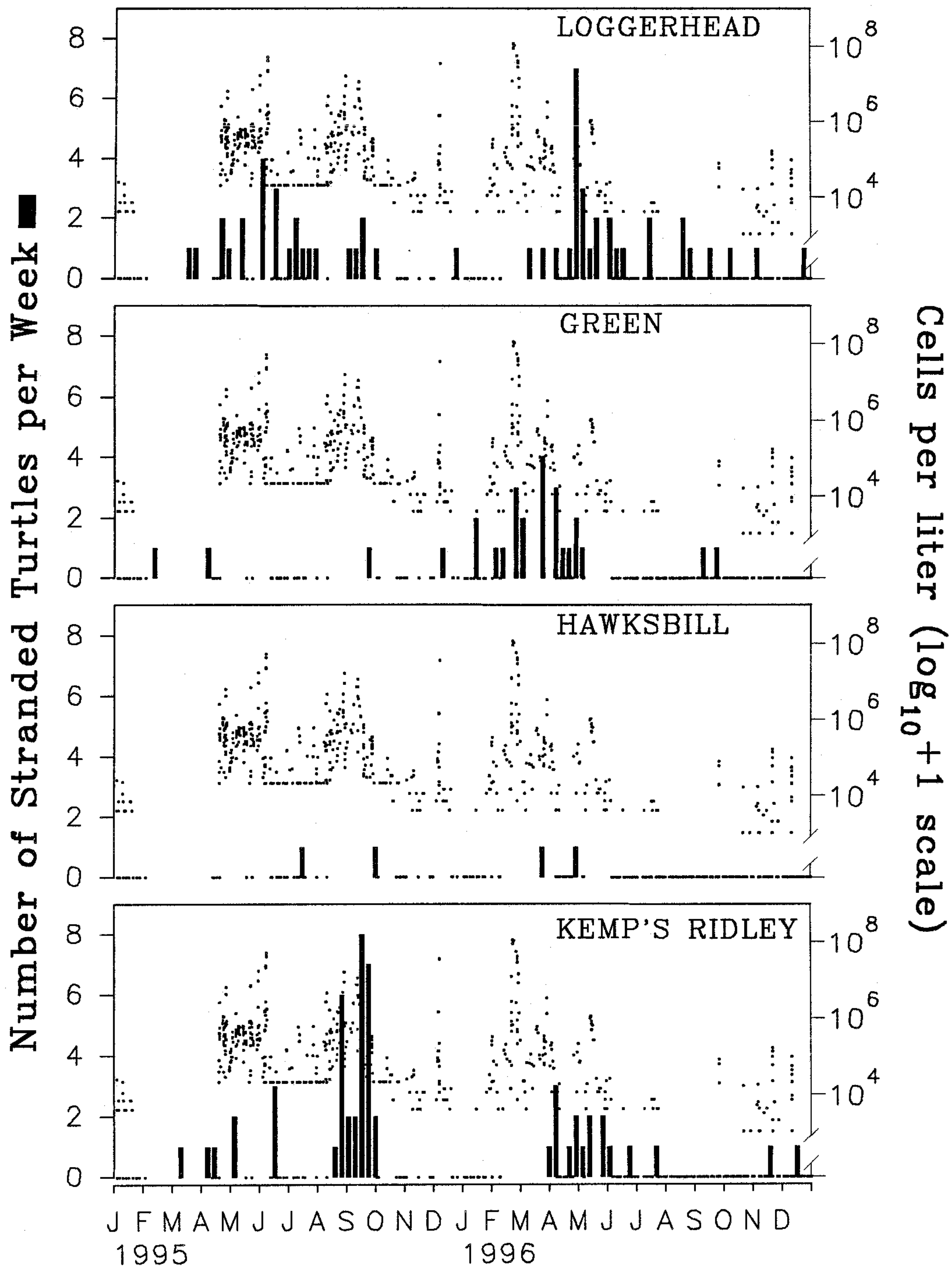

Figure 2. Number of stranded turtles per week during 1995 and 1996 superimposed on red tide cell counts (symbols) in Sarasota County, Florida. Mote Marine Laboratory.

HURRICANES, HABITAT LOSS, AND HIGH TEMPERATURES: IMPLICATIONS FOR HAWKSBILL HATCH SUCCESS AT BUCK ISLAND REEF NATIONAL MONUMENT

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At Buck Island Reef National Monument (BIRNM), St. Croix, US Virgin Islands, hawksbill sea turtle (*Eretmochelys imbricata*) nesting activities occur predominantly within shoreline vegetation and beach forest (Hillis, pers comm.), as is common for the species (Diamond, 1976; Witzell and Banner, 1980; Limpus *et al*., 1983; Ryder *et al*., 1989; Horrocks and Scott, 1991; Mrozovsky *et al*., 1992). Temperature measurements from beaches utilized by other sea turtle species, as well as preliminary examinations at Buck Island Reef N.M., have shown that nest temperatures are significantly cooler in locations shaded by vegetation (Moreale, 1982; Standora and Spotila, 1985; Spotila *et al*. ,1987; Schmelz and Mezich, 1988; Godfrey unpubl.). Therefore, the vegetative cover shading hawksbill nests may have an important influence on the temperature regimes which are critical for the development and hatch success of hawksbill eggs.

The vegetation on BIRNM has been heavily affected by hurricanes. On September 17-18 of 1989, hurricane Hugo passed directly over BIRNM killing approximately 75-90% of the mature manchineel trees (*Hippomane mancinella*) and sea grape (*Coccoloba uvifera*) (Starbird, unpubl.; Hillis, 1990). In September of 1995, Hurricane Luis passed to the north of the island and caused minimal vegetative damage, however ten days later, hurricane Marilyn passed within 5 miles of Buck Island with winds in excess of 150 mph and 20 foot seas, leaving the nesting beach habitats unrecognizable (Hillis, 1996). With the destruction of the mature beach forest, the primary nesting habitat utilized by hawksbills has been altered dramatically. Areas once located under a thick manchineel canopy are now exposed to direct sunlight. In addition, due to years of leaf litter being deposited and decomposing on the beach forest floor, the soil in the nesting habitat is dark with a high level organic matter. We postulate that the exposure of dark, organic soil to increased levels of solar radiation creates incubation temperature conditions which adversely affect hawksbill hatch success at BIRNM.

A small section of remaining mature beach forest on the island interior was selected as being representative of the pre-hurricane beach forest nesting habitat. Mid day light intensity was measured in the mature beach forest in 20 randomly selected locations using a light meter pointed vertically. The mean light intensity was calculated. 3'x 3' shade frames were constructed using pvc pipe and greenhouse screening placed in successive layers on the frame until the light level under the screening matched the average reading taken in the remaining mature beach forest.

Omega Temperature Data Loggers (DL) were used to record beach and nest temperature All DLs were calibrated in an incubator against an NIST traceable mercury thermometer. Each was programmed to record the temperature at 1.2 hour intervals over the course of a 90 day cycle and sealed in plastic bags with desiccant vials. In each site, one DL was placed at a depth of 30cm to record ambient beach temperature. This corresponds to the mid to upper portions of the egg mass in hawksbill nests (Mrosovsky *et al*., 1992). Two hawksbill nests were relocated to within approximately 5 m of each Beach Temperature Data Logger. DLs were placed at 30 cm within each clutch. Shade cloth frames were placed over one nest to simulate the conditions found in the pre-hurricane beach forest. The other nest was covered only by vegetation existing at the site.

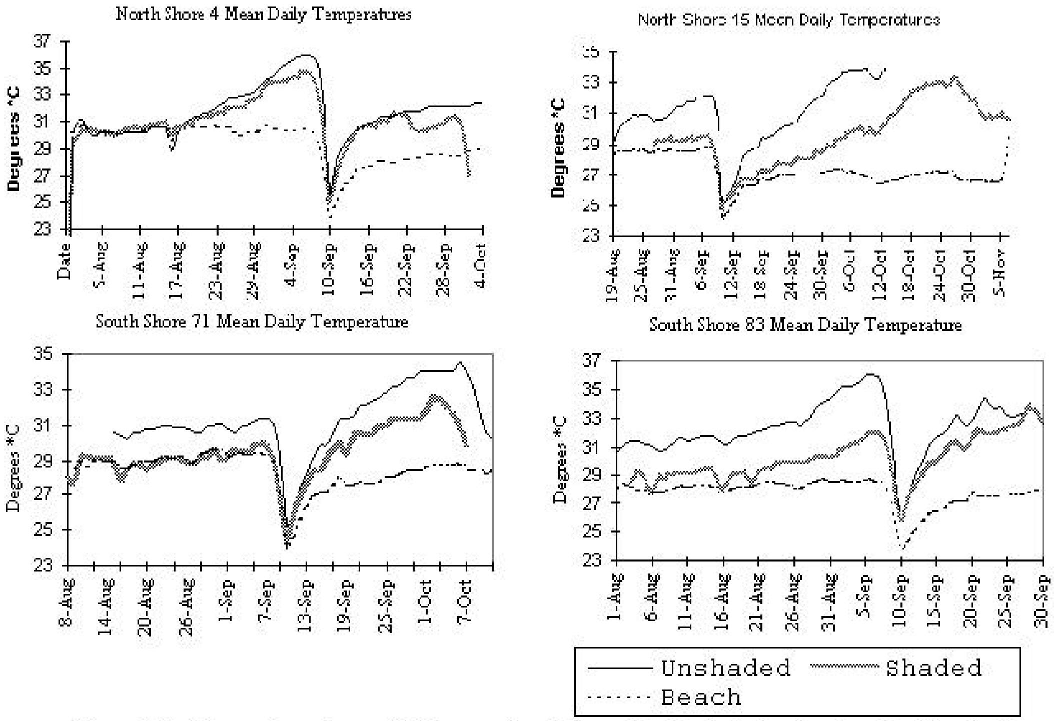
The nests were then left to incubate. After emergence, the nests were excavated to determine hatch success. All nest contents were removed and sorted into categories: hatched shells, dead and live trapped hatchlings, full term pipped and unhatched eggs including yokeless, undeveloped, mid term, and full term unpipped. All unhatched eggs were opened to determine at what stage embryonic development ceased. DL units were removed and the temperature data was retrieved.

The results of this study fall into two categories: temperature measurements and hatch success determination. Combined nest temperatures were an average of 2.6 C warmer than beach temperatures. Temperatures in unshaded nests were significantly warmer than those in shaded nests (see Fig. 1-4). Unshaded nests were found to be an average of 2.1 C warmer than shaded nests in the same location (n=8, min= 0.79, max= 2.19). Percent hatch success was calculated for all experimental nests (# hatched shells / # eggs laid). Mean hatch success in shaded and unshaded nests was 71.053% and 54.994% respectively (see Fig. 5). The mean number of embryos which died in the final stages of development (full term) was calculated for all experimental nests. Shaded nests contained an average 5.58 percent full term dead (pipped and unpipped) embryos while unshaded nests contained an average of 15.23 percent (see Fig. 6). In addition, there appears to be an exponential relationship (r=0.8536) between the maximum nest temperature reached and the percentage of embryos which suffered mortality late in development (see Fig. 7).

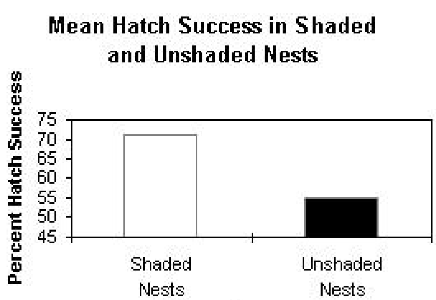
The success of hawksbill nests at BIRNM has been adversely affected by a reduction in vegetative cover due to the destruction of the beach forest by hurricanes. At BIRNM, shaded nests were found to be significantly cooler than unshaded nests. In each case, shaded nests were cooler and experienced greater hatch success than did unshaded nests. While there are a host of variables which affect the hatching of sea turtle eggs (Bustard and Greenham, 1968) and each of those should be examined, it appears that increased incubation temperatures have had a negative effect on the success of nests at BIRNM.

Perhaps one of the more interesting findings of this study is the apparent correlation between the maximum nest temperature and the percent of embryos which experienced late term mortality. This provides a powerful tool for further examining the effects of hurricane disturbance on temperature regimes. Preliminary analysis indicates that overall hatch success declined significantly since the landfall of Hurricane Hugo in 1989. In addition, the percentage of late term dead embryos increased markedly in the years following the destruction of the mature beach forest canopy. By examining Buck Island Reef National Monument nesting data from previous years, we might use the number of embryos which experienced late term mortality as an indicator of temperature stress.

A complete list of references is available upon request.



Figures 1-4. Comparison of mean daily temperatures between beach, shaded nests and unshaded nests No Shore 4, North Shore 15, South Shore 71 and South Shore 83 nesting locations throughout the incubation j All temperature measurements were taken at 30 cm. (The significant drop in mean daily temperature is the of Hurricane Hortense, September 8, 1996)



'igure 6.

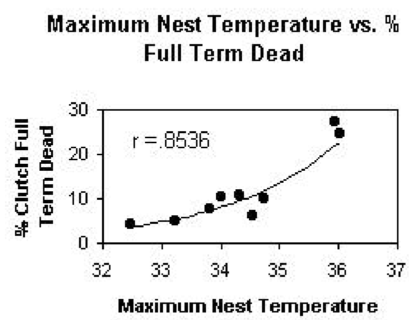


Figure 8.

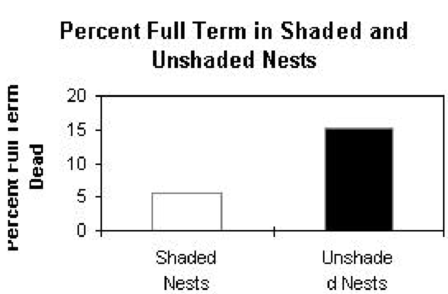


Figure 7.

Figure 6. Comparison of mean hatch success in shaded and unshaded nests in NS 4, NS 15, SS 71 and SS 83 nesting habitats. **Figure 7**. Comparison of the percentage of clutch which experienced late term embryonic mortality in shaded and unshaded nests in the same locations. **Figure 8.** Demonstrates the relationship between maximum mean nest temperature and the percent of clutch which experiences late term embryonic mortality.

STRANDINGS, AND WHAT TO DO WITH THEM: A NEW KEY FOR STRANDING IDENTIFICATION AND THE IMPORTANCE OF USING STRANDINGS AS RESEARCH TOOLS

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A Guide for the Identification of Stranded Sea Turtles: The Eastern United States and the Gulf of Mexico, Savannah Science Museum Special Publication No. 4 was compiled using a variety of sources including previously constructed keys to various aspects of sea turtle anatomy and from over a hundred previously constructed keys to various aspects of sea turtle anatomy and from over a hundred strandings catalogued in the Savannah Science Museum herpetology collection. The goal of this guide is to provide as much information as possible on ways to identify sea turtles while keeping procedures easy to follow. Sections of this manual include: charts of common species characteristics, six keys for stranding identification, figures showing various aspects of sea turtle anatomy, and a glossary of terms commonly associated with turtle identification. Illustrations were interpreted from actual specimens and not 'borrowed' from previously released texts. Each year the STSSN has to place a reasonable number of catalogued, stranded turtles into an 'unidentified' category. Hopefully, with the addition of this guide as a resource to field studies, the number of unidentified turtles each year should decrease significantly. Upon completion of the 'stranding/I.D. manual' it became apparent that a vast amount of valuable information could b obtained by one or several researchers from a single turtle carcass. A list of individuals/organizations and the samples they require would benefit all researchers and streamline the sampling request process. In an effort to compile such a list, over a hundred letters were mailed to individuals and organizations associated with sea turtle research. Each letter extended an invitation to include, into a list, a particular organization or individual and the samples that they need from specimens during the regular 'turtle season'. The list would then be distributed to each state's STSSN coordinator(s). This would allow each coordinator to provide eligible individuals with certain requested samples to aid in their ongoing research rather than just discarding the turtle carcass and losing potentially valuable data. A complete list would also allow researchers to increase his or her sample size, inform colleagues of ongoing projects and sample needs as well as fully utilize the research potential of a turtle carcass.

While sea turtle research has its veterans, it continues to grow by leaps and bounds each year with novice field researchers. Hopefully, updating projects and newer resources can be used as 'tools' for 'new recruits' who are often times thrown into sea turtle field work and left to learn on a trial and error basis.

ACKNOWLEDGMENTS

I would like to thank the following individuals who assisted in the preparation of this manuscript: Anne Lindsay, Kristina Williams, Patricia Mouchet, Todd Gedamke, Karen Leigh Creech, Kristine Davis, Heather Woodson, Kate Mansfield, Brad Winn, Mike Harris, John Robinette, Mark Musaus, Randy Isbister, Charles Warnock, and Sam Drake.

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

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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 and pound net capture data obtained from 1980-1996, loggerheads are most abundant (43.6%), followed by ridleys (28.9%), leatherbacks (18.8%), and green turtles (8.6%). Risks to sea turtles in this area include hypothermia, boat collisions, entanglement in fishing gear, and ingestion of marine debris. Here data are analyzed to assess the causes of turtle mortalities in the New York Bight.

METHODS

Since 1980 the New York State Marine Mammal and Sea Turtle Stranding Program has maintained a data base on all stranded sea turtles encountered in the area. Dead turtles are necropsied to determine cause of death, and all turtles are examined for evidence of human interaction. A beach patrol network has been established to facilitate the recovery of hypothermic turtles. Additional turtles are acquired through an ongoing mark-recapture study with the cooperation of Long Island's commercial fishermen, who retain any sea turtles, alive or dead, that are incidentally caught in their gear. These animals are retrieved, healthy turtles are tagged and released, and turtles that require medical attention for propeller wounds or hypothermia are retained for treatment. A data base is maintained on all captured turtles.

RESULTS

Since 1979, the New York State Marine Mammal and Sea Turtle Stranding Program has recovered 1074 turtles: 541 of these animals stranded dead (50.4%), 51 turtles died in captivity despite rehabilitation efforts, and 75 turtles were successfully rehabilitated. Remaining turtles were incidentally captured and recovered through the mark-recapture program. Recovery, evidence of human impacts, and associated mortalities follow:

Incidental Catch in Commercial Fishing Gear

Pound Nets - Since 1984, 36.5% of all turtles encountered have been recovered through the pound net program. Although sea turtle mortality has been associated with entanglements in pound nets in other areas (Musick *et al.*, 1983), there are no known reported incidences of pound net drownings in New York waters. Therefore, these captures are addressed separately from captures in other commercial gear types.

Other Gear Types - During the study period, 55 turtles (5.1%) were incidentally captured in other gear types, including trawl (29), gill net (10), long line (4), lobster pot line (11), and one capture in an unknown gear type. Fourteen captures were fatal, involving 12 drownings (trawl net - 4, gill net - 3, lobster pot line - 4, unknown gear type - 1), and 2 deaths due to ingestion of long line hooks. Thus 25.5% of all incidental captures in fishing gear other than pound nets prove fatal in this area and represent 2.4% of all turtle mortalities. The majority of live turtles encountered were removed from the gear and released. Six turtles required invasive rescue measures: 2 leatherbacks were disentangled from line or net at sea to prevent drowning, 2 turtles required surgery to remove long line hooks (one turtle did not survive), and 2 turtles were treated for prolonged submergence but could not be rehabilitated. Over half (50.9%) of the turtles incidentally captured in potentially lethal gear types were loggerheads, and nearly one third (30.9%) were leatherbacks.

Vessel Collisions

A total of 114 turtles (10.6%) exhibited evidence of propeller wounds. Ninety-four turtles stranded dead or died in captivity as a result of their injuries. Three turtles stranded alive due to boat strikes and were successfully treated by the New York State Marine Mammal and Sea Turtle Stranding staff. An additional 17 turtles were incidentally caught or stranded cold stunned with non lethal boat strike wounds. Of these, 10 turtles had old, healed or partially healed wounds that may have been inflicted outside of the study area, and 7 turtles exhibited fresh wounds that required treatment. Thus half of the live turtles suffering from boat strikes required human intervention to facilitate survivorship. While 82.5% of vessel collisions are fatal, they comprise 15.9% of the total mortalities. Loggerhead's are most often impacted, as they account for 58.7% of all boat struck turtles, followed by leatherbacks which comprise 25.4% of the total.

Hypothermia

During the study period, 287 turtles (26.7%) were cold stunned, 189 of which stranded dead. Of the 98 turtles that stranded alive, 62 (63.3%) survived due to rehabilitation efforts. Dead turtles account for 78.4% of all hypothermic strandings, and mortality due to hypothermia comprises 38% of the total number of deaths. Kemp's ridley turtles make up 67% of all cold stunned turtles and 61.3% of all ridley's encountered stranded due to hypothermia.

Ingestion of marine debris

Stomach contents and necropsy findings indicate that 17 turtles died due to ingestion of marine debris. One turtle ingested oil, as evidenced by an oil covered esophagus, 5 turtles suffered fatal ileocecal valve blockages, and 11 had debris in their digestive tracts that was considered contributory to death. Additionally, 3 turtles that expired due to other causes had also ingested trash, and a pound net captured turtle passed plastic in its fecal matter. The majority of ingested material consisted of plastic bags but also included items such as a plastic tampon applicator and a plastic coffee cup lid. Of the turtles encountered during the study period, 21 (2%) had evidence of ingestion, of which 81% died as a result of ingesting trash or debris was considered to be contributory to death. Ingestion accounted for 2.9% of all mortalities. The most frequently impacted species was the leatherback, which comprised 71.4% of all turtles having ingested trash.

Other Mortalities

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

DISCUSSION

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). In New York waters, cold stunning accounts for 38% of turtle mortalities, nearly doubling all human induced mortalities combined. Cold stunning can impact significant numbers of turtles, as evidenced by the recent cold stunning events of 1985/86 (involving 54 turtles) and 1995/96 (involving 83 individuals), as well as historic events such as the one that occurred in 1924 involving 103 turtles, all dead (Latham, 1969). Prior to the initiation of the stranding program, beach patrols, and established cold stunning protocols (Sadove *et al*., in review), virtually all hypothermic turtles stranding on area beaches died. With these programs and protocols in place, survivorship of rehabilitated hypothermic turtles is increasing. As impacts are greatest to the critically endangered Kemp's ridley, due to the species tendency toward early physiological response to cold water temperatures (Schwartz, 1978) and their small size in this area (Morreale *et al*., 1992), further improvements of pre-clinical as well as clinical methods must be explored in order to reduce mortalities associated with cold stunning. Vessel collisions account for 15.9% of mortalities, despite the fact that they occur in only 10.6% of all turtles encountered, and thereby rival cold stunnings comparatively. As the majority of vessel collisions occur at sea, most animals encountered are in advanced stages of distress or have already succumbed to their injuries when recovered. Efforts must be made to work cooperatively with boaters to expedite alerts to stranding program staff. Quicker recovery of these animals would facilitate reduced mortalities associated with boat strikes. Ingestion of marine debris resulted in death or was contributory to death in 81% of all turtles having ingested trash. Leatherbacks are at great risk of ingesting floatable trash due to their primary diet of jelly fish, and further development of marine debris education is needed. Fatalities associated with capture in commercial fishing gear are insignificant as compared to cold stunning and vessel collision mortalities and are not a major concern in this area. In the New York Bight, non-human induced mortality is the leading cause of death in sea turtles where a cause of death could be determined. However, rescue and rehabilitation efforts must be concentrated in areas where survivorship is increased due to human intervention. Therefore, further work must be done to expedite recovery and reduce mortalities of turtles impacted by hypothermia and vessel collisions.

ACKNOWLEDGMENTS

We wish to thank Kimberly Durham and Debra Spangler of the New York State Marine Mammal and Sea Turtle Stranding Program for providing the data presented in this report, and all the past stranding biologists, too numerous to list here, who have collected specimens and data over the last 16 years. Thanks to the many sea turtle beach patrol volunteers, Long Island's commercial fishermen, U.S. Coast Guardsmen, and local police officers who aided in the recovery of the various specimens included in this study. Thanks also to the New York State Department of Environmental Conservation "Return a Gift to Wildlife" Program, and to Sam Sadove of Puffin Consulting, Inc. for supplying pound net capture data for 1996.

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CONSERVATION STRATEGIES ABOVE ALL THE SEA TURTLE PROBLEMS IN MARGARTITA ISLAND, NUEVA ESPARTA STATE, VENEZUELA

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From very remote tiems and by being the margarita Island a region whose principal economical activity is fishing, they have existed problems from the point of view of the marine species exploitation, one of them the sea turtle. Traditionally in Margarita Island have been captured and marketed with these species of investigation of Gomez and lira on the Sea Turtle Commercialization Routes in Nueva Esparta State. In the lats year a problem has surged additional that make worse the situation of sea turtle has surged additional that make worse the situation of sea turtle in the island it's the not planned tourist development that there is a serous environmental problems that harm the survival of these species; so we have that big urbanistic developments have modified and destroyed nesting beaches, a type of tourist activity called Jeep Tours has incentive the traffic of traction vehicles across the few nesting beaches still exists, craft stores and artisans sell elaborated products with sea turtles, restaurants offer prepared dishes with sea turtle in their menus, also have been published magazines, books and tourist pamphlets that promote the island like a tourist destination to national and international level that offers attractive dishes and handicraft products elaborated with sea turtles. Also exist a lacking information to all populations levels and the authorities on this problem.

For these reasons have come back developing plans and strategies like the computer system called BDTM (Sea Turtle Data base) with the purpose of make scientific studies about the nesting frequency, moreover environmental education campaigns like: courses, posters to be placed in beaches and restaurants and T shirts to stimulate the sea turtle protection.

COMPARATIVE TAG RETENTION RATES FOR TWO STYLES OF FLIPPER TAGS

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INTRODUCTION

Poor retention of tags is a widely recognized problem in sea turtle research (Balazs, 1982; Henwood, 1986). Despite the emergence of Passive Integrated transponder (PIT) tags, flipper tags in various designs and materials remain the mainstay of most tagging programs. Numerous studies have examined the problem of tag loss (Balazs, 1982; Henwood, 1986; Bjorndal *et al.*, 1996), and the search for the ideal tag design and material has proven elusive. Self locking Monel and Inconel metal tags, such as those supplied by National Band and Tag Company (U.S.A.), have been widely used, and plastic two piece Roto-tags manufactured by Dalton (U.K.) have been in use for several years. Studies comparing the two tag styles (metal and plastic) have not achieved a consensus on the superiority of one style over the other. Green (1979) found plastic tags clearly superior to Monel metal tags on green turtles in the Galapagos Islands, as did Alvarado *et al*. (1988) for east Pacific black turtles. Eckert and Eckert (1989) however, found very poor retention of plastic tags on leatherback turtles. It is likely that the relative performance of different tag styles varies with the species of turtle under consideration, the size class of turtles within a species, and the various environments the tags are exposed. This study examines rates of tag losses for Inconel metal size 681 tags and plastic Roto-tags on green and loggerhead turtles captured at the Florida Power and Light Company St. Lucie Power plant on the Florida East Coast between November 1990 and March 1996.

MATERIALS AND METHODS

Turtles were captured and tagged at the Florida Power and Light Company St. Lucie Nuclear Power Plant located in St. Lucie County on the Florida East Coast. The plant draws cooling water from the Atlantic ocean via intakes 365 meters off the beach. The water travels through three intake pipes under the beach to an enclosed canal system. Sea turtles entrained with the cooling water became entrapped in the intake canal, and were captured by tangle nets or divers. After tagging, turtles were released from the beach about 1 km north of the intake.

Tags used in this study were supplied by the National Marine Fisheries Service (NMFS). The metal tags used were Inconel size 681 self piercing tags manufactured by National Band and Tag Company (U.S.A.) and plastic tags used were blue jumbo Roto-tags from Dalton Supplies (U.K.). Tags were applied to the trailing edge of the front flippers, generally through the second or third scale from the body. Metal tags were sometimes applied through the webbing between the scales when the scales were too thick to accommodate the tag locking mechanism. During the period from November 1990 to March 1996 when both types of tags were being supplied by NMFS, turtles were tagged with one tag of each type. A total of 791 loggerheads and 786 green turtles were tagged in this manner. Tagged turtles for both species were dominated by juveniles and subadults.

Tag loss probabilities were calculated from a total of 327 recapture events, with recapture intervals ranging from 1 to 1545 days. Calculations of probabilities of tag loss were performed using the equations of Mrosovsky and Shettleworth (1982) where:

$$P_a = \frac{N^{1b}}{N^2 + N^{1b}} \qquad \text{And:} \qquad P_b = \frac{N^{1a}}{N^2 + N^{1a}} \qquad \text{Where:}$$

P_a = probability of type a tag loss
P_b = probability of type b tag loss
N_{1a} = number of recaptures with only type a tag remaining
N_{1b} = number of recaptures with only type b tag remaining
N_2 = number of recaptures with both tag types remaining

These equations provide the probability that a tag will be lost in a selected time interval. We performed calculations for 100 day time intervals from 0-500 days and for 500+ days, analyzing results separately for green turtles and loggerheads. We also performed a simple probability analysis on the 47 turtles recaptured with just one of the two tag types missing to determine if the missing tags were equitably distributed between the two tag types (Z test) (Sokal and Rohlf, 1981).

RESULTS

For recapture intervals from 0-300 days, the Inconel metal tags showed slightly lower probabilities of loss in green turtles (Fig. 1) but in the 400-500 day and 500+ day recapture interval classes, Inconel tags began to show higher probabilities of loss, although sample sizes were small for the longer recapture intervals. Tag loss probabilities for both types of tags were at or exceeding 50% after 400 days.

Loggerheads showed considerably lower probabilities of inconel metal tag losses compared to Roto-tags for recapture intervals from 0-200 days (Fig. 2). Data were insufficient for comparisons over longer recapture intervals for loggerheads. Tag loss probabilities in general were lower for loggerheads with either tag type at all recapture intervals than for green turtles.

Examination of the 47 turtles of both species combined that were recaptured with only one tag remaining revealed that the Inconel metal tag was lost in 12 cases and the plastic Roto-tag was lost in 35 cases. Statistical testing against the null hypothesis that both types of tags were equally likely to be lost showed the Inconel metal tag was significantly less likely to be lost ($Z=3.355$, $p>.001$).

DISCUSSION

The results of this study confirm the general conclusion that flipper tags are not a reliable method for the long term identification of sea turtles. Tag loss rates exceeding 50% within 2 years can provide only limited information on long lived species. Tag loss probabilities in our study are similar to results in other studies for the Inconel tags (Bjorndal *et al*., 1996; Henwood, 1986). Tag loss probabilities for the plastic Roto-tags in our study were much higher than those reported by Alvarado *et al*. (1988) for black turtles and Green (1979) for green turtles. A likely explanation for this difference is that the above referenced studies involved adult turtles on nesting beaches while our tagged turtles were primarily juveniles. In the case of the green turtles, most tagged turtles were under 35 cm carapace length. Small turtles do not offer as secure an anchor, particularly for the more massive plastic Roto-tag, and the more rapid growth of this size class of turtle may also present problems. The generally lower tag loss probabilities for loggerheads in this study may be due primarily to their larger average size in our capture population than to any real difference between species. Examination of recaptured tags and tag scars can give some indication of likely modes of tag failure. In many cases, the piercing section of the size 681 metal tag was too short to allow application through a flipper scale, particularly on larger individuals. Tags applied to the webbing between the scales are relatively easy to tear out. Possibly, larger tag sizes or a redesign of the size 681 tag would reduce tag loss rates. We did not see any instances of significant corrosion on our Inconel metal tags, so the noncorrosive nature of the plastic tag was not a significant advantage in this case. The most significant problem experienced with the Roto-tags was the enlargement of the attachment hole and subsequent tearing of the flipper or slippage of the tag body through the enlarged hole. In many cases this problem was exacerbated by very heavy barnacle fouling of the Roto-tag, which adds to the force exerted by the tag on the attachment hole during swimming motion. The decision by NMFS to discontinue suppling the Roto-tag was based in part on heavy barnacle fouling encountered in many applications (A. Woodhead, personal communication).

If there is no clear generally superior tag style for all applications (which we feel is the case), examination of tag loss rates becomes a crucial tool for all turtle tagging researchers in order to fine tune tag choice and tagging protocols for their particular situation.

ACKNOWLEDGMENTS

We would like to thank Robert Ernest and R. Erik Martin of Ecological Associates Inc., who founded and managed the sea turtle conservation program at the St. Lucie Plant from 1976 to 1994, and Florida Power and Light Company for their continuing support of the program.

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CORRELATION OF LOGGERHEAD TURTLE NESTING ACTIVITIES WITH BEACH EROSION RATES ON TOPSAIL ISLAND, NORTH CAROLINA

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Edaphic and biotic factors used by sea turtles to select a suitable site for nest excavation may include sand grain size, dune slope, compaction of beach sand, smell, moisture content, surface temperature, accessibility from the sea, extent of predation pressure on the beach, and competition from other species of turtles (Horrocks and Scott, 1991; Mortimer, 1995; Stoneburner and Richardson, 1981). In this study we determined if a correlation existed between loggerhead turtle (*Caretta caretta*) nesting activities and average beach erosion rates on Topsail Island, North Carolina.

METHODS

Nesting activity records (n = 928) of loggerhead turtles on Topsail Island during 1990-1995 were used to determine if a correlation existed between choice of nest site or false crawl site and beach erosion rates. Average erosion rate data obtained from the N.C. Department of Coastal Management were superimposed, to the nearest 0.1 mile, with locations of nesting activities. Data for the 1996 season were excluded from this analysis because of the severe erosion events generated by two hurricanes.

RESULTS AND DISCUSSION

The distribution of nesting activities was nearly uniform along much of Topsail Island, with slightly less activity near the inlets (Fig. 1). Average annual erosion rates along Topsail Island (excluding the actual inlets) varied from + 2.0 feet (0.6 m)/year (accretion) to - 4.2 feet (1.3 m)/year (erosion), with most 0.1 mile (0.16 km) segments of the beach eroding at rates between - 0.6 feet (0.18 m)/year and - 2.4 feet (0.7 m)/year (Fig. 2). Likewise, most nest sites (Fig. 3) and sites of false crawls (Fig. 4) occurred in areas with those erosion rates. There was no correlation (r^2 =0.0002, P = 0.913) of nest sites with mean erosion rates and there was also no correlation (r^2 = 0.0033, P = 0.657) of false crawl sites with mean beach erosion rates. Nearly twice as many nests were found at mile # 224.

Historically, much of this zone had significant intact dunes, no buildings, no lighting, and limited human disturbance.

Other factors (slope, lighting, disturbance, dune profile, moisture content, temperature, grain size, etc.) appear to be more important in nest site selection by Loggerhead Turtles on Topsail Island. Annual erosion rates on Topsail are such that a sea turtle nest is not likely to be impacted by normal erosion events during the two-month incubation period. Major nesting season erosion events (hurricanes) may destroy all or nearly all turtle nests (see poster by Redfearn *et al*.).

ACKNOWLEDGMENTS

We are grateful to the many volunteers working with the Topsail Turtle Project for data gathering and to the N.C. Department of Coastal Management for supplying the erosion rate map of Topsail Island.

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"TORTUGA NEWS": CONNECTION FOR THE CONSERVATION OF THE SEA TURTLES IN VENEZUELA

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INTRODUCTION

"Tortuga News" is a divulgative bulletin about the sea turtles in Venezuela. The first issue was published in 1995 and since that date it has been produced each three months. This bulletin arose with the goal to motivate and maintain the flow of information about the research, conservation activities and the problems for the survival of the sea turtles in the country. The format was motivated by "The MTSG Bulletin" (produced by the Marine Turtle Specialist Group since 1994). Before of the "Tortuga News", once appeared an informative bulletin of the Work Group on Sea Turtles of Venezuela (GTTM), prepared by Genaro Sole (FUDENA, March 1995).

Through the "Tortuga News" we promote the conservation and protection efforts of the national institutions. Although with an excellent legal basis for the protection of the five species of sea turtles that occur in Venezuela (*Chelonia mydas*, *Caretta caretta*, *Eretmochelys imbricata*, *Lepidochelys olivacea* and *Dermochelys coriacea*), our country has not many projects on sea turtles along the coastline or the islands nor enough connection between conservationists, scientists and governmental offices. By this reason we wanted to create a network of people with access to the best information to initiate or maintain their project or to go to the right place for a denounce, between other aspects.

Additionally, it is included foreign information too, as the most important NGOs related with the sea turtle conservation projects in the world, new books, journals with papers on marine turtles, electronic lists and WEB sites, workshops, symposiums and other events at regional or global level.

The "Tortuga News" is auspiced by the Wider Caribbean Sea Turtle Conservation Network (WIDECAST). During 1996 and begins of 1997 its production and distribution has been supported by the Columbus Zoo (Powell, Ohio).

METHODS

The format of the bulletin is one page with information in both sides. To prepare the "Tortuga News" we check several sources. At country level, we request information from the subscribers (through phone, fax or electronic mail). At a global level we review mainly: the "Marine Turtle Newsletter", "The MTSG Bulletin", the CTURTLE, the "Species"(IUCN/SSC) bulletin and the "Chelonian Conservation and Biology", although we may request notices from the foreign subscribors..

The distribution of the "Tortuga News" is free. The bulletin is received by almost all the participants in the five short "Courses on Sea Turtle Biology and Conservation" realized in Venezuela between 1992 and 1996. Moreover, the "Tortuga News" is sent to key persons or institutions related with the sea turtle conservation or protection, at governmental and private level, in the country or outside of Venezuela.

RESULTS

During the period December 1995 - March 1997 we have produced five issues of the "Tortuga News" bulletin. Our list has almost 130 subscribors, with some of them distributing copies to several other persons and countries (as example, through IUCN Mesoamerica the bulletin is distributed to Guatemala, Nicaragua and other Central America countries). In some special opportunities we have distributed more than 200 bulletins as during the "International Symposium for the Conservation of the Sea Turtles" and the III Round of Negotiations of the Hemispheric Sea Turtle Treaty, both in Caracas, Venezuela in April of 1996.

The subscribors list in Venezuela include students, professors and personnel in:

• Universities: Universidad de Oriente - Nucleo Nueva Esparta (UDO-NE), Nueva Esparta State, Universidad Simon Bolivar, Valle de Sartenejas, (USB), Caracas, Instituto Universitario de Tecnología del Mar (IUTEMAR-FLASA), Nueva Esparta State, Universidad del Zulia, (LUZ), Zulia State, Universidad Central de Venezuela (UCV), Aragua State, Caracas, Universidad Nacional Experimental Romulo Gallegos (UNERG), Portuguesa State, Universidad de Los Andes (ULA), Merida State.

• Governmental Organizations: INPARQUES (National Parks Institute), PROFAUNA (Fauna Service), SARPA (Fisheries Service), FONAIAP (Fisheries Research), Environmental Commission of the Senate of the Republic of Venezuela, National Council of Scientific Research (CONICIT).

• Non-Governmental Organizations: Foundation for Defense of Nature (FUDENA), Proyecto Paria Foundation, Los Roques Scientific Foundation (FCLR), National Foundation of Zoological Parks and Aquariums (FUNPZA), Venezuelan Stranding Network (RVV), OIKOS Foundation, Proyecto Paria Foundation, PROVITA, Herpetological Association of Venezuela, Oscar Ochoa Palacios Foundation.

The foreign mailing list includes to:

• Dr. Karen Eckert, WIDECAST; Dr. Karen Bjorndal, Archie Carr Center for Sea Turtle Research, U.S.A.; M. Sc. Marydele Donnelly, MTSG Program Officer; Ocean. Neca Marcovaldi, Chairman, MTSG; Dr. Jack Frazier, CINVESTAV, México; Dr. Fred Berry, IOCARIBE, M. Sc. Glenda Medina, Caribbean Conservation Association, Barbados; Alessandra Vanzella-Khouri, Caribbean Environment Programme, UNEP, Jamaica; M. Sc. Nestor Windevoxhel, UICN Mesoamerica, Costa Rica; Mr. Roderic Mast, Conservation International, U.S.A., Dr. Peter Pritchard, Florida Audubon Society, between others.

In this moment, we are extending the distribution list to GOs and NGOs along the coastline. Moreover, we are planning to add one page more to the "Tortuga News", to translate each issue in English and to transmit it by electronic mail. We would like to include the "Tortuga News" in some Web site, but we would need support for the design and maintenance in INTERNET. Our main interest is to continue enhancing the connection between the people to improve and coordinate better the sea turtle conservation efforts.

SEA TURTLE NESTING AND EDUCATIONAL EFFORTS IN NORTHWESTERN PUERTO RICO FROM 1992-1996

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INTRODUCTION

In 1992 a non-profit organization called Proyecto Tortugas Marinas was formed to promote research, education, and conservation of marine turtles in northwestern Puerto Rico. One goal of the project was to identify nesting beaches and gather baseline biological data of the species nesting. Another was to curtail poaching by being on the beach, camouflaging nests, and through public education.

METHODS

Slide presentations were given to students (elementary - university), fishermen and other coastal residents, government employees, and members of civic, scouting, and environmental organizations. Displays were mounted at festivals, universities and malls. Sign-up sheets were available at these activities for those who wanted to participate in field activities. Volunteers were trained in data collection and management techniques at the nesting beaches. The volunteer's collaboration not only made the project possible by keeping funding to a minimum, but created awareness of the sea turtle's plight among people of diverse socioeconomic backgrounds.

Diurnal patrols were conducted to locate tracks on known nesting beaches and on other beaches where volunteers were willing to walk. Nocturnal patrols were set-up on nights when turtles were expected on a particular beach, according to internesting intervals. The main study area was Añasco Beach (5 km) and North El Maní (2 km) (Fig. 1), which was patrolled several times a week by the author, employees of the Department of Natural and Environmental Resources (DNER) in Mayagüez, and volunteers. Coverage of the other beaches was usually by volunteers and beach residents, and was quite variable from year to year. Beaches were patrolled primarily during leatherback season, which overlaps with hawksbill season for several months. Also leatherback tracks were easier for volunteers to identify.

Nesting turtles were measured and double-tagged, and a sample of eggs was measured and weighed when possible. Nests were camouflaged *in situ* and only translocated if they were in imminent danger from poaching or an abiotic threat. The incubation period was determined, and nests were excavated to document clutch size, hatching success, and emergence success. Live hatchlings encountered were measured and weighed.

RESULTS

Most nests encountered were from leatherbacks (*Dermochelys coriacea*), then hawksbills (*Eretmochelys imbricata*). There was a bias toward finding leatherback activities, due to the large durable tracks and surveys being conducted primarily in spring and summer. Also, the smaller beaches hawksbills frequent were too numerous and difficult to access. A green turtle clutch was laid and hatched at Jobos Beach, Isabela in 1993.

Nesting by both leatherbacks and hawksbills occurred principally at beaches within the municipalities of Añasco, Mayagüez, Arecibo, Barceloneta, Isabela and Rincón (Fig. 1). It should be noted that patrolling effort was highest at these beaches.

An average of four leatherbacks have been tagged a year, but it has become clear that these turtles often return to the same beaches to renest both intraseasonally and interseasonally. Three 2-yr remigrants and one 3-yr remigrant have been documented. Migrants have been recorded from Culebra and Piñones, PR. Nest loss has not been accurately determined, but was probably low because of the reduction in poaching, lack of major predators, and beach stability. Hatching and emergence success were high as can be seen in Table 1, along with other biological data for leatherbacks and hawksbills.

Educational efforts appear successful because of the positive change in attitude amongst individuals, families, and even communities. An example is Añasco Beach, where enough people in the community became involved in caring for "their" turtles, that the poachers forsook their practice.

ACKNOWLEDGMENTS

Principal collaborators included the USFWS, DNER, Sea Grant, Univ. of Puerto Rico, Interamerican Univ., and the Liga Ecológica. Special thanks to Millagros Justiniano (DNER Mayagüez) who carried out much of the field work over the years, and to all the volunteers that made it possible.

TESTOSTERONE LEVELS IN HATCHLING LOGGERHEADS

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INTRODUCTION

Like many other members of the Class Reptilia, sea turtles possess temperature-dependent sex determination, or TSD (reviewed by Mrosovsky, 1994). Research has indicated that sexual differentiation in TSD species is determined by the temperature at which the eggs are incubated, the crucial period being the approximate middle third of development (Yntema and Mrosovsky, 1982; Wibbels *et al*., 1991).

TSD is an important factor to consider when struggling with the conservation of the sea turtle species. Not only does this aspect of their development affect the natural populations, but should be an important consideration when designing nest relocation and hatchery programs. It is imperative that an accurate and nonlethal sexing technique be developed so that sex ratios can be monitored in conservation programs.

This study serves to validate and extend the sexing technique developed by Gross *et al*. (1995) for loggerhead sea turtles. This technique is based on the premise that hatchling loggerhead sea turtles have sex-specific levels of steroid hormone levels in their blood and chorioallantoic/amniotic fluid (CAF).

METHODS AND MATERIALS

Blood Samples

One hundred and sixty loggerhead eggs were collected from eight freshly laid nests (20 eggs per nest) on the Archie Carr National Wildlife Refuge near Melbourne Beach, Florida. The eggs were brought back to the University of Alabama at Birmingham and were randomly selected for incubation at one of four temperatures: 26°, 27°, 32°, or 33°C. These temperatures were specifically selected to ensure male (26° and 27°C) or female (32° and 33°C) differentiation, since the pivotal temperatures reported for loggerheads are approximately 29° to 30°C, (reviewed by Mrosovsky, 1994). Constant incubation temperatures were maintained in custom incubators which held the selected temperatures to within + 0.2°C.

Prior to hatching, the eggs were placed in plastic cups. The cups allowed for the collection of the CAF after pipping. Blood was sampled from the hatchlings approximately three to five days after hatching in order to imitate natural emergence. The blood was collected from the dorsal neck sinus or the midline and placed into tubes coated with sodium heparin. Blood samples were immediately placed on ice and spun down within an hour after sampling. The plasma samples were then stored at -80°C.

Radioimmunoassay

The radioimmunoassay procedure used in the current study was similar to that described by Coytupa *et al*. (1972). Briefly, the CAF and plasma samples (1 ml and 50 µl respectively) were extracted with 5 ml of diethyl ether, dried down under nitrogen, reconstituted in Tris/gel buffer and then assayed in duplicate. Testosterone antisera and tritiated testosterone were added to each assay tube and the tubes were incubated overnight at 4°C. Bound versus unbound fractions of the steroids in each tube were separated with a charcoal suspension. Scintillation fluid was added to the bound fraction, and it was counted for 5 minutes on a beta counter. The antibody for the assay was obtained from Endocrine Sciences and the tritiated testosterone from Amersham Life Sciences. The assay was validated for sea turtle plasma using pooled samples from juvenile sea turtles and CAF from the loggerhead eggs. In order to validate the assay, both plasma and CAF were stripped with charcoal to remove the steroids. Aliquots of the stripped CAF and plasma samples were then spiked with known amounts of testosterone and run in the assay at various volumes. Additionally, samples of stripped plasma and CAF without testosterone added were also run in the assay at various volumes.

RESULTS

Assay Validation

The testosterone RIA produced consistent standard curves. The stripped plasma and CAF always resulted in nondetectable values well below the sensitivity of the assay. The testosterone- spiked samples of stripped plasma and CAF consistently yielded predictable testosterone concentrations regardless of the volume assayed. The sensitivity of the assay was conservatively determined by estimating 80% bound from the standard curve. The minimum sensitivity for the assay was 8.4 ± 2.25 pg per assay tube. The average extraction efficiency was 92.2 ± 4.3%. Control pooled samples were run in each assay. The intra- and interassay coeffiecient of variation were 18.9% and 11.1% respectively.

<u>CAF and Plasma Levels</u>
The following results represent a preliminary analysis of a small subset of the total samples which we are currently assaying. To date, 18 CAF samples and 10 plasma samples have been assayed. Half of these samples were from hatchlings from a male-producing temperature (26°C) and half were from hatchlings from a female-producing temperature (33°C). The CAF assay results ranged from nondetectable (*i.e.*, less than 8.5 pg/ml) to 58 pg/ml. Fifty percent of the samples were greater than 90% bound in the assay and therefore recorded as nondetectable (*i.e.*, below assay sensitivity). The assay results from the plasma samples were all greater than 90% bound (*i.e.*, below assay sensitivity).

DISCUSSION

The results indicate that this assay is valid for measuring plasma and CAF testosterone, with an assay sensitivity typical of many testosterone radioimmunoassays (*e.g,*. approximately 8.4 pg per assay tube). However, our preliminary results indicate that this sensitivity is not sufficient for detecting testosterone levels in the majority of the samples which we have assayed. With the CAF samples, we were able to extract 1 ml per sample which facilitated the detection of testosterone levels in the range reported by Gross *et al*. (1995). However, our results suggest much lower levels, with many samples being below assay sensitivity. Regarding plasma levels, Gross *et al*.(1995) recorded higher mean testosterone levels in males versus female hatchlings, with males having concentrations slightly over 200 pg/ml in plasma and CAF samples and having maximal levels near 400 pg/ml. A limiting factor in assaying plasma levels in hatchlings is the limited amount of blood that can be obtained without killing the hatchling. For example, we were extracting 50 μl samples and then assaying them in duplicate. Under such limitations, a minimum of a 10 to 100 fold increase in assay sensitivity is required (*i.e.*, a sensitivity of approximately 0.1 pg per tube).

ACKNOWLEDGMENTS

This research was supported through funding provided by University of Alabama at Birmingham. The blood sampling technique development was supported by Mississippi-Alabama Sea Grant Consortium (grant # NA56RG0129) and University of Alabama at Birmingham.

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MORPHOLOGY AND BEHAVIOUR OF MEDITERRANEAN MARINE TURTLE HATCHLINGS (*CHELONIA MYDAS* AND *CARETTA CARETTA*) IN NORTHERN CYPRUS, EASTERN MEDITERRANEAN

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INTRODUCTION

The aims of this investigation were:
1) to describe basic morphological parameters
2) to carry out preliminary observations of behaviour in hatchlings of the two species of marine turtle which nest in Northern Cyprus, in the Eastern Mediterranean (*Caretta caretta* and *Chelonia mydas*) (see Broderick and Godley, 1996).

METHODOLOGY

Morphology: The following measurements were recorded for each hatchling: maximum straight carapace length and width, maximum length and width of right fore-flipper and body weight.

Behaviour: A runway, 4m long and 1m wide, was delineated between 2 wooden planks wedged into the sand, effectively creating walls 15 cm high. The axis of the runway was perpendicular to that of the beach and ran between 3 and 7m from the high water mark. Hatchlings of both species were released at the top of the runway and the transit time under a series of conditions was recorded. The treatments attempted to mimic different substrate conditions commonly experienced by hatchlings. These were:

1) Smooth sand - as a control.
2) Footprint - sand covered in footprints.
3) Litter - 6 plastic bottles and 2 polythene bags in a set pattern.
4) Seagrass - 20 litres of dried seagrass spread evenly along the runway.

Only one individual was involved is setting up the courses (DH) and it is thought that treatment conditions were relatively standardised. Hatchlings were released at dawn and transit times recorded. Data can only be regarded as preliminary, however, we feel they are useful in highlighting behavioural patterns worthy of further empirical study.

RESULTS AND DISCUSSION

Morphology: Table 1 shows descriptive statistics for each of the morphological parameters measured. *C. mydas* hatchling are larger and heavier than those of *C. caretta*. No data are available to compare *C. mydas* hatchlings in Cyprus with those elsewhere in the Mediterranean. However, the sizes recorded are similar to those previously recorded in Cyprus and outside the Mediterranean (Broderick and Godley, 1996; Chen and Cheng, 1995). *C. caretta* hatchlings were found to be similar in size to measurements of conspecifics from the Göksu Delta, Turkey (Peters and Verhoeven 1992) and Zakynthos, Greece (Sutherland,, 1985). However, as more than one hatchling was examined from the same clutch, the need to avoid pseudoreplication prevented robust statistical analysis (Hurlbert, 1984). Although caution should be exercised in the interpretation of these data, it is worthy of note that although *C. caretta* hatchlings in Northern Cyprus appear to be similar in size to those at other sites in the

Mediterranean, this is not the case for adult female size. *C. caretta* females nesting in Cyprus appear to be the smallest in the Mediterranean (Broderick and Godley, 1996).

Behaviour: Although in general, *C. mydas* hatchlings were more vigorous and fast moving than those of *C. caretta*, data collected at dawn showed no marked interspecific differences. It is thought that the transit time of *C. mydas* was slowed by orientation behaviour undertaken at the start of the runway. Fig. 1 shows a box and whiskers plot of median transit times for each species under the different runway conditions. Statistical analyses using Kruskal-Wallis tests showed that for each species, significant differences existed in transit times under different runway conditions (*C. caretta*: $H=56.38$, $p<0.00001$; *C. mydas*: $H=12.03$, $p<0.01$). Although data for *C. mydas* is equivocal, it is apparent that for *C. caretta* all the treatments increased transit time. It may be that being smaller, obstacles are relatively more difficult to negotiate for this species.

Other behaviour patterns investigated which may be worthy of empirical investigation were, the time from reaching the surf to successfully enter the sea, the number of attempts needed to successfully enter the sea and breathing rate. Apparent differences exist in the species which may well have fitness consequences. Significant variations were recorded between the breathing rates of hatchlings of the two species. *C. mydas* hatchlings surfaced on average every 4.5 seconds (∇ s.d. 0.003, n= 95) and *C. caretta* every 3.7 seconds (∇ s.d. 0.036, n = 98). This analysis was performed using a t-test ($t = -3.43$, $p<0.005$).

The transit time of hatchlings was also examined at night in both the presence and absence of moonlight. Variation in ambient light conditions appeared to have a profound effect. Although this was not quantified in this study it is important that this factor is rigorously incorporated into any further similar studies.

ACKNOWLEDGMENTS

We would like to thank all the members of GUTCE 1996 for their help with the field work and all the individuals and organisations that supported this project. Donna Harris thanks the Carnegie Trust for the Universities of Scotland for support. Brendan Godley acknowledges help from the Overseas Student Travel Fund.

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	C. mydas				*C. caretta*			
Parameter	**Sample size**	**Mean ±SE**	**95% C.I.**	**range**	**Sample size**	**Mean±SE**	**95% C.I.**	**range**
C.L. (cm)	152	4.68±0.02	4.64 - 4.72	3.3 - 5.1	249	4.19±0.01	4.16 - 4.22	3.05 - 4.97
C.W.(cm)	152	3.62±0.02	3.59 - 3.65	2.6 - 4.0	249	3.25±0.01	3.22 - 3.28	2.03 - 3.90
F.L.(cm)	152	4.05±0.03	3.99 - 5.00	3.0 - 4.7	249	3.42±0.01	3.39 - 3.45	2.60 - 3.95
F.W.(cm	152	1.27±0.01	1.24 - 1.29	1.0 - 1.6	249	1.26±0.01	1.24 - 1.28	0.35 - 1.73
B.Wt.(g)	6	18.45±0.14	18.09-18.81	18.1-18.9	104	17.19±0.11	19.98-17.40	14.4-19.5

Table 1: Morphological parameters of marine turtle hatchlings in Northern Cyprus.
(C.L. (cm) = Straight carapace length, C.W. (cm)=Straight carapace width,
F.L. (cm)=Flipper length, F.W.(cm)=Flipper width, B.Wt. (g)=Body weight.)

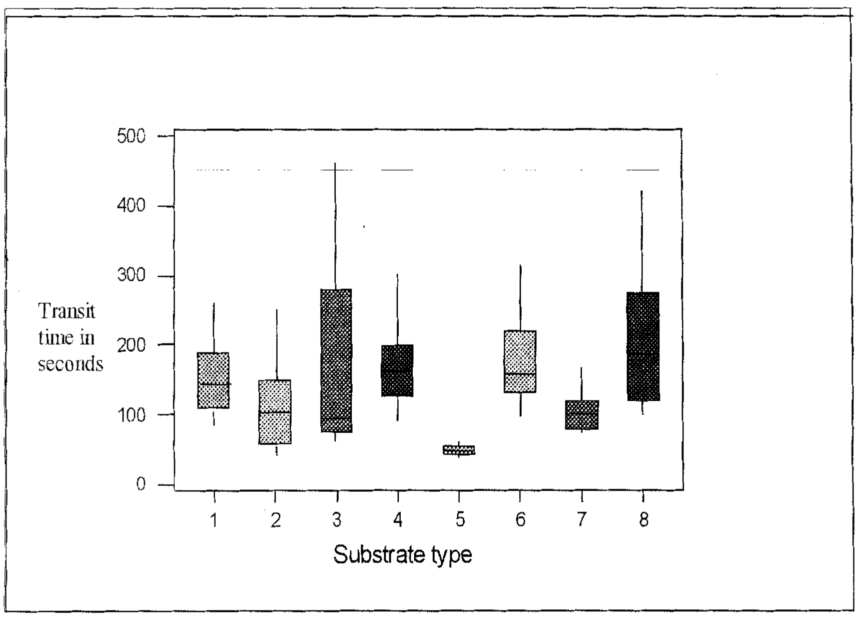

Figure 1: Box and whisker plot to show median, inter-quartile and absolute ranges
of transit times of hatchlings (seconds) under different runway conditions.

1. *C. mydas* (control) ▩ 5. *C.caretta* (control)
2. *C. mydas* (footprints) ▩ 6. *C.caretta* (footprints)
3. *C. mydas* (litter) ▩ 7. *C.caretta* (litter)
4. *C. mydas* (seagrass) ▩ 8. *C.caretta* (seagrass)

TED TECHNOLOGY TRANSFER: A SUMMARY OF NMFS TED WORKSHOPS, 1988-1997

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American shrimp trawlers have been required to use Turtle Excluder Devices (TEDs) since 1989. Since then, U.S. TED regulations have been expanded to include most countries which have an indigenous sea turtle population and export wild caught shrimp to the United States. Those countries must have sea turtle protection laws which equal those of the U.S., including the use of TEDs in their shrimp trawl fishery. In 1988, NMFS began an extensive program to provide training to host countries to train fishermen and fisheries managers in the construction and operation of TEDs.

SURVIVORSHIP ESTIMATES FOR FEMALE LOGGERHEAD SEA TURTLES, *CARETTA CARETTA*, NESTING ON WASSAW AND PINE ISLANDS, GEORGIA

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In this study, survivorship estimates for adult female loggerheads, *Caretta caretta*, nesting on Wassaw and Pine Islands, Georgia, were calculated using data from a tagging project run by the Savannah Science Museum. These data were used in a mathematical model by Frazer (1983) for the same analysis on the nesting population of Little Cumberland Island. As the age of loggerheads at sexual maturity is unknown, survivorship was calculated in years survived past neophyte (denoted as alpha). Frazer's model provides two survivorship estimates. One estimation is based upon the assumption that if a turtle does not return she is dead. This method does not take into account tag loss and may result in low estimates. The second estimate adjusts for tag loss by assigning turtles who appear on the beach with tag scars but no tags the identity and history of turtles that never returned.

Survivorship estimates for Wassaw and Pine Islands uncorrected for tag loss were 7.87% for the first year after alpha and 73.99% for subsequent years. Estimates corrected for tag loss were 8.7% for the first year after alpha and 72.91% for subsequent years. Frazer's analysis of Little Cumberland Island from 1964 to 1981 showed annual survivorship rates of 73.84% uncorrected for tag loss and 80.91% corrected for tag loss and did not show the massive mortality for the first year after alpha that was estimated for Wassaw and Pine Islands.

As a method of comparing the relative fitness of Wassaw and Pine Islands with Little Cumberland Island, a ratio of summed l_x values from age alpha on was calculated. The l_x values were based on survivorship estimates. The ratio of summed l_x values for Wassaw and Pine to Little Cumberland is 0.368, and is simply an index useful in comparing the two nesting populations. Assuming equal reproductive output by all females, Wassaw and Pine Islands will produce on the average 63.2% less eggs per individual over their lifetimes than that of Little Cumberland Island. This decreased fitness estimate could be an indication of a decrease in the overall fitness of the loggerhead sea turtle population of the Atlantic coast over the past fifteen years, or could possibly be attributed to differing geographical locations of the two study sites. Perhaps more likely, females nesting on Wassaw and Pine

Islands may shift nesting sites to other locations along the Georgia and South Carolina coast, thereby reducing probabilities of observing some individuals over time. This would lead to reduced survivorship estimates which would also lower R_o values.

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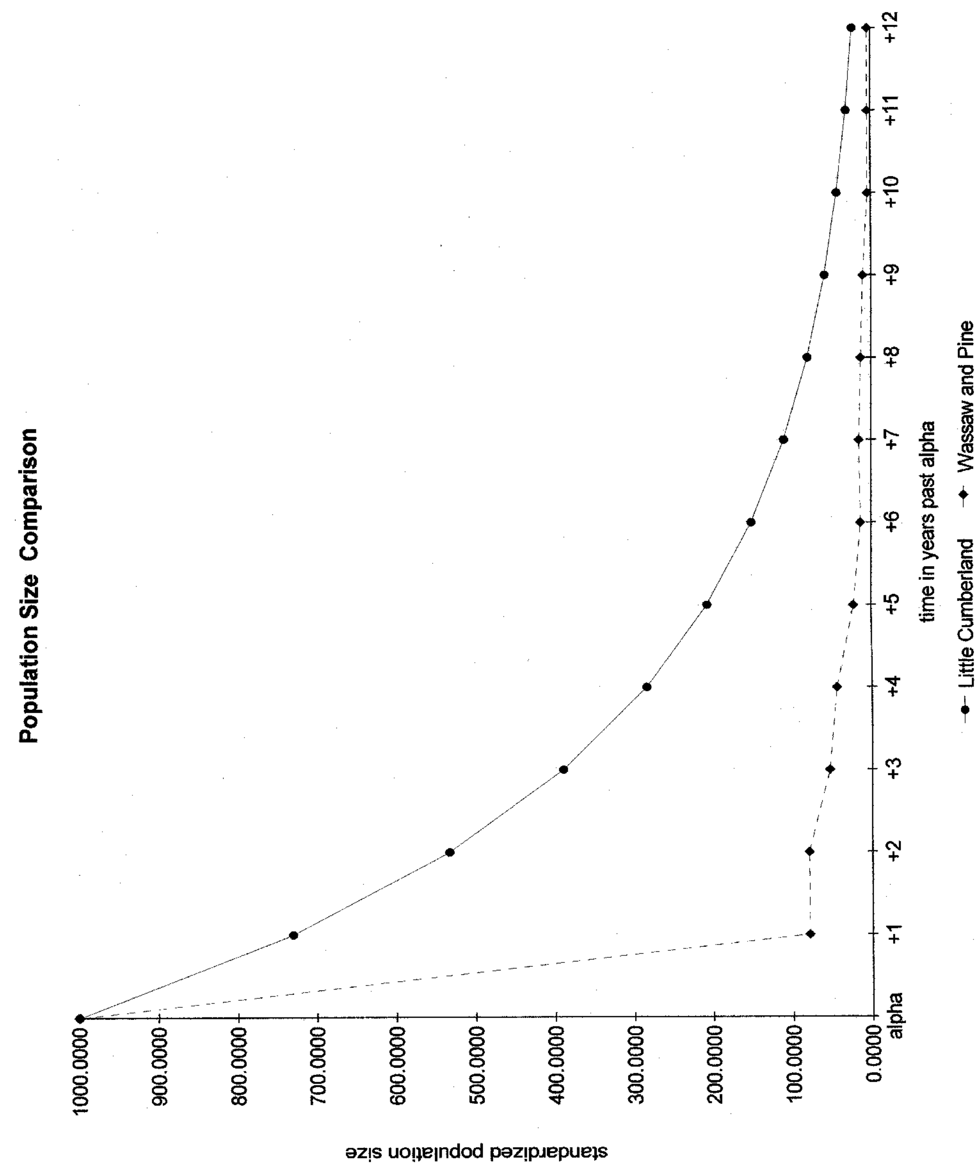

A WINDOWS OPERATED DATABASE FOR SEA TURTLE RESEARCH

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In 1995, Buck Island Reef National Monument (BIRNM) was chosen as one of the national parks included in the National Inventory and Monitoring Program for Natural Resources (I&M), a collaborative effort between the National Park Service and U. S. Geological Survey, Biological Resource Division. The I&M Program focuses on developing protocols and methodologies to inventory and monitor the natural resources. As one of the I&M prototype parks for tropical/sub-tropical ecosystems, BIRNM has begun standardizing and documenting all types of natural resource data and developing long-term protocols for data management. In 1996, Buck Island Reef Sea Turtle Research Program received funding from the National Park Service's Natural Resource Preservation Program for endangered hawksbill sea turtle research. In conjunction with the I&M Program agenda, part of this funding was dedicated to the development of a relational database for the sea turtle research program.

BACKGROUND

The Buck Island Reef Sea Turtle Research Program currently has nine years of field data on nesting sea turtles, three year's data on foraging juvenile hawksbill turtles, stranding reports, and historical sea turtle field data going back to the early 1980's. We wanted a computer program that would fulfill several objectives:

1. Allow us to input past, present, and future data in a user-friendly environment.
2. Provide flexibility so as to meet the needs of many individual sea turtle projects.
3. Be responsive to real-time needs, *i.e.*, allow us to manipulate and analyze the data in response to both present and future needs.

Not wanting to reinvent the wheel, we turned to Dr. Colin Limpus, who has developed and refined the Queensland Turtle Research (QTR) Database over the past twenty years. He kindly offered to lend us his program to serve as the foundation for the creation of a Windows-based sea turtle database. The QTR database assigns a unique sea turtle tag number to each turtle; this tag number is retained through all subsequent activities, a philosophy that we adapted for the new program.

We began working with a computer programmer familiar with complex relational database programs. Together, we chose Visual FoxPro as the platform for the transition of the QTR database to Windows. Visual FoxPro was selected after careful examination of several products for the following reasons: It is a stable, reliable programming environment, widely supported around the world; it has the capability to accept data from a variety of existing database formats; and the same program code can be compiled into a program for Windows 3.11 or for Windows 95, with both programs utilizing the same databases.

DATABASE

Buck Island Reef Sea Turtle Research Program has several field data sheets, including nesting beach, juvenile foraging study, and strandings. The data input screens were designed to resemble BIRNM's sea turtle field data sheets. The following general database files were adopted from the QTR database structure:

Tags Database: Includes primary tagging information, species, sex, age class, genetic haplotype, passive integrated transponder tag number or satellite/radio tracking tag identification, tag position, and date applied. Each primary tag record contains a subset of all secondary tags applied to a given sea turtle across time. The secondary tagging information includes application date, tag number, position, age class, activity number, and technician.

Capture Database: Includes turtle primary tag number, capture information, tag history (status of all existing and applied tags during the target capture), experiments, measures, location, and notes.

Clutch Database: Includes nest location, location of relocated nest and reason moved, clutch count, nest measurements, egg measures, hatchling measures, and nest outcomes.

Teams Database: Includes names and addresses of all members of the research team for a given season (password protected).

Localities Database: Includes the region (geographical region of the project), locality (island or country), sector (beach or section of study), and longitude/latitude.

The program has evolved into a data management tool that will answer questions in real time. It will, for example, enable easy reference to any individual sea turtle's history within a project or easy reference to all activities within and across seasons. Furthermore, the user can ask for any combination of data, apply filters to the data, create sorts, and produce reports via a report generator (FoxFire). Examples of reports that can be generated include tag lists and tag histories, nesting distribution, nesting success of individuals within a season or over time, number of eggs laid within a season, mean weights and measurements, hatch success of individual nests or of all nests laid within a season or over time, individual turtle growth rates, summary results of experiments, percentages of nest relocations and their success rates, etc., etc. All of the reports can be written to fit specific research questions, titled and saved, and then run over and over with different parameters. Seasonal summaries will be much easier and quicker once a report request has been written and saved: simply change the filter on the year's data. The report is done quickly, without flipping a log of pages and pushing a lot of calculator buttons!!!

RECOMMENDATIONS

We encountered several difficulties and offer the following recommendations:

1. We found it difficult to recall historical changes in methodology, experiments, and data collection. Standardize at the beginning and keep concise, complete records as to how the data was collected.

2. Make copies of all field data sheets. Never keep your originals and copies in the same room. Hurricanes can and will happen!

3. Verify computer data entry immediately after it is entered. The data is only as accurate as the person entering it.

In summary, the computer database will never replace the field data sheet. It does, however, provide both the researcher and the manager with a very powerful tool for maintaining, manipulating, and analyzing information.

MARINE LITTER ON SEA TURTLE (*CHELONIA MYDAS* AND *CARETTA CARETTA*) NESTING BEACHES IN NORTHERN CYPRUS, EASTERN MEDITERRANEAN

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INTRODUCTION

The Mediterranean has long been recognised as having major pollution problems. It is essentially enclosed, surrounded by a large population and also hosts intense shipping activity. International laws regarding litter disposal exist. These regulations have not been adequately enforced, evidenced by the fact that 71% of benthic trawls carried out in the eastern Mediterranean were found to contain litter (Galil *et al*,. 1995). Comparable statistics are 57% in the Gulf of Alaska (Jewett, 1976) and 41% in the Bering Sea (Feder *et al*., 1978). It is not surprising therefore, that a large amount of litter is washed up on Mediterranean shores. Previous litter surveys have shown that levels present on beaches are correlated with the size of surrounding human population. This however, is not the case in Cyprus, where winds have been shown to be the predominant factor determining litter accumulation (Gabrielides *et al*., 1991). Since marine turtles depend upon coming ashore on sandy beaches to lay their eggs, there is a possibility that the nesting process or resultant success may be adversely affected by litter present on the beach. This study was a preliminary attempt to investigate any such effects on marine turtles (*Chelonia mydas* and *Caretta caretta*) nesting in Northern Cyprus.

METHODOLOGY

The beaches of Northern Cyprus have been monitored annually since 1992 to assess marine turtle nesting and hatching activity (Broderick and Godley, 1996; Godley and Kelly, 1996). In 1996, beaches were inspected to quantify litter levels, using an ordinal scale of pollution with a range of 0 to 10. A score of 0 indicated no litter pollution, while, 10 indicated extreme litter pollution. This scale was then validated by carrying out a series of transects, on seven study beaches with differing litter pollution scores, none of which were subjected to regular cleaning. The litter pollution present in eleven 1m wide transects, from the back of the beach to the high water mark, at regular intervals (every 10% of beach length) was recorded. By measuring the typical area covered by samples of items in all categories, it was possible to generate an estimate of the percentage of beach covered by debris. Whilst carrying out transects, the composition of the litter was also noted. It was not possible to ascertain the origin of most items. However, on those with printing, language/manufacturers' address was noted.

For *C. mydas*, *C. caretta* and both species combined, the 1996 levels of the following parameters were compared to the pollution score given to individual beaches using a correlative approach:

(1) Nest density (nests km^{-1})
(2) Emergence success % (proportion of adult female nesting emergences which resulted in clutches laid).
(3) Hatching level (the proportion of unpredated nests which hatched).

Anecdotal observations (B.G. and A.B.) suggested that the general pattern of litter pollution levels had been similar over the four previous nesting seasons. Median level of reproductive parameters (1-3 above) over the five successive seasons (1992-1996) were also compared to pollution score ascertained in 1996. Due to the ordinal nature of the pollution score, Spearman rank correlation coefficients were calculated for parameters being tested.

RESULTS AND DISCUSSION

Test of the methodology: There was close agreement between visual score and quantitative coverage calculated from transect data (Spearman rank correlation: r_S=0.901, $p < 0.01$). Thus it is felt that these scores reliably represent pollution levels.

Turtles and pollution: Statistical comparisons were made between litter score and nest density, emergence success and hatching success *C. mydas* and *C. caretta*, and both species combined, in 1996, and over the five years of this study. The only statistically significant correlation between litter and any reproductive parameter was a positive correlation between the median *C. mydas* nesting density over the five years (1992-1996) and litter pollution (r_s=0.331, p=0.01). It is highly unlikely that *C. mydas* females actively select to nest on a beach because it is heavily polluted. *C. mydas* females are thought to display a level of natal philopatry and nest site fixity, therefore, it is likely that high litter levels have coincidentally built up on the natal beach/preferred nesting sites of *C. mydas*. Conditions which promote litter deposition may also promote nesting *e.g.*, currents and wave action which promote sand deposition, resulting in the depth of sand necessary for nesting in this species.

Constitution of the litter: The beaches of Northern Cyprus, although used by marine turtles, are highly polluted. Plastics are clearly the main constituent of litter pollution on the beaches of Northern Cyprus (69% of litter, see Fig. 1). The median number of items of plastic per metre of beach was 28. This is likely to be due to its low density and persistence in the environment. Medical waste has often been documented in beach surveys. Presence of such items were recorded:- glass and plastic medicine bottles, syringes, intravenous fluid giving sets and hypodermic needles. These items only formed a small component of beach coverage, approximately 0.25%.

There is very little human usage of the study beaches and virtually 100% of litter is deposited from the sea. It was not possible to definitively assess the origin of any items. Many of the objects found had deteriorated quite markedly in quality, suggesting they had been exposed to environmental wear for a considerable period. Only the language or the manufacturers address gave possible clues as to the origin (Fig. 2). Whilst a proportion, 29%, had Turkish labeling and may have been locally derived in Northern Cyprus, it is likely that some of these will have originated from Turkey, international shipping and countries importing these products. In addition, items of Turkish origin may be over-represented due to a lower level of degradation and therefore an increased probability of detection.

Is litter a real threat?: These results suggest that high levels of marine litter on nesting beaches can be tolerated by marine turtles. However, whilst litter may have no effect on the behaviour of the adult female and the hatchability of nests as a whole, hatchlings, on numerous occasions, have been recorded trapped in the sand column or on the beach as a result of litter. In addition, we have observed juvenile turtles stranded both dead and alive as the result of entanglement in discarded fishing gear and other items of litter.

Possible cooling effect?: Whilst this study has examined the effect of marine litter on the success of nesting females and clutches we have not attempted to quantify or qualify the possible effect of marine litter on the temperature of the incubating eggs below. In areas where a heavy covering of litter occurs, a cooling of the clutch may result in a unnaturally skewed sex ratio. This factor might be worthy of further investigation.

ACKNOWLEDGMENTS

We would like to thank all the members of the Glasgow University Turtle Conservation Expedition 1992-6 and all the individuals and organisations that have supported this initiative. Brendan Godley and Annette Broderick would like to acknowledge help from the Overseas Student Travel Fund.

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A SUMMARY OF PELAGIC LONGLINE - SEA TURTLE INTERACTIONS BASED ON U.S. OBSERVER DATA

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ABSTRACT

At-sea observer programs have documented interactions between sea turtles and pelagic longline gear in the Atlantic, including Mediterranean sea, and Pacific Oceans. The frequency of observed interactions is highly variable and there are concerns about the biological consequences of these interactions. Analyses of U.S. observer data collected from 1991 through the second quarter of 1996 provide a starting point for understanding the operational and environmental parameters that influence sea turtle interactions. Differences between regional and seasonal observer sampling and sea turtle interaction rates are described. Interactions are classified when possible by the status of the sea turtle (*i.e.*, alive, dead, injured). Differences between interaction rates that can be attributed to operating, gear, and environmental features were investigated. Less than three percent of the observed sets account for 41% of the observed turtles. Unique environmental events significantly affect the number of turtles that are vulnerable to longline gear. The frequency of these events and annual differences in temporal/spatial effort distribution must be considered when fleet-wide estimates of total turtle catch are developed. Patterns in temporal/spatial effort distribution on an ocean-basin scale will be especially important in evaluating the impacts of longline interactions on sea turtle stocks. Extrapolation of U.S. observer data to other Atlantic fleets may not be appropriate.

SEA TURTLE LONGLINE INTERACTIONS

Observers have recorded longline interactions with 485 sea turtles on 10.8% (289) of the observed sets monitored (2,674) between the third quarter of 1991 and the second quarter of 1996. Vessels are randomly selected based on logbook reported effort from the previous year.

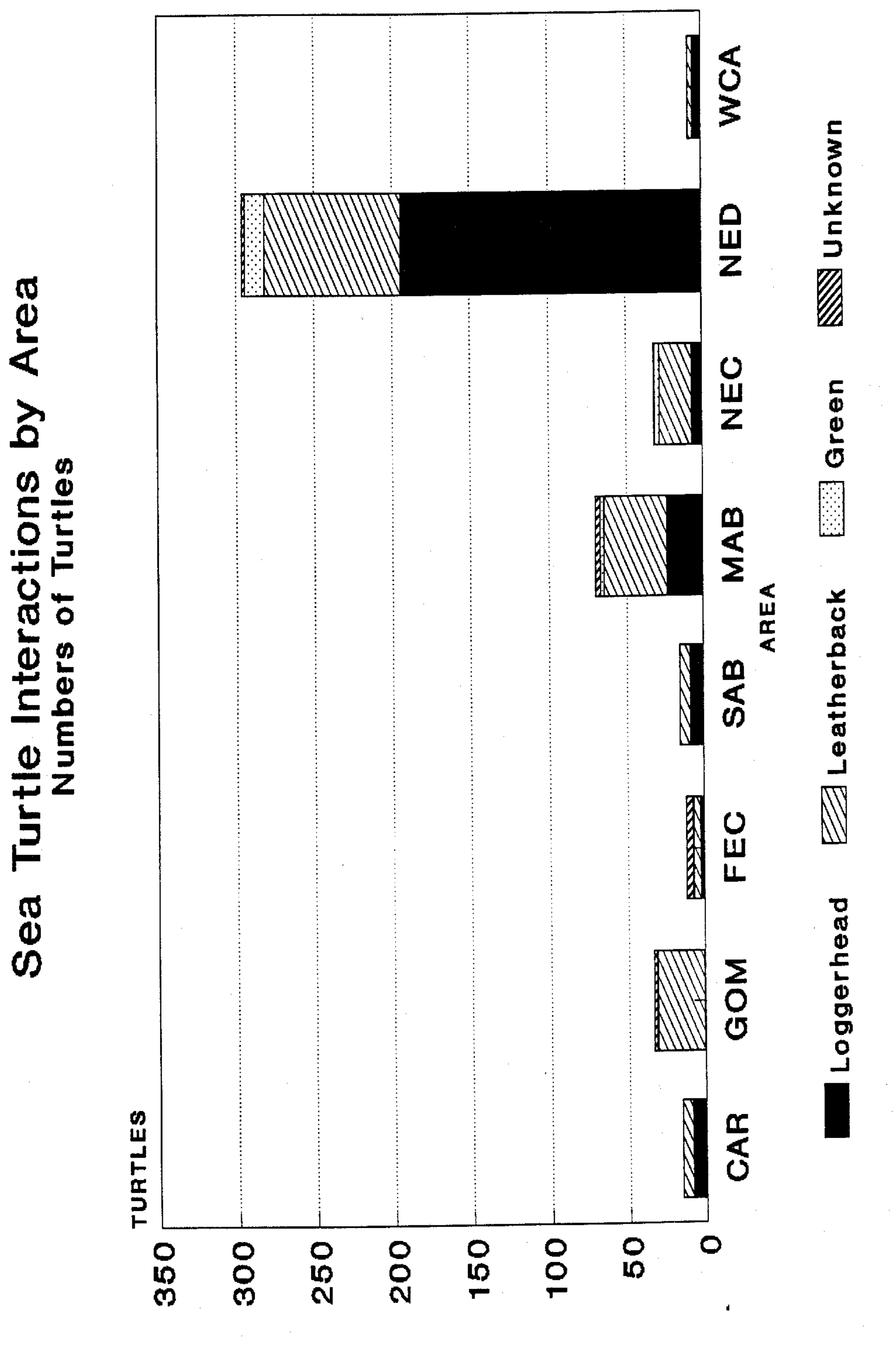
Loggerhead, *Caretta caretta* (253) and leatherback, *Dermochelys coriacea* (201) turtles are the predominant species (94%) involved in these interactions. Species identifications of green turtles, *Chelonia mydas*, north of Cape Hatteras and especially on the Grand Banks, and the Kemp's ridley, *Lepidochelys kempii*, are questionable.

Seven (7) of the observed 485 sea turtles were recorded as released dead. Observer release codes indicate that the remaining turtles were released alive with most coded as not injured. Interaction forms indicate that turtles were tangled in the gear, snagged by hooks on the shell, flippers, and head, and also caught by hooks in the jaw and occasionally in the throat. In a number of cases observers indicated that captured turtles had other visible hooks in the jaw. Improved forms and observer protocols are critically needed to define interactions and the nature of injuries.

About 3% of the observed sets involve interactions with multiple turtles, 7.6% with one turtle, and 89% are not involved with turtles. The Northeast Distant area, including international waters south and east of the tail of the Grand Banks of Nova Scotia, accounts for a disproportionate number of sea turtle interactions.

Examination of average temperatures and gear dimensions for sets with and without interactions by area and quarter did not provide consistent evidence of patterns in interactions. Because the number of positive sets and trips is small, relative to the total number of sets and trips when both are subdivided into area-quarter strata, it is unlikely that statistical analyses will have sufficient power to detect significant differences. This problem is exacerbated by the fact that data is also summarized across almost 5 years.

However, of the 359 trips that were observed the top 4 in total interactions accounted for 70 sets (2.6% of total observed sets) and 199 sea turtles (41% of the total). These trips occurred east of the tail of the Grand Banks between August and October during 1994 and 1995. In 1994 and 1995, 126 observed sets accounted for 240 sea turtles. During 1992 and 1993, 167 observed sets accounted for 53 turtles. The catch per set in 1994 and 1995 was six (6) times that observed in the preceding two years. The Captain of one of the observed vessels indicated that the unusually large number of interactions occurred while he was fishing a decaying warm-core ring of the Gulf stream that was surrounded by colder water. Turtle interactions, as well as daily sightings, increased during the trip as the ring diminished in size both linearly and in depth. Multiple captures of the same turtle were thought to occur. Gear dimensions were shorter than usual because the ring was essentially a rather shallow cup of warm water in a larger basin of colder water north of the Gulf Stream.


Sea Turtle Interactions by Area
Numbers of Turtles
TURTLES
350
300
250
200
150
100
50
0
CAR
GOM
FEC
SAB
MAB
NEC
NED
WCA
AREA
Loggerhead
Leatherback
Green
Unknown

PRELIMINARY ASSESSMENT OF STRESS AND RECOVERY IN KEMP'S RIDLEYS CAPTURED BY ENTANGLEMENT NETTING

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The paucity of at-sea information on sea turtles mandates current research rely on live capture to describe their pelagic life history stages. However, physiological effects of at-sea capture methods on sea turtles remain a mystery. Research reported herein uses plasma lactate analysis to assess physiological stress in Kemp's ridleys captured by entanglement nets off Texas. Rate of recovery from netting-induced stress is compared between two post-capture holding methods. Baseline hematological parameters are used to characterize overall health of the captured population.

MANAGEMENT POLICIES FOR THE CONSERVATION OF THE NESTING HABITAT OF *CARETTA CARETTA* ON THE ISLAND OF CRETE, GREECE

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INTRODUCTION

The island of Crete in the eastern Mediterranean is the largest and one of the most southerly in the Greek archipelago. After initial surveys by the Sea Turtle Protection Society of Greece identified significant numbers of nests along some of the beaches of Crete, monitoring, nest conservation and public awareness projects were started in 1990 (Margaritoulis *et al*., 1992). These projects operated in the three most important nesting areas, Rethimno and Hania along the northern coast, and Messara in the south. A total of 32 km of beach were monitored on a daily basis throughout the entire nesting and hatching season (May-Oct). Data between 1990-96 show an average of 401 nests in Rethimno, 125 in Hania, and 56 in Messara, totaling 582 nests annually, or 21% of the total observed nesting for all of Greece. Nests were monitored, protected or transferred as necessary. Nest survival and excavation data indicate an estimated annual production of 37,500 hatchlings.

HUMAN IMPACTS

These coastlines are under heavy pressure due primarily to their increasing use for tourist and recreational purposes. New developments are built directly behind the beaches, with associated lighting and human disturbance problems. The beaches themselves are becoming covered in sunbeds and umbrellas. Sea walls and other coastal defenses are leading to fundamental changes in the beaches. There is currently no legal protection for these important coastlines, although large parts of the nesting beaches are being considered for inclusion in the Europe-wide “Natura 2000” network of habitat conservation sites. Any legal protection is likely to be delayed for several years, by which time STPS fears that the beaches will have deteriorated severely.

PROPOSALS

An E.U.-funded LIFE project for three years (1995-97) has enabled the STPS to improve their monitoring, nest protection and public awareness activities in Crete. As a part of this project, management proposals are being prepared which will be completed by December 1997. Specific proposals will be made to improve the state of the nesting beaches by negotiating solutions to existing problems, such as light pollution, beach cleaning, and sunbeds. Guidelines for future development of the area will also be made, including a set-back distance for new buildings, height restrictions, lighting restrictions. These will have to implemented through national legislation, but until that time, STPS will begin a proactive policy of informing local authorities, developers and architects about sea turtle requirements and sustainable coastal development, and asking for their co-operation. Finally, crucial gaps in the existing knowledge about the population of turtles nesting on Crete are identified (*e.g.*, feeding grounds, migration rates, breeding rates, survivorship), and proposals made as to the research necessary before appropriate conservation policy can be devised.

In order for the plan to achieve its conservation objectives, and at the same time to be widely accepted by local authorities and businesses, it is expected that the plan must:
* have clear and realistic objectives, backed by scientific justification;
* balance the conservation needs of the sea turtles, with the local need for sustainable tourist development;
* consult with, and incorporate proposals from local authorities and businesses, and obtain clear statements of support from them;
* incorporate the sea turtles into the tourist product of the area, thereby encouraging local co-operation in conservation efforts and helping improve the quality of the tourist product;
* make maximum use of existing regulations; and
* be easily implemented and enforced.

METHODOLOGY

Beach sectors will be assessed according to nesting density and success, hatching success, and trends over the monitored period. Problems will be assessed as to their seriousness, frequency, and current and potential future impact on turtles. Each beach sector will then be evaluated as to ease of nesting, success of nest and levels of specific problems. A major source of data will be 1996 season, having been tailored to answer certain questions, but this will be checked for consistency with available data from previous years, and if necessary, will be compared with data from other areas.
Additional data from the 1996 season that will be used for the management plan:
* survey of tourist attitudes;
* detailed records of hatchling disorientation;
* counts over the summer of numbers of beach users and types of activities;
* survey of artificial lighting visible from the beach;
* details of umbrella/sunbed coverage per sector;
* additional details from the normal monitoring program (including number and type of attempts, obstructions and disturbances, and nest conditions.

Conservation efforts will be aimed at beach sectors that exhibit consistently high nesting density, high levels of nest survivorship, and high hatchling success rates, and areas that have had high levels in the past, and where declines can be explained by resolvable impacts (*e.g.*, disturbance or sunbeds). Some areas of low importance may, due to the high levels of investment (in terms of both money and effort) that would be required for rehabilitation, have to be allowed to continue to decline as nesting beaches. In these areas monitoring will continue, and any nests will be transferred to safe beach hatcheries. The pragmatic ‘sacrifice’ of small areas or low number of potential nests is an important step to ensuring local support for other conservation measures in more important areas.

LOCAL SUPPORT

Experience in Greece has shown that even protected areas covered by strong national legislation will fail if there is a lack of support for it at the local level. All indications are that the levels of local support are currently high in all three nesting areas. Local authorities are actively seeking solutions to some of the problems faced by the turtles, and involve the STPS in an advisory role, but also in some instances as part of the local authority decision-making process. All the local authorities in the three nesting areas are included in the consultation process during the preparation of the management proposals by the STPS. Many local tourist businesses see the sea turtles of Crete as an important resource, that could be used to improve the tourist 'image' of the areas, thus helping to maintain a high quality product.

CONTINUING ACTIVITIES

The STPS will continue its current conservation management of nests and turtles. Nests are caged for their protection, or transferred to avoid destruction or damage through inundation or human activities. Local property owners are approached to help resolve light pollution causing hatchling disorientation, and in most cases are found to be co-operative. An intensive public awareness campaign operates year-round involving local and national media. Six seasonal information stations operate in the nesting areas, and over 300 informative slide shows are given in the hotels to visiting tourists.

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HAWAII SEA TURTLE CONSERVATION PROJECT

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ARCAS conducts its Hawaii Sea Turtle Conservation Project on the southern, Pacific coast of Guatemala on the outskirts of a small fishing village named Hawaii. This program, ARCAS solicits donations of eggs from local turtle collectors which are then reburied in protected hatchery and released after hatching. ARCAS collected 7000 eggs in 1994, 10,000 in 1995 and 8,000 making it the most productive of the 21 turtle hatcheries in Guatemala. ARCA also offers technical advise and material support to other groups along the south coast interested in setting up their own hatcheries.

Another important aspect of ARCAS's Hawaii Program is environmental education. ARCAS staff and volunteers offer classes, develop teaching materials and conduct participatory activities such as beach clean ups and puppet shows to instill in local children the need to conserve the natural resources on which they depend. ARCA has also established 4 school hatcheries where the students themselves collect and bury their eggs and release them when they hatch.

In 1996, ARCAS organized a Regional Workshop on Sea Turtle Conservation and Hatchery Management. The workshop aimed to improve sea turtle conservation techniques in Guatemala and other central American countries, focussing primarily on the management of hatcheries and to strengthen the central American sea turtle network. Concrete results of the workshop include the establishment of a Guatemalan Sea Turtle Conservation Committee and the formation of a research strategy aimed at collecting and analyzing country-wide sea turtle data in Guatemala.

AFTER 3 YEARS AT THE SEA TURTLE RESCUE CENTRE, GREECE - THE CASE OF "IKAROS"

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ABSTRACT

Since 1994, the Sea Turtle Protection Society of Greece (STPS) in cooperation with the Municipality of Glyfada has been operating the Sea Turtle Rescue Centre near Athens. Injured and sick sea turtles from all over Greece are brought here to be treated by specially trained personnel under the supervision of three veterinarians. Most turtles admitted are *Caretta caretta* (there have also been two juvenile *Chelonia mydas*) suffering mainly from entanglement in fishing nets, deliberate human attack, speedboat injuries and ingestion of fishing hooks and other material. Of the 47 turtles received at the Centre, 27 have been rehabilitated and released into the sea. Special emphasis will be given to the case of "Ikaros", a juvenile loggerhead that suffered from severe head injuries and managed to recover after many months of intensive care.

INTRODUCTION

Since 1983, the Sea Turtle Protection Society of Greece has been carrying out beach monitoring and public awareness programmes on the last most important loggerhead nesting areas in the Mediterranean, as well as an environmental education programme for Greek school children across the country.

Since 1984, the STPS has been operating a Rescue Network, in coordination with the Ministry of the Environment and the Ministry of Mercantile Marine. The Port police send us reports of both live and dead strandings. Many turtles were treated at the animal hospital in Aegina, but the increasing number of sick and injured turtles necessitated the setup of a Rescue Centre for sea turtles.

In 1994, the STPS set up a Rescue Centre in Athens, with the support of the Municipality of Glyfada, the Ministry of Agriculture, the Ministry of Mercantile Marine and the Ministry of the Environment. The Greek Railway Company kindly donated train wagons to be transformed into different facilities. Injured and sick sea turtles are brought to the Centre from all over Greece. This is done in coordination with the Port Authorities and Olympic Airways, who do not charge for the transport. The most common injuries are from entanglement in nets, deliberate human attack, ingestion of fishing lines, hooks and from boat propellers. The treatment of the turtles is carried out by volunteers, under the supervision of trained staff and the Centre's vets. As soon as the turtle has recuperated, a release is arranged. From the 47 loggerhead and 2 green turtles that have been taken care of at the Centre, we have successfully released 27.

At present we are taking care of a juvenile loggerhead with a severe head injury. The recovery process of Ikaros is an exciting one to follow because of the 12 head injury turtles that have been admitted to the Centre, only one has previously survived. The swimming and feeding capabilities of Ikaros have changed dramatically over the last months.

THE CASE OF "IKAROS"

When Ikaros first arrived at the Centre, on 30 June 1996, he was very weak and floated on the pool's surface with no movements. He had been washed up onto the shore of a crowded beach at Kavouri (on the coast near Athens), he was taken in by a tavern owner, who contacted the local port authorities. The turtle was then brought to the Centre by two STPS volunteers.

There were fresh wounds to the head and carapace (from human action) and a deep cut (1.5cm) between the eyes and nostrils. The head injury had a surface area of 4.5cm x 3.0 cm. Ikaros is a juvenile turtle, on arrival weighing 8kg, with a curved carapace length of 41.5cm and curved carapace width of 37.5cm. He has 6 vertebral scutes and 6 right costal scutes.

On admission to the Centre, Ikaros was placed in freshwater for 24 hours (then transferred to sea water) and antibiotic medication commenced. After a few days, a surgical procedure was also performed by the Centre's vet, placing two stitches in the head wound. This helped to close the deep cut to a certain extent, even though the stitches came out at a later date.

Over the seven months since Ikaros has been at the Centre, his condition has improved greatly - from complete inactivity to swimming, diving, as well as eating on his own. Ikaros has been kept in sea water pools, with the temperature ranging from 15-27°C, depending on the time of year and Ikaros' condition.

THE RECOVERY PROCESS OF IKAROS OVER THE LAST MONTHS

<u>The healing of the head wound</u>. The dead tissue is slowly coming off from the wound, revealing healed tissue underneath.

<u>Swimming progress</u>. At first, Ikaros was only at the surface. After four months (from 3 November 1996) he started making diving attempts. He is now able to rest on the bottom of the pool (from 2 December 1996), coming up to the surface to breathe.

<u>Feeding progress</u>. At first, Ikaros was fed via a drip and by tube feeding into the stomach. As he became stronger (from 3 August 1996), this progressed to force feeding - first with liquid fish and then small pieces of fish (from 10 October 1996). Ikaros is now able to eat on his own (from 4 January 1997)- his diet is varied and includes small non-oily fish, mussels, shrimps and squid.

<u>Medication</u>. Intramuscular antibiotic injections (Baytril, dosage of 0.1ml/kg) were given for the first month. In addition the head wound is cleaned daily, by flushing with fresh water and spraying with the antibiotic Oxyvet. Ikaros also receives vitamin injections every ten days (Zingul, which contains vitamins A, D and E).

<u>Blood analysis</u>. Blood is taken from the turtle on a monthly basis. This gives us valuable information on the turtle's physiology, for example, letting us know if we need to change the diet. At present, the blood values of Ikaros are within the normal range for sea turtles.

<u>Behavioural observation</u>. For the last two years we have monitored and recorded the behaviour of each turtle at the Centre - from which we learn about feeding, swimming, resting and respiratory patterns. This is carried out once every two weeks for each turtle. As described, the swimming and feeding abilities of Ikaros have altered. The respiratory pattern of Ikaros has changed as well. In the beginning, the respiratory frequency was very low (around 7 breaths/hour). As Ikaros gained strength and became more active, there was a marked increase in his respiratory frequency.

WHEN WILL IKAROS BE READY FOR A RELEASE?

Although Ikaros is able to rest on the bottom of the pool and able to eat on his own, this behaviour is not always consistent. On some days, Ikaros is floating on the surface and makes diving attempts but is unable to reach the bottom of the pool. Sometimes Ikaros will only eat if the food is offered near his mouth. This feeding behaviour maybe due to Ikaros becoming too accustomed to human presence. Therefore human contact with Ikaros, as with any turtle, will be limited to as little as possible. Another factor that has to be considered before a release can be arranged is the temperature of the sea. The temperature of Ikaros' pool is controlled to be closer to that of the sea, so that he will be acclimated prior to release. Once Ikaros is acclimated and as soon as we are confident that he will be able to survive in the wild, he will be released back into his natural environment at the location where he was found.

HATCHING SUCCESS OF GREEN AND LOGGERHEAD TURTLE NESTS AT THE WEST COAST OF NORTHERN CYPRUS

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Nesting of loggerhead and green turtles, at the west coast of Northern Cyprus, was studied in summer 1995. One hundred eighteen (75 loggerhead and 43 green) nests hatched and 50 (40 loggerhead and 10 green) failed. Nest failures were mainly due to predation by foxes. 27 nests were totally destroyed by foxes and another 51 were partly destroyed. A total of 77 nests were caged. Caging improved hatching success. Though loggerhead nests faced predation during the whole of the incubation period, predation occurred on green turtle nests mainly around the hatching period . The majority of embryonic mortalities were found in the second half of the incubation period. Early embryonic mortalities were found in inundated and early predated nests.

INTRODUCTION

About 2000 female loggerhead turtles *Caretta caretta* and about 350 female green turtles *Chelonia mydas* nest each year in the Mediterranean (Groombridge, 1990). The main nesting grounds in the Mediterranean are in the beaches of Cyprus, Turkey, Greece, Croaita, Israel and Libya . Broderick and Godley (1995) estimated that between one quarter and one third of the green turtles and one tenth of the loggerhead turtles in the Mediterranean nest in Northern Cyprus. Although there are other factors affecting the turtle population in the Mediterranean, nest predation is one of the main factor decreasing the hatching success of sea turtles in Northern Cyprus (Godley and Broderick, 1994).

This study was conducted on five beaches on the west coast of Northern Cyprus to examine predation patterns, to assess the success of caging to protect nests, and to examine embryonic mortalities.

MATERIALS AND METHODS

Beaches were patrolled during daylight, from 20 May to 5 October 1995, and all turtle and predator activities and on the beaches were recorded. Accurate positioning of the turtle activity and egg chamber was possible by triangulating from fixed marker posts behind the beach.

Species identification was possible using the criteria of track and nest pit morphology (Groombridge, 1990). Finding the exact places of the egg chamber is very important in order to mark and cage the nest correctly. Miscaging a nest may not protect the nest from predators and wrong marking may not allow us to get detailed information on hatching, predation, clutch size and incubation period. A 30 cm. long metal probe was used in order to locate the exact place of a nest. Sand where it has been dug is softer than in the surrounding area. With experience this method is safe. After finding the egg chamber, caging and marking the nest is very easy. Location of any activity was measured to the nearest marker posts and strand line. Tracks were then raked over to avoid double counting.

The number and distribution of nests on all beaches and predation in the study area were determined by patrolling the beach for turtle crawl tracks and evidence of nesting activity and predation in order to investigate factors which might affect this pattern and to determine when the majority of predators occur.

Recently opened nests often had tracks leading to the nest, allowing identification of the predator as dog or fox. Dogs have larger pads that are closer together than a fox's (Bang and Dahlstom, 1990). The tracks of any other potential predators (usually ghost crabs, scavenging birds and hedgehogs) were noted and identified where possible.

The sand column surrounding the nest was checked for eggs left by the predator. Any damaged or unviable eggs were taken for determination of the stage of development. Any eggs which were considered viable were sometimes relocated and sometimes covered again and caged.

The cage (made of 10 cm. wire) was placed at depths of 20-40 cm (depending on the depth of the egg chamber and the species) below the sand surface so that the middle of the cage was located on top of the egg chamber. This is important because if the cage was misplaced, predators could reach the egg chamber from the side of the cage. Each cage was marked and held in position by 4 stakes, one at each corner.

These caged nests were checked for signs of attempted predation and for evidence of emerged hatchlings during the surveys and were removed after the nests had hatched. Some of the nests were caged at different times after the eggs were being laid.

If a nest was recorded as hatched, but only a few hatchling tracks were apparent, the nest chamber was marked with a small bamboo cane and the nest was left for a few days to allow the majority of hatchlings to emerge and the nest was then excavated by hand roughly one week after the first emergence. Care was needed during excavation, as a few live hatchlings could be found in the nest column. Any live hatchlings found in the nest column or chamber were counted. If the time was late and the weather was hot, these live hatchlings were brought back to camp- site, kept in water and released early next morning. If the time was not late, these hatchlings were released immediately and allowed to crawl from the nest site to the sea unaided, whilst being carefully monitored, as predation from ghost crabs and birds was a threat. There was also a risk of overturning whilst maneuvering around obstructions on the beach such as litter and wheel tracks.

A count of the eggs removed from the nest was made recording the number of hatched and unhatched eggs. Unhatched eggs were taken to examine the level of development, opened in saline and the early stage fixed in Bouin's solution, late stages and hatchlings in 10% formalin. All the embryos were staged according to Miller (1985).

RESULTS AND CONCLUSION

The main laying season was June and July and during this period there were a total of 482 nesting activities recorded, 167 of these were successfully laid nests, of which 113 were loggerhead and 54 were green turtles. A total of 113 hatched nests were recorded (69 loggerhead and 44 green turtles). The main hatching period was during August and September.

A total of 29 nests (19 loggerhead and 10 green) did not hatch because of predation and/or inundation. Main nest predators were red foxes, feral and domestic dogs, ghost crabs, scavenging birds, lizards and hedgehogs. Predator activities were higher on the beaches holding more nests. 25 loggerhead nests were totally predated (tp). Although 32 (29 loggerhead and 3 green turtle nests) nests were predated to some extent (partly predation pp), 27 (14 loggerhead and 13 green turtle nests) were assessed to have hatched prior to predation (hp). A total of 68 nests (45 loggerhead nests and 23 green nests) were caged either next morning after laying, after predation or before hatching. Almost every caged nest faced attempted predation (ap) during the incubation period.

Although loggerhead nests were vulnerable to predation during the whole incubation period, the majority of the predation occurred early or late in the incubation period. Green turtle nests suffered to predation just before or during the hatching period.

Embryonic mortalities were higher during later developmental stages (that is in the second half of the incubation period). The hatching success of loggerhead nests was lower than green turtle nests due to heavier predation. Caging is one way of protecting these nests during the whole incubation period, or if the temperature profile of the beach is known, relocation of these nests to a fenced area would be an alternative.

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INTER- AND INTRA- CLUTCH TEMPERATURE VARIATION OF LOGGERHEAD AND GREEN TURTLE NESTS IN THE MEDITERRANEAN

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INTRODUCTION

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

In most of these studies, temperature was recorded at intervals, not continuously, during incubation and related to sand and air temperatures. Temperature and sex ratio differences between different zones and different seasons were reported (*i.e.*, Hays *et al*., 1995; Mrosovsky *et al*., 1995) but no data have been reported showing the temperature and temperature differences within the clutch during the whole incubation period.

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

MATERIALS AND METHODS

The temperature of green and loggerhead turtle nests were recorded during the summers of 1995 and 1996 at the beaches of Northern Cyprus and Turkey. Temperature of the nests was measured using "Tiny talk" temperature recorders (Orion Components (Chichester) Ltd., U.K.). The device fits with in a 35 mm film case (not very different from a turtle egg size). The accuracy of the device was tested under laboratory conditions against standard mercury thermometers, and they have a mean resolution of 0.35°C (min. 0.3°C, max. 0.4°C) for temperatures between 4°C and 50°C. We set a recording period of 60 days with readings taken at 48 min. interval. They were placed at three different depths (top, middle and bottom) of the nest during laying or after excavating the nest in the morning of laying. The nest was then covered and protected with wire mesh against dog and fox predation.

A few days before anticipated date of hatching these "tiny talks" were taken from the nest and the information offloaded to a computer. Six eggs were taken from each level together with the Tiny talks. These eggs were inembated in moist sand for a few days until they hatched; hatchlings were then killed (CITES permit nos 81772, 81773, 94207 and 94208), dissected and preserved in Bouin's solution for sex determination. The gonads were cut in half transversely and one half was embedded in paraffin wax, sectioned at 8-10 m from the middle of the gonad, and stained with the Periodic Acid Schiff reaction (PAS and Harris' hematoxylin). Sex designation was based on development of cortical and medullary regions and presence and absence of seminiferous tubules.

RESULTS

Between 1200 - 1600 readings were taken per nest. The temperature of the nests was not constant, increasing during the incubation period for both species. The mean temperature of the whole incubation period for 5 green turtle nests ranged from 29.3 to 31.5°C. The temperature of green turtle nest increased from 24.9°C, at the beginning of the incubation period, to 34.5°C at the end of incubation period. For the first third of the incubation (about 18 days) the top of green turtle nest was the warmest, and the bottom was the coolest with the middle of the nest temperature being intermediate. During the next 18 days the temperature of the middle increased due to metabolic heat and became the same as the temperature of the top of nest, and during the last third of the incubation period sometimes become warmer. Temperature differences between top and bottom of a green turtle nest were observed up to 1°C during the incubation period. There were no diel cycles in green turtle nest temperatures.

The mean temperature of the whole incubation period for 10 loggerhead turtle nests ranged from 27.0 to 31.7°C. The temperature of loggerhead turtle nest increased from 24.5°C, at the beginning of the incubation period, to 34.1°C at the end of incubation period. The top of the loggerhead nest was warmest, and the bottom was coolest, except for a few days after inundation caused by high tides. The temperature of the middle was intermediate early in the nesting season. It rose to the same as top of the nest later in the season and exceeded it only early in September when the weather was cooler. Temperature differences between top and bottom of a loggerhead turtle nest were observed up to 2.6°C during the incubation period. Marked diel cycles in loggerhead nests were detected with a range of up to 1.5°C during the incubation period. All nests showed a female biased sex ratio for both species.

CONCLUSIONS

Our data generalise that the temperature of marine turtle nests in the Mediterranean is between 24 and 35°C and rises by up to 9.6°C during the incubation. Our data also showed that top eggs were warmer and bottom eggs were cooler with the middle ones intermediate in the first third of incubation but later in incubation temperatures become the same as the temperature of the top eggs or even sometimes warmer due to metabolic heat.

Our results did not show any evidence of a diel temperature cycle for green turtle nests, but up to 1.5°C variation for loggerhead turtle nests. Presumably, since green turtle nests are very deep, diel temperature variations occurring near the surface are very much reduced at green turtle nests, but have some influence on loggerhead turtle nests. This would be the expected result, since loggerhead nests are shallower than green turtle nests. Hays *et al*. (1995) also did not detected any diel cycle in temperatures for green turtles on Ascension Island, but Standora and Spotila (1985) reported very small (0.5°C) diel temperature variations for green turtle nests in Costa Rica.

There was a female biased sex ratio from our results. Similar results were also reported elsewhere (cf. Mrosovsky, 1994).

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GENETIC SEQUENCE DIVERSITY IN THE MITOCHONDRIAL DNA CONTROL REGION OF THE GREEN TURTLE POPULATION OF NORTHERN CYPRUS

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INTRODUCTION

The natal homing hypothesis for the reproductive migration of sea turtles suggests that females return to breed and nest at the same beach from which they had hatched (Carr, 1967). Hatchlings and juveniles move among several habitats during development, adults migrate between feeding and nesting grounds that are hundreds or thousands of kilometers apart, and both movements are difficult to track in the marine environment (Carr, 1980). Much of what is known about the life history of sea turtles has come from tagging experiments on nesting females.

Green turtles, *Chelonia mydas*, are distributed circumglobally in tropical and subtropical oceans (Carr, 1967). One prediction of the natal homing hypothesis is that each nesting colony should comprise a group of isolated maternal lineages as females assort themselves according to their natal beach. Only a small population of green turtles nest in the Mediterranean, approximately 400 females per season (Groombridge, 1990).

In recent reports, analyses of maternally transmitted mitochondrial DNA (mtDNA) have proven useful for resolving questions about nesting behaviour and population demography in sea turtles. mtDNA has the virtue of a maternal, nonrecombining mode of inheritance, rapid pace of evolution, and extensive intraspecific polymorphism. It is tightly packed with genes for 13 messenger RNAs, 2 ribosomal RNAs, and 22 transfer RNAs. In addition to these 37 genes, an area known as the "D-loop", roughly 0.8 kilobases long, appears to exercise control over mtDNA replication and RNA transcription (Avise *et al*., 1987). Bowen *et al*. (1992) have tested the natal homing hypothesis for 15 colonies of green turtles in the Pacific and Atlantic regions using restriction-fragment-length-polymorphisms (RFLP) of mtDNA. Their study identified significant differences among most colonies, thereby extending the earlier conclusions based on mtDNA analyses in favour of natal homing (Meylan *et al*., 1990). Recently, Allard *et al*. (1994) and Lahanas *et al*. (1994) applied mtDNA control region sequences to problems in green turtle biology and more recently Encalada *et al*. (1996) employed mtDNA control region sequences to assess the population genetic structure and phylogeography of green turtles in the Atlantic Ocean and Mediterranean Sea.

The purpose of this study was to determine whether the Mediterranean populations of green turtles are genetically distinct from their Atlantic relatives, by comparison with published work on green turtles from Costa Rica and Florida (Allard *et al*., 1994). Following published work (Encalada *et al*., 1996) with the same aim, our goal became a further exploration of the diversity present on the Cyprus which we hoped would help refine estimates of the rate of genetic exchange with the Atlantic populations.

MATERIALS AND METHODS

We collected tissues from 17 green turtle hatchlings from west coast beaches of Northern Cyprus during the hatching season of 1995, either from the hatchlings sacrificed for sex determination purposes (CITES permit no: 81773) or from hatchlings which had been found dead in the nest column during nest excavation after hatching. One sample per nest was taken. Heart, liver and brain samples from the hatchlings were dissected and preserved in absolute alcohol and stored at room temperature. Total DNA isolations from heart samples were conducted by digesting with proteinase K at 50°C for 4 h. Contaminating proteins were removed by sequential extraction with equal volumes of phenolchloroform and the DNA recovered from solution by ethanol precipitation in the presence of 1.25 M ammonium acetate and resuspended in TE buffer (10 mM Tris.Cl (pH: 8.0), 1 mM EDTA) (Sambrook *et al*., 1989).

Samples were amplified by the polymerase chain reaction (PCR) by using primers LTCM1 (5'-CCC AAA ACC GGA ATC CTAT3'), LDCM1 (5'-AGT GAA ATG ACA TAG GAC ATA-3'), and HDCM1 (5'-ACT ACC GTA TGC CAG GTTA-3') developed by Allard *et al*. (1994) and LTCM2 (5'-CGG TCC CCA AAA CCG GAA TCC TAT-3') and HDCM2 (5'GCA AGT AAA ACT ACC GTA TGC CAG GTT A-3') developed by Encalada *et al*. (1996). These primers were designed to target an area of 510 basepairs of the 5' end of the control region. Amplified double- stranded mtDNA was purified with Amicon centricon centrifugal microconcentrators (Centricon-100 and 30) and singlestranded mtDNA templates sequenced manually using the Promega Sequenase kit, according to manufacture's instructions for two of the samples. Other samples were sequenced with fluorescently labeled primers and analysed with an automated DNA sequencer (Applied Biosystems model 373) and individual sequences were then aligned by eye.

RESULTS AND CONCLUSION

The samples were aligned for 487 bases from the 5' end of the control region. There were no polymorphisms among the 17 samples. This finding lowers the estimated genetic diversity for the green turtle population nesting on Cyprus and fails to detect any genetic exchange with the Atlantic population. An inverse relationship between nesting population size and mtDNA diversity is apparent for other populations (Lahanas *et al*., 1994; Encalada *et al*., 1996). However, some of the small population with very low diversity have been observed (e.g,. Aves Island, Guinea Bissau). These results help to confirm the idea that the Mediterranean population of green turtles was founded recently by migration of a very small number of female from the Atlantic.

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PREDATION OF LOGGERHEAD SEA TURTLE *(CARETTA CARETTA)* NESTS BY ARMADILLOS *(DASYPUS NOVEMCINCTUS)* AT HOBE SOUND NATIONAL WILDLIFE REFUGE, FLORIDA

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Accounts of predation of sea turtle nests by armadillos are anecdotal and virtually absent from the literature record. However, armadillo predation at the Hobe Sound National Wildlife Refuge (HSNWR) has increased dramatically since Drennen et al. (1989) described the first isolated instances of armadillo predation on sea turtle nests there during 1988. During 1996, 28 (14%) of 201 marked nests were depredated solely by armadillos at HSNWR. In this presentation we describe the characteristics of armadillo predation, quantify its importance at HSNWR over the last 7 years, discuss management concerns, and speculate on the cause behind the isolated character of this problem.

USE OF CHEMICAL DETERRENTS AND WIRE SCREENING TO REDUCE THE INCIDENCE OF PREDATION OF MARINE TURTLE (*CHELONIA MYDAS* AND *CARETTA CARETTA*) NESTS IN NORTHERN CYPRUS, EASTERN MEDITERRANEAN

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INTRODUCTION

The beaches of Northern Cyprus are regionally important nesting sites for both loggerhead (*Caretta caretta*) and green turtles (*Chelonia mydas*). For these nesting populations, one of the most important causes of nest failure is predation by foxes and dogs (Broderick and Godley, 1996). The purpose of this investigation was to determine possible efficacy of chemical deterrents in reducing nest predation. In addition, an existing anti-predation nest screening programme was critically assessed.

METHODOLOGY

Chemical Deterrents: To test the potential usefulness of using chemical deterrents, a controlled experimental approach was used, utilizing artificial nests consisting of hens' eggs. To guard against the possibility of attracting predators on to marine turtle nesting beaches previously unaffected by predation, a study site on the west coast known to suffer from virtually 100% nest predation was chosen. This was also thought to be likely to ensure a more rigorous test of treatment efficacy. Each artificial nest consisted of four whole hens' eggs buried at 50cm depth in an artificial egg chamber. An additional egg was broken and mixed in the sand column above the egg chamber, in an attempt to give olfactory cues analogous to a hatching marine turtle clutch (in Cyprus, a large proportion of nest predation occurs around the hatching period). The artificial 'nests' were then exposed to a selection of six different treatments (n=12 nests for each treatment).

1.Control: no screening or chemicals were used.
2. Mothballs only: eight naphthalene mothballs (Dragon Co. Ltd.) were buried at 20cm depth; four above the egg chamber and one at each corner of the metre square centred over the egg chamber.
3. Spray only: an equal amount of a proprietary dog 'Anti-chew' spray (Secto Co. Ltd.) was deposited over the square metre centred over the egg chamber.
4. Screened/no chemical: a one square metre wire screen was buried at a 20cm depth, centred above the egg chamber and secured using 50cm stakes before covering with sand to original level.
5. Screened/mothballs: combination of treatments 2 and 4.
6. Screened/spray: combination of treatments 3 and 4.

Nests were monitored daily for a 7 day period for spoor, indicating signs of predation. The number of successful predation attempts and number of eggs taken were enumerated. At the end of this period all artificial nests were excavated and remaining contents removed from the beach.

Screening of marine turtle nests: A proportion of marine turtle nests of both species were screened as a part of routine conservation work (Godley and Kelly, 1996). The fates of these and unscreened nests were monitored and compared.

RESULTS AND DISCUSSION

Chemical deterrents: Every experimental nest suffered attempted predation on at least one occasion. The number of nests successfully depredated and number of eggs taken for all experimental treatments are shown in table 1. The results show that control nests were most heavily predated, followed by 'spray only' and 'mothballs only' respectively. All screened nests experienced very little predation (1/36 nests with only 1 egg taken). Chi square test with Yates' correction showed the effects of screening versus the control to be highly significant (Chi-sq.=75.48, $p<0.0001$) and the effect of both chemical treatments pooled to be significant (Chi-sq.=5.89 $p<0.05$). However, 'spray only' had no significant effect on its own (Chi-sq.=0.23. $p>0.05$) whereas 'mothballs only' appeared to have a moderate but significant effect (Chi sq.=5.89. $p<0.05$).

Nesting in 1996 was at a relatively low level and finished early in the season. Consequently, validation testing of these techniques on turtle nests was not possible. However, from experimental results it is likely that mothballs may be of value, but possibly only to augment existing screening effort. These findings suggest screening affords the highest degree of protection against predation.

Screening of marine turtle nests: Fig. 2 illustrates the fates of *C.caretta* nests in Northern Cyprus in 1996 with respect to caging. Chi-square analysis with Yates' correction showed the effect of screening to be statistically highly significant for *C.caretta* nests (Chi-sq.=29.818, $p<0.001$). Data for *C.mydas* nests are equivocal, the facts that a small number of clutches were laid in the study area in 1996 and the relatively small proportion screened precluded statistical analysis.

RECOMMENDATIONS

1) Intensive screening has been shown to protect a significant proportion of *C.caretta* nests. This practice should be continued.
2) The use of mothballs to augment screening of in situ turtle nests should be investigated.

ACKNOWLEDGMENTS

The authors wish to thank all the members of GUTCE 1996 for their help with the field work, all the organisations and individuals that supported this project, and Mr. Randy Isbister for giving us the idea of using mothballs. Brendan Godley and Annette Broderick would like to acknowledge the assistance of the Overseas Student Travel Fund.

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Table 1: The number of experimental nests successfully predated and number of eggs taken versus the different anti-predator treatments.

Experimental Treatment	**Number of nests predated (from 12)**	**Number of eggs taken (from 48)**

Control	12	42
Mothballs only	6	30
Spray only	10	17
Screen only	1	1
Mothballs & screen	0	0
Spray & screen	0	0

UPDATE ON LONG TERM EXPERIMENTAL TRANSMISSION STUDIES OF GREEN TURTLE FIBROPAPILLOMATOSIS (GTFP)

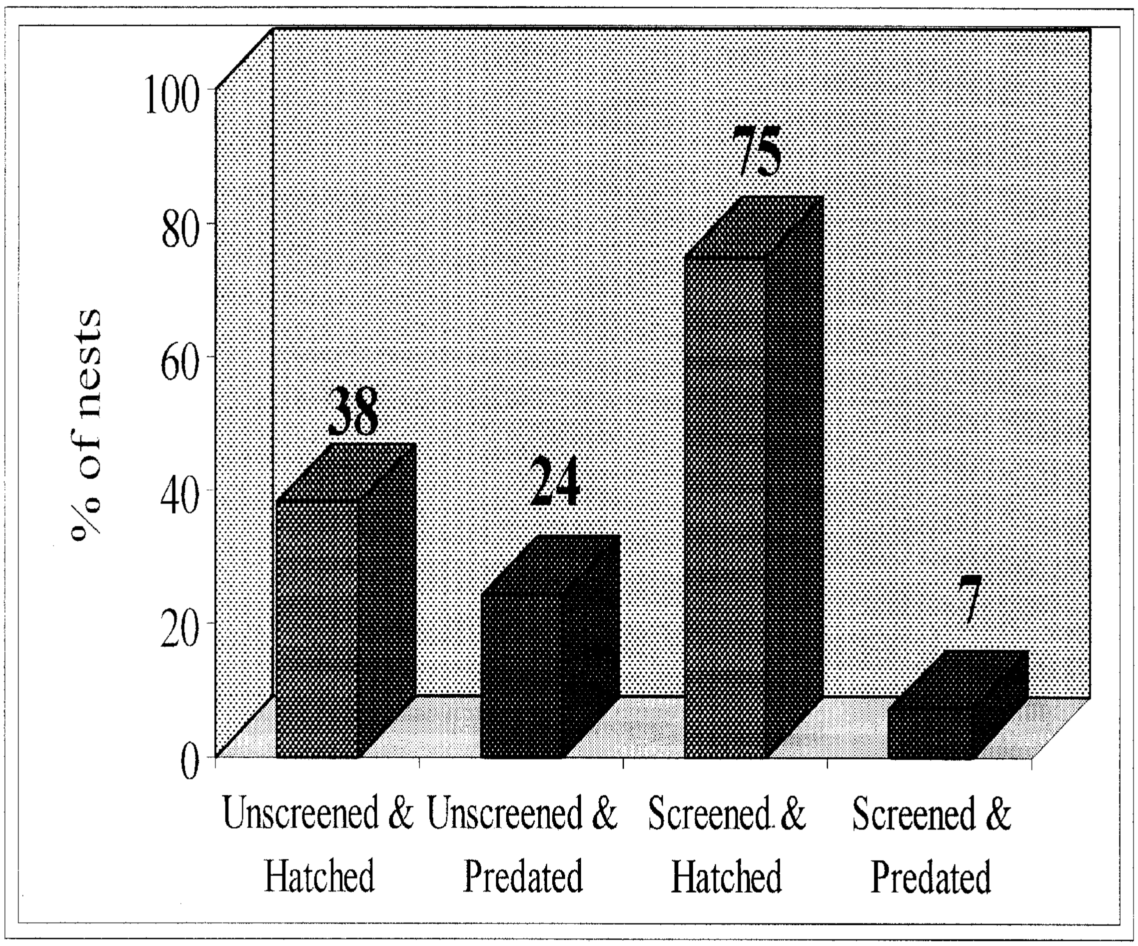

Figure 1. The fate of *C.caretta* unscreened versus screened nests.

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Experimental transmission studies in captivity by our research group have clearly demonstrated that GTFP is caused by an infectious subcellular agent. We have demonstrated a herpesvirus in experimentally induced and spontaneous fibropapillomas using electron-microscopic, molecular, and serological techniques and this virus remains a candidate for the etiology of the disease. Fulfillment of Koch's postulates through a controlled transmission study using cultured candidate viruses remains to be achieved. This report updates the status of these long-term transmission studies with regard to medical history and pathology in turtles with experimentally-induced GTFP. In addition, recent laboratory findings will be reviewed.

AGE DETERMINATION OF HAWKSBILL TURTLES (*ERETMOCHELYS IMBRICATA*) BY SURFACE PATTERN WITH YELLOWISH BANDS OF SCUTE

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We examined whether it is possible to estimate age of Hawksbill turtles by using surface pattern with yellowish bands of scute or not. The coastal (C1) pictures of 13 individuals which were recaptured between 1992 to 1996 at Mona Island, Puerto Rico were used on this research and analyzed density plot of black and white brightness on the C1. As a result of this analysis, it became clear that new yellowish band increased for the space of one year as to those samples (estimated age: 4-7 years). But we need to examine how to make surface pattern of scute about hatchling juveniles and matured adults, after this.

NOTES ON THE MARINE TURTLES OF SAL ISLAND, CAPE VERDE ISLANDS

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Data collected between 1 April and 15 May 1996, and during implementation of Cape Verde Humpback Whale Project are presented. Three species of marine turtles were recorded: loggerhead turtle (*Caretta caretta*), hawksbill turtle (*Eretmochelys imbricata*) and leatherback turtle (*Dermochelys coriacea*).

Results of the beach survey show that loggerhead females lay eggs on Sal Island, although the actual size of their nesting population is unknown. Along 30 km of sandy beaches, remains of more than 40 loggerheads were found, mostly heavy injured (bone and scull fractures, decapitations), obviously by humans. According to the local inhabitants, marine turtle females are constantly slaughtered during the eggs-deposition. They are mostly used for consumption.

Three major threats on marine turtle nesting population at Sal should be emphasized: (I) loss of nesting beaches due to tourism development; (ii) exploitation of nesting females, eggs and hatchlings, and (iii) incidental catch. Data on loss of eggs and hatchlings caused by natural predators do not exist. All species of marine turtles on Cape Verde Islands are legally protected. Nevertheless, human impact on their population is still out of control. Therefore, research and conservation program is urgently needed.

IN-THE-WATER STUDIES FOR HAWKSBILL TURTLE (*ERELMOCHELYS IMBRICATA*) AT PARQUE NACIONAL JARAGUA, DOMINICAN REPUBLIC

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In the Dominican Republic (DR), the hawksbill turtle has been traditionally exploited for its meat and its decorative shell, but few studies have been conducted to assess this species status. Aerial surveys and interviews from mid 1970's and early 1980's identified several important nesting areas for sea turtles (including hawksbills) at DR’s coastline. One of these areas is the Jaragua National Park located at the south-west coast of DR. For the first time, in-the-water studies were conducted during 1996 to evaluate the use of the park’s coastal areas as hawksbills foraging habitat. The results of such in-the-water studies will be presented here. Some of the findings that be discuss are diet, habitat characterization, size composition and the conservation status of hawksbill turtles in the area.

STORM EFFECTS ON SEA TURTLE NESTS AT ST. VINCENT NATIONAL WILDLIFE REFUGE, FLORIDA, U.S.A.

Thomas E. Lewis

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The sea turtle nesting season on St. Vincent National Wildlife Refuge (May-October) overlaps with the hurricane season (June-November). During the 1992-1996 nesting seasons, eight storms (range 1-3/year) impacted sea turtle nests on St. Vincent NWR. Storms eroded, flooded, and/or deposited sand on nests. Beach erosion caused changes in the beach profile which affected future nesting.

We conducted nesting surveys from May-September and monitored nests until 75 days after the last nest was laid. We monitored nests at least twice a week and determined hatching success (eggs emerged/total eggs) and age of embryo death when possible.

We evaluated nests lost prior to 75 days of incubation for yearly storm loss totals. Storms totally destroyed 55 of 211 nests (26%) laid from 1992-1996. We lost no nests to storms in 1993 and 1996. In 1992, 1994, and 1995, we lost 38%, 50%, and 43% of nests, respectively.

We evaluated insitu nests with insignificant depredation losses to compare hatching success for inundated and non-inundated nests. Thirty-nine non-inundated nests had 79% hatching success and 31 inundated nests had 26% hatching success.

We determined age of embryo death for 15 nests from 1994-1996. In 13 of 15 (87%), the age of embryo death coincided with a major storm or inundation from groundwater.

Storms can have major impacts on beaches. In 1995, Hurricane Opal washed away many of the dunes on St. Vincent NWR. The result was a beach that was flatter with its surface closer to the underlying groundwater. In 1996, no storms inundated nests. However, groundwater inundated and caused total loss in at least seven nests. These nests appeared to be a sufficient distance from high tide, but without dunes to raise them above the groundwater they were lost.

Storm effects on sea turtle nests can be significant and managers can not usually predict when or how storms will impact nests. We relocate nests only if we are certain they will be destroyed. However, when a nest is in a location that subjects it to regular groundwater inundation, moving it may increase hatching success. A test hole could be dug near the nest. If groundwater is near the surface, nest relocation may be warranted. Care must be used when making this decision so nests are not moved needlessly.

KEMP'S RIDLEY NESTING IN VOLUSIA COUNTY

Beth Libert

Volusia Turtle Patrol, Inc., 4738 S. Peninsula Drive, Ponce Inlet, FL 32127, U.S.A.

This poster will exhibit photographs of the only documented nesting of a Kemp's Ridley on the east coast of Florida. There were 2 documented nestings of what is believed to be the same turtle, based on photograph comparisons. The poster will provide measurements taken at both nesting sites and give details of the weather conditions at the time of nesting. Nesting success evaluation data will be included as well as weights and measurements of a random sampling of hatchlings.

We may also have back the DNA analysis that is being done by Steve Johnson that will determine whether or not the hatchlings are pure Kemp's Ridleys or hybrids.

UNUSUAL ACCOUNTS OF LEATHERBACK NESTING IN NORTHWEST FLORIDA

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INTRODUCTION

In the continental United States, Florida is the only state to consistently document nesting of the leatherback sea turtle, *Dermochelys coriacea*, although nesting has been reported from Texas to Georgia (Ernst *et al*., 1994; Ruckdeschel *et al*., 1982). Approximately 50% of all leatherback nesting emergences in Florida occur on Palm Beach County beaches in the southeast portion of the state (Meylan *et al*., 1995). However, only a few historical accounts of leatherback nesting exist for the beaches of northwest Florida.

A single leatherback nest was confirmed between Phillips Inlet and Destin in September 1962 when hatchlings were discovered on the beach (Yerger, 1965). St. Vincent National Wildlife Refuge in Franklin County was the site of an additional leatherback nesting event in 1974 (LeBuff, 1990; Meylan *et al*., 1995). St. Joseph Peninsula State Park in Gulf County also documented three emergences, including two nests and a false crawl, more recently in 1993 (Meylan *et al*., 1995; J. Mitchell, pers. comm.). During the summer of 1995, ANERR biologists surveying sea turtle nesting activity on Franklin County beaches documented three leatherback nests and a false crawl (Fig. 1).

NESTING OBSERVATIONS

The first documented nesting event occurred on 5 May 1995, and the final emergence was documented on 10 June 1995. Since leatherbacks generally average 5-7 nests per season (NMFS and USFWS, 1992) with only about 16-31 individuals of the species nesting in Florida each year (Meylan *et al*., 1995), these 1995 accounts may be attributed to multiple emergences by the same nesting female.

The location of each nesting event was recorded with the use of a hand-held Loran-C unit. All four emergences occurred on St. George Island with the second nest located within St. George Island State Park boundaries. The distance between consecutive nesting attempts varied from 0.8 to 13.7 km, with an average distance of 8.4 km between successive emergences.

RESULTS

In early August, the first leatherback nest was evaluated and was found to include 127 unhatched eggs including 85 large eggs and 42 smaller, yolkless eggs. The presence of smaller, yolkless eggs is common for this species, and nesting observations have revealed that these eggs are usually laid last (Hirth and Ogren, 1987). Examination of this clutch revealed that the eggs lacked white spots or visible embryos, and thus were probably infertile since white spot development between the vitelline membrane and the shell membrane is generally considered an indicator of fertile eggs (Whitmore and Dutton, 1985).

Staff from the St. George Island State Park examined the second nest for hatching success in mid-August. This clutch, comprised of 139 unhatched eggs, included 96 large eggs (Ogles, pers. commun.). Once again, no eggs appeared to contain embryos. These clutch sizes, although representing only two samples, appear consistent with previous studies which exclude smaller, yolkless eggs from clutch size estimates (Hirth and Ogren, 1987). Northwest Florida was impacted by three hurricanes during the 1995 nesting season, and the final nest was not relocated to evaluate hatching success after Hurricane Erin.

DISCUSSION

Poor nest site selection, infertility, embryonic mortality, and predation have been recognized in the past as reasons for reduced hatching success for leatherback and green sea turtles, *Chelonia mydas* (Whitmore and Dutton, 1985). Due to the few historical records of leatherbacks in northwest Florida and the characteristics of these two clutches, evidence seems to suggest infertility as the reason for lack of embryonic development and hatching success. The panhandle region of Florida, especially Franklin County, is relatively undeveloped in comparison to other regions of the state. Certainly the possibility exists that leatherback females nested on remote beaches in the past, thus escaping human detection. Further monitoring of local nesting beaches in years to come may provide additional knowledge concerning the nesting density of the leatherback sea turtle and a better estimate of the number of nesting females in northwest Florida.

ACKNOWLEDGMENTS

Thanks to Thom Lewis of the U. S. Fish and Wildlife Service and to Roy Ogles and Bruce Drye of the St. George Island State Park for their time and support in monitoring sea turtle nesting in Franklin County and, in particular, the leatherback nests of 1995. The authors would also like to extend their appreciation to Joe Mitchell of the St. Joseph Peninsula State Park for contributing information from past leatherback nesting events on Gulf County beaches and to Karen Mitchell of the National Marine Fisheries Service, Pascagoula, Mississippi, for providing leatherback sighting locations for the Florida panhandle.

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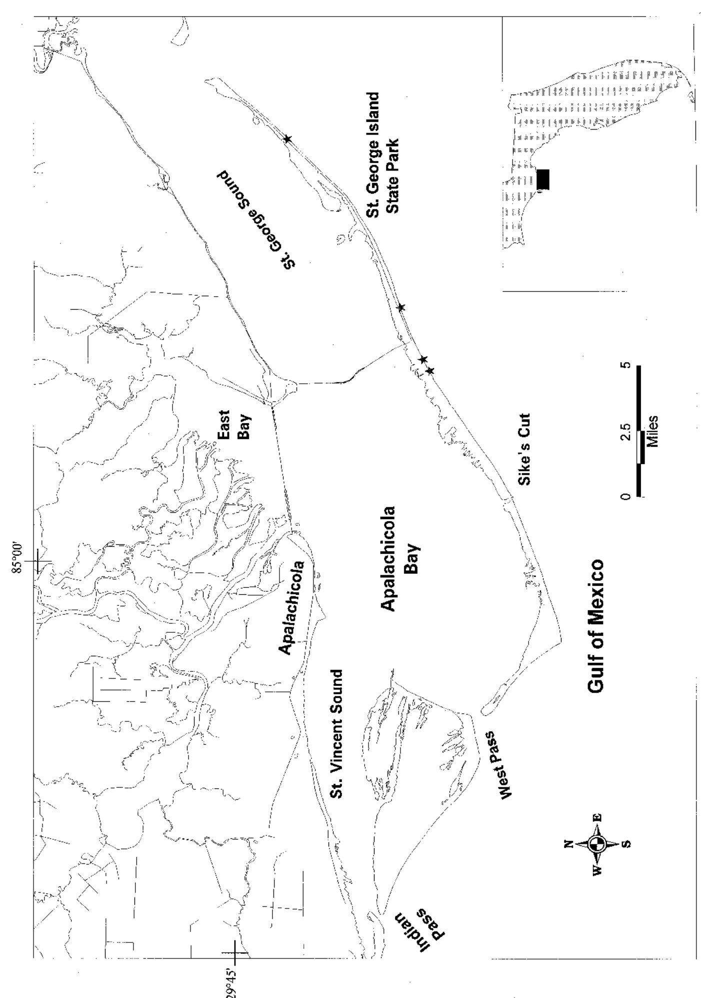

Figure 1. Leatherback emergence locations in Franklin County, Florida, during the 1995 nesting season.

COMPARATIVE DEVELOPMENT OF GREEN (*CHELONIA MYDAS*) AND HAWKSBILL (*ERETMOCHELYS IMBRICATA*) SEA TURTLES

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Turtles nesting along the coast of the Yucatán Peninsula of México have been protected for many years by federal, state and private groups. The protection of nests in this geographic area is warranted since the beaches on the east Yucatán coast serve as major rookeries for green (*Chelonia mydas*) and loggerhead (*Caretta caretta*) sea turtles (Zurita *et al*., 1991). Parque Xcaret, about 80 km south of Cancun, is located next to some of the principle beaches employed by nesting females. Parque Xcaret is an "eco-archeological park" dedicated to sea turtle conservation, research and education. There, thousands of hatchlings have been given a "living tag" and once recovery is complete, they are released into the ocean. A relatively small number of hatchlings are retained at the aquarium for educational purposes for a year before being released. This year long head starting program combined with the living tag procedure has given us the opportunity to observe individuals as they develop. We are interested in their physical development as well as the behavioral changes displayed and the relationships among physical and behavioral measures. Here we summarize our findings for the first six months of development in individually identified green and hawksbill hatchlings. The project will continue for an additional six months.

METHODS

A total of 36 green (*Chelonia mydas*) and 36 hawksbill (*Eretmochelys imbricata*) hatchlings were given an individually unique living tag. This was done by assigning a number to each costal and last vertebral scute, then marking two scutes out of the nine so that each hatchling could be identified from its carapace as easily as reading numbers off a clock. At periodic intervals, the turtles were weighed, measured and given a set of behavioral tests developed in part, from our prior experiments (*e.g.*, Mellgren and Mann, 1996). To date, the behaviors we have measured have been fairly simple indices of physical responsiveness including: time spent struggling after being picked up by a human time to turn over when placed upside down on their carapace (*i.e.*, the righting reflex)time spent struggling (while inverted) prior to righting themselves time between the introduction of a novel food item and the initiation of feeding attempts.

The turtles were maintained on commercially available pelleted turtle chow supplemented with a gelatin consisting of pureed spinach, lettuce, cod liver and fish oil with yeast and vitamins A,D,E and B complex. Hatchlings were held in glass aquaria (1 meter depth) and fresh filtered sea water was changed daily.

RESULTS AND DISCUSSION

There were substantial differences in the sizes of turtles within and between species. Table 1 shows the average body weights on our initial and last measurement periods. At 75 days posthatch, the largest green hatchling weighed 340 g and the smallest weighed 140 g, a 157% difference. The largest hawksbill weighed 131 g and the smallest weighed 31 g, a 323% difference. As shown in Table 1, green turtles initially weighed twice as much as hawksbills at three weeks posthatch. Five months later, greens were five times heavier than hawksbills.

It is important to note that there were a significant number (10 of 36) of deaths among hawksbill hatchlings. Only two green turtles died. Those hawksbills that eventually died did not differ from survivors in body weight at two weeks of age. However, those that eventually died did weigh significantly less than survivors at 55 and 75 days of age (*e.g.*, 47.5 g vs. 36.1 g and 60.4 g vs. 40.9 g, respectively).

The carapace size of green hatchlings is only slightly greater than that of hawksbill hatchlings at two weeks posthatch. Flipper lengths of green hatchlings rival carapace lengths at this time. At six months posthatch, green turtles have tripled in carapace width and length and doubled in their flipper length. Hawksbill hatchlings exhibited more modest changes, doubling their carapace and flipper size. Comparing these species on the last measurement day, Table 2 indicates that green hatchlings had attained twice the carapace length and almost three times the carapace width of their hawksbill counterparts. Given that morphometric features of geographically distant green turtles can vary significantly (*e.g.*, Wynekan and Balazs, 1996) it would be important to replicate this work in Mexican turtles. This is one goal of our future research.

The results of one behavioral test from our inventory of tests is shown in Table 3, data for the righting reflex. Green hatchlings readily righted themselves; only one failed to exhibit the righting reflex on both trials. Five hawksbills failed to right themselves on the two trials; about half failed on 1 out of the two trials on the first test day.

The ability of turtles to right themselves has obvious survival value during the immediate posthatch period. We have previously reported that the response to being turned over then placed in water was associated with a shorter average latency to begin swimming as compared to other types of simulated predation (Bushong *et al*., 1996). We plan to evaluate this reflexive response on land and water during the frenzy and postfrenzy period since species differences in swimming activity are evident at these times (Wyneken and Salmon, 1992). We anticipate that the display of the righting reflex and other markers of biological preparedness will be valuable indices of turtle development and survivorship.

ACKNOWLEDGMENTS

We thank the staff and administration of aquarium at Xcaret for their support, particularly Martin Sanchez, Director. The continuing support of Miguel Quintana, owner and operating partner of Parque Xcaret is gratefully acknowledged. We also thank the University of Texas at Arlington for research enhancement funds and the National Science Foundation for current and past support. Many thanks, too, to Karen Twohey and Susan Sterling for the preparation of poster materials and manuscripts.

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Table 1. Mean (+ SE) body weights of green and hawksbill turtles on initial and last measurement periods.

Date	Green	Hawksbill
9/28/96	35.3 + 7.6	17.3 + 0.6
2/20/97	706.2 + 31.3	37.8 + 14.8

Note.: Body weights (in grams) were recorded initially three weeks posthatch and periodically over the last five months.

Table 2. Mean (+ SE) carapace length, carapace width and foreflipper length for green and for hawksbill turtles on initial and last measurement periods.

Date		Green	Hawksbill
9/28/96	carapace length	5.70 + 0.50	4.35 + 0.40
9/28/96	carapace width	4.61 + 0.03	3.21 + 0.03
9/28/96	flipper length	5.29 + 0.03	3.73 + 0.03
2/20/97	carapace length	17.96 + 0.23	10.08 + 0.42
2/20/97	carapace width	18.82 + 3.80	8.62 + 0.32
2/20/97	flipper length	10.19 + 0.11	6.00 + 0.18

Note: Straight line carapace lengths and widths (in cm) were recorded during initial measurements; curved lengths and widths were determined thereafter.

Table 3. Mean (+ SE) latency to display the righting reflex in green and hawksbill hatchlings

Day	Trial	Green	Hawksbill
1	1	4.64 + 1.24	19.2 + 1.90
1	2	3.21 + 0.60	12.6 + 1.90
2	1	6.84 + 1.80	11.4 + 1.68
2	2	7.60 + 1.69	9.02 + 1.65

Note: The righting reflex was examined at 3-4 weeks posthatch. The hatchlings were turned over and placed on a level surface. The latency (in seconds) to right themselves was recorded during each of two days during two trials of 30 seconds each.

DRY TORTUGAS SEA TURTLE MONITORING PROGRAM YEAR TWO: A SEASON OF GREEN TURTLE (*CHELONIA MYDAS*) NESTING ACTIVITY

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In its second year of comprehensive monitoring, the Dry Tortugas Sea Turtle Monitoring Program recorded a total of 504 turtle crawls, 392 of which (77.8%) were loggerhead (*Caretta caretta*) and 112 (22.2%) were green turtle crawls (*Chelonia mydas*). This is the most green turtle activity recorded by researchers in the Dry Tortugas, and Monroe County, Florida to date. A total of 238 nests and 266 false crawls were documented within the park, with 48 of the nests and 64 of the false crawls identified as green. The greatest activity by both loggerhead and green turtle species occurred on East Key (64.8%), an island with a beach length of 0.45 km. Loggerhead Key with a beach length of approximately 2.80 km hosted 27.8% of the total nesting activity. East Key also hosted the most green turtle activity (60.4%), with the remaining green activity occurring on Loggerhead Key.

The average loggerhead incubation was 52.6 d, with an average clutch size of 99.5 eggs. The average incubation of green nests was 51.6 d with an average clutch size of 131 eggs. Severe weather, coupled with spring high tides resulted in 67 nests being flooded with salt water, 23 of which were completely eroded away by tidal activity. The resulting hatching success of inventoried nests for the entire park, including both species, was 77.1%, with a release rate of 75.9% (n=207). The average loggerhead hatching success was 79.7%, with a release rate of 78.8%, and the average green turtle hatch rate was 73.1%, with a release rate of 70.7%. A total of 16,818 hatchlings (both species) were recorded to have entered the Gulf of Mexico.

Over 2,297 crawls including 871 nests and 1,408 false crawls have been recorded by researchers within the Park since 1982. During the last two years of daily monitoring throughout the entire nesting season, the Dry Tortugas Sea Turtle Monitoring Program has recorded a total of 1,201 turtle crawls. This includes 690 false crawls, 76 of which were identified as green, and 511 nests (52 of which were green). These nests contained an estimated 38,880 eggs that released 30,620 hatchlings into the Gulf. The data from the past two seasons suggest that the Dry Tortugas is host to one of the largest green and loggerhead turtle rookeries in South Florida.

INTERCHANGE OF NESTING LOGGERHEADS AMONG GREEK BEACHES

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INTRODUCTION

The loggerhead turtle, *Caretta caretta*, in the Mediterranean has important nesting areas in Greece (Fig. 1). These are found on the island of Zakynthos (Bay of Laganas), in Peloponnese (Bay of Kiparissia and Lakonikos Bay) and on the island of Crete (Rethimnon and Bay of Hania). All these areas are monitored by the Sea Turtle Protection Society of Greece in the context of a long-term conservation project. In the period 1982-1996, a total of 2,971 loggerheads have been tagged at these areas. Of the tagged turtles about 71% were tagged on Zakynthos which is the oldest monitored area and, by far, the most densely-nested.

METHODOLOGY

Tagging was done during the night, after oviposition of eggs. A specific beach or beach sector (usually the most turtle-frequented) at each nesting area was patrolled every night, during the nesting season, by experienced project personnel. Nesting turtles were recorded and in case they did not bear old tags, they were tagged with one or two tags.

RESULTS

In the course of this 15-year period, nine individual turtles were observed to change nesting area. One turtle changed nesting area twice (Table 1). In total, 10 cases of interchange between nesting areas were documented. Seven cases of interchange occurred in different seasons while three cases occurred during the same season.

Most changes occurred between Zakynthos and the Bay of Kiparissia. This is understandable as the distance between these two nesting areas is about 85 km. The longest interchange occurred between Kiparissia Bay and Rethimnon, the shortest route being about 365 km (Fig. 1).

DISCUSSION

It is generally known that sea turtles exhibit a strong philopatry. Why these individuals changed their traditional nesting area? Were they disturbed in such a way that they were forced to abandon their original site? As can be seen from Table 1, most turtles left one of the least developed nesting areas in Greece (*i.e.*, Kiparissia Bay) for more touristic places, namely Zakynthos and Rethimnon. It seems, therefore, rather improbable that disturbances at the nesting site can make an individual turtle change its general nesting area. Nevertheless, changes due to disturbances between adjacent or nearby beaches are known to occur (*i.e.*, among the 6 beaches in the Bay of Laganas, Zakynthos).

Another possibility could be that the individuals that changed their nesting area, were somehow lost or confused. The case of Y5833 is characteristic. This turtle after 2 seasons of nesting (1992, 1994) at Kiparissia Bay, ventured to build a nest during 1996 on the island of Crete (Rethimnon) and after eight days appeared back at its original site (Kiparissia Bay). This looks as if the animal was confused and made a nest at Rethimnon, before "finding", after a while, its traditional site. This kind of opportunistic nesting might explain the widely distributed "diffuse" nesting on Greek beaches (Margaritoulis *et al.*, 1995).

ACKNOWLEDGMENTS

I thank the STPS field leaders and assistants as well as the many hundred volunteers who spent many hours of patrolling the nesting beaches.

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Table 1. Interchange of nesting loggerheads among Greek beaches in the period 1982-1996.

Tag Number	Locality & season(s) of nesting before the (observed) interchange	Locality & season(s) of nesting after the 1st (observed) interchange	Locality & season of nesting after the 2nd observed) interchange
A1241	KIPARISSIA (1984)	ZAKYNTHOS (1986,1988)	
B2314	KIPARISSIA (1985)	ZAKYNTHOS (1987,1989,1993)	
B2352	KIPARISSIA (1985)	ZAKYNTHOS (1986)	
P4669	KIPARISSIA (1987)	ZAKYNTHOS (1995)	
N5069	ZAKYNTHOS (1988	KIPARISSIA (1988)	
E583	KIPARISSIA (1994)	HANIA (1994)	
H3213	LAKONIKOS (1989	KIPARISSIA (1992)	
Y5780	ZAKYNTHOS (1992)	KIPARISSIA (1995)	
Y5833	KIPARISSIA (1992,1994)	RETHIMNO (1996)	KIPARISSIA (1996)

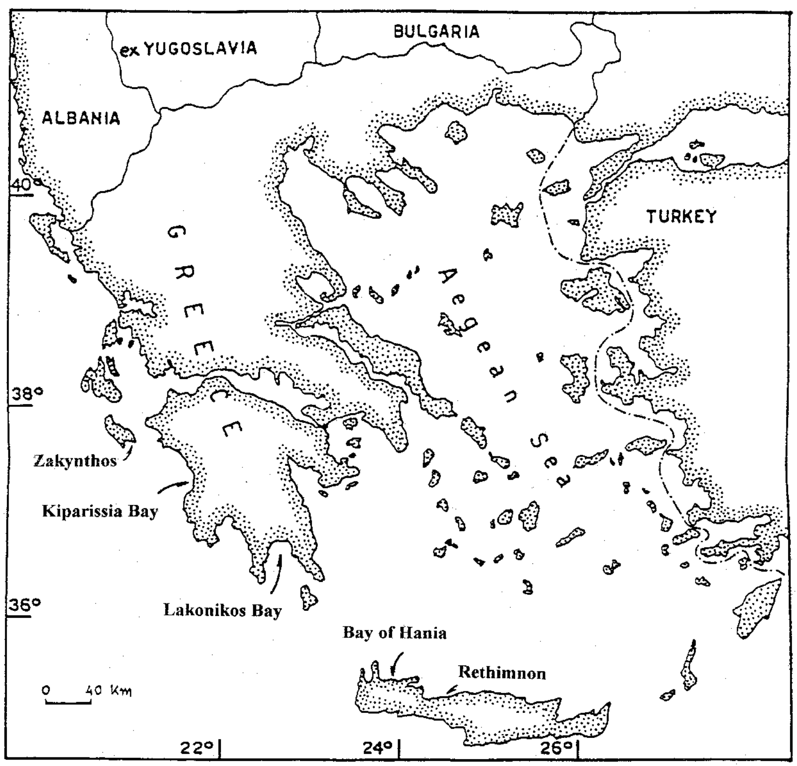

Fig. 1. Map of Greece showing the main nesting areas of the loggerhead turtle.

NESTING BIOLOGY OF THE OLIVE RIDLEY SEA TURTLE (*LEPIDOCHELYS OLIVACEA*) IN LA FLOR WILDLIFE REFUGE, RIVAS, NICARAGUA

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Biological studies regarding the nesting behavior of the olive ridley sea turtle (*Lepidochelys olivacea*) have been carried out during the last four years in La Flor Wildlife Refuge, Rivas, Nicaragua. The sea turtle population, which nest in the massive synchronous behaviors known as "arribada", has been consistently monitored, and biological studies include hatching success and nest density, and hatchling mortality due to predation (by birds). Our goal is to provide the biological background on which to base the elaboration of a unique management plan, including harvest of eggs, designed to directly benefit the local communities that surround La Flor.

The University of Central America in Managua (UCA) and the Nixtayolero Cultural Association joined efforts to carry out theater animation activities in the communities that surround La Flor Wildlife Refuge, in Rivas, Nicaragua. Popular theater is being used as a communication technique for the creation of communities, of not only an active attitude, but a critical one as well towards the policies regarding the management of the sea turtles that nest in La Flor

SEX RATIOS OF LOGGERHEAD SEA TURTLES HATCHING ON SOME MAJOR NESTING BEACHES IN JAPAN

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We estimated annual sex ratios of emerging loggerhead hatchlings at three major nesting beaches in Japan. In the estimation we used a model based on the correlation between sex ratio and sand temperature. Sand temperature and number of nests were recorded at each rookery throughout the nesting seasons from 1993 to 1995. Interesting features were found. First, the higher sand temperature was observed at the higher latitudinal beaches, hence, the ratio of female to male hatchlings was higher at the higher latitudinal beaches than the lower ones. Secondly, the ratio was estimated to vary more widley at the higher latitudinal beaches than the lower ones. In order to examine these mechanisms, irradiative sand reflectance was measured at major nesting beaches, including the three. This measurement showed that the reflectance was inversely correlated with latitude.

GRASS ROOTS CONSERVATION: AN IDEA WHOSE TIME HAS COME - SOUTH WALTON TURTLE WATCH

Sharon S. Maxwell and Tiana L. Burton

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The South Walton Turtle Watch, a volunteer non-profit organization, was formed with goal of helping to conserve sea turtles, including the loggerhead (*Caretta caretta*) and the Atlantic green (*Chelonia mydas*) that nest in South Walton, Florida, U.S.A. The poster will discuss features unique to Florida panhandle beaches, the structure and organization of the volunteer group, the monitoring methods used, and the results of two years of monitoring, which include the first ever documentation of nesting green turtles in this particular county.

LEATHERBACK TURTLE NESTING ON THE PACIFIC COAST OF COSTA RICA

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We conducted aerial and ground surveys along the Pacific coast of Costa Rica from October 1996 to February 1997 to determine the locations of leatherback turtle (*Dermochelys coriacea*) nesting beaches and to quantify the size of the Costa Rican nesting population. Aerial surveys were conducted twice during the nesting season; daily ground surveys were conducted in Las Baulas National Park (Playas Grande-Langosta-Ventanas) the largest leatherback nesting aggregation in the eastern Pacific Ocean; and bimonthly ground survey were conducted in the Santa Rosa National Park (Playa Naranjo). Important nesting locations and density estimates of the Costa Rican nesting population will be presented.

RESULTS OF THE STOMACH CONTENT ANALYSIS ON THE JUVENILE HAWKSBILL TURTLES OF BUCK ISLAND REEF NATIONAL MONUMENT, U.S.V.I.

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INTRODUCTION

Since 1988, the National Park Service (NPS) has studied the biology of nesting hawksbill sea turtles at Buck Island Reef National Monument (BUIS), St. Croix, U.S. Virgin Islands. In 1994 the research was expanded to investigate the juvenile hawksbill sea turtle population living in the waters surrounding BUIS. In addition to tagging, weighing, measuring, taking blood samples, photographing and recording diagnostics of captured turtles, gastric lavage was conducted on 25 turtles during 1996 to identify consumed food items. Eighteen of the 25 lavages yielded food specimens. Gastric lavage provides a method by which samples of an animal's diet can be retrieved with no physical harm to the animal (Forbes and Limpus, 1993). Previous studies have described the hawksbill as an omnivorous scavenger (Witzell, 1983) that specializes in sponges (Carr and Stancyk, 1975; Meylan, 1988; Diez and van Dam, 1992; Anderes Alvarez, 1994). Since 1988, the NPS has conducted coral reef monitoring and findings show that there is little to no sponge present at BUIS (Bythell *et al*.,1993). The objective of this study was to identify what the hawksbill turtles at Buck Island Reef NM were eating.

STUDY SITE

Buck Island Reef NM is an uninhabited island 2 km northeast of St. Croix. An emergent bank-barrier reef girdles the island from the southeast to the northwest, enclosing a 50-150 m wide lagoon. BUIS is a nesting site for hawksbill, green, and leatherback sea turtles. In addition, juvenile hawksbill and green turtles inhabit the surrounding waters.

METHODS AND MATERIALS

All captures were made by hand during snorkel surveys. Water depth ranged from 1 to 15 m. Two to six snorkelers would spread out in a line to maximize the area covered while keeping visual contact with one another and survey the area for hawksbill turtles. Upon sighting a turtle, the snorkeler would get the attention of at least one other team member to assist with the capture. If the snorkelers were not noticed by the turtle, one person would dive down directly over the animal and attempt capture. If the turtle was aware of the snorkelers, one person would dive in front of the animal to distract it while another person would come from behind to make the capture. If the attempt failed, the snorkelers at the surface would continue the pursuit. Once captured, the turtle was slowly brought to the surface and guided back to the boat. Gastric lavage performed on 25 turtles yielded food particles from 18. Turtles were placed carapace down with their posterior end slightly elevated. A water container was suspended at a height of 1.5 m to maintain sufficient water pressure and flexible plastic tubing was attached. The turtle's jaws were pulled open by hand and a bite block was placed in the mouth to prevent closing. The lavage tube coated with K-Y lubricant was inserted into the esophagus. Once the tube was inserted approximately 5 cm, salt water flow was started and the insertion was continued. Insertion depth was approximately to the anterior edge of the plastron. Water and food particles expelled through the mouth were collected in a bucket held beneath the turtle's head. Water flow was stopped after 1.5 min to allow the turtle to breath, then continued for another 1 to 1.5 min. The tube was slowly pulled free and the bite block removed. The turtle was turned upright and observed for about 5 min prior to release to make sure there were no complications. In the lab, samples were drained, sorted, and stored in vials containing Fisher Scientific Formalde-Fresh solution diluted with filtered sea water to 4%.

Samples were studied using a Bausch & Lomb dissecting scope and a Whatman binocular microscope. Samples were weighed using an Acculab Pocket-Pro scale Model PP-250-B. Because the scale was not sensitive enough to weigh small individual samples, identical specimens from all of the samples were added together and the total wet weight was taken.

RESULTS

This field season, a total of 257 effort hours was conducted by the NPS sea turtle research team and volunteers. Sightings were made of 103 hawksbill turtles, of which 58 were captured and 23 of those were new untagged captures for the season. Turtles captured ranged in size from 27.1 to 70.5 cm CCL N-T and one adult male was captured (79.3 cm CCL N-T). From 25 lavages, food particles were obtained from 18 turtles. Table 1 shows a rank list of the dominant phyla encountered and Table 2 is a list of all the food sources encountered in stomach content samples collected. The stomach content of 11 of 18 turtles consisted of zoanthids (*Zoanthus sociatus*) which comprised over 85% wet weight of all samples. Algae was found in 17 of 18 samples however it accounted for only 5.6% of the total wet weight.

DISCUSSION

Carr and Stancyk (1975) found sponges and tunicates to be the dominant food item in the hawksbill's diet. Studies in Panama, the Dominican Republic, and the Lesser Antilles by Anne Meylan (1988) showed hawksbill turtles greater than 25 cm CCL feed almost exclusively on sponges. Juvenile hawksbills at Mona Island, Puerto Rico, and Cuba also showed sponges as the primary food source (Diez and van Dam 1992; Anderes Alverez 1994, respectively). The results of this study at Buck Island Reef NM are in contrast to the results published so far. The juvenile hawksbill turtles of Buck Island feed mainly on zoanthids. We believe the great variety of algae present in the samples is due to incidental consumption when foraging for zoanthids. To test this, we collected of a zoanthid sample from BUIS, and found 9 of the 14 algae species in the sample. However, we observed one juvenile hawksbill turtle (44.5 cm CCL N-T) feeding on algae. Close examination of that foraging site, revealed three red (*Martensia pavonia*, *Gelidiella* sp., *Jania* sp.) and one green algae (*Halimeda* sp.). Diez's study in the Dominican Republic has also found zoanthids to be the dominant food item of juvenile hawksbills (V. Vincente, pers. comm.). A possible explanation for this previously unrecorded behavior is that hawksbills forage is habitat dependent. That is, they eat the food source most available. Further investigations are necessary to understand the feeding behavior of this juvenile hawksbill population. In future we hope to increase the sample size as well as conduct behavioral studies using radio tags and time-depth recorders.

ACKNOWLEDGMENTS

Funding for this project was provided by the National Park Service, Natural Resource Preservation Program (NRP), and National Biological Service (NBS), Virgin Islands National Park, Biosphere Reserve Center, Inventory and Monitoring Program.

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Table 1: Rank list of the dominant phyla encountered.

Organism	# in which found	Percent	Total Wet Weight (g)	% Wet Weight	Rank
Zoanthids	11	61.1	43.1	85.7	1
Red Algae	16	88.9	1.9	3.8	2
Green Algae	10	55.6	0.8	1.6	3
Corallimorphs	3	16.7	2.5	4.9	4
Soft Coral	3	16.7	1.7	3.4	5
Brown Algae	12	66.7	0.1	0.2	6
Sponges	5	27.8	0.2	0.4	7

Table 2. List of food sources encountered in 18 hawksbill stomach content samples collected at Buck Island Reef NM.

Clorophyta (green algae)
- *Dictyosphaeria cavernosa*
- *Codium* sp.
- *Halimeda opuntia*
- *Bryopsis* sp.

Rhodophyta (red algae)
- *Laurencia* sp.
- *Polysiphonia* sp.
- *Herposiphonia* sp.
- *Heterosiphonia sp.*
- *Martensia pavonia*
- *Spermothamnion* sp.
- *Ceramium* sp.
- *Gelidiella* sp.

Amphiroa sp.
- *Jania* sp.
- *Kallymenia* sp.
- *Botryocladia* sp.

Phaeophyta (brown algae)
- *Dictyota* sp.
- *Dictyopteris* sp.
- *Giffordia* sp.

Chrysophyta (diatoms)

Cyanophyta (blue-green algae)

Cnidaria
- *Zoanthus sociatus* (zoanthid)
- *Ricordea florida* (corallimorph)
- *Scleractinia* (stony coral)

Arthropoda
- *Cirripedia* (barnacles)

Mollusca

Fissurellidae (limpets)
Porifera (sponge)
Tethia sp.
Protista
Homotrema rubrum (foraminifera)

THE USE OF ELECTRONIC DATA STORAGE TAGS IN STUDIES OF MARINE ANIMAL BEHAVIOR

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Obtaining information about the large scale movements and migrations of free ranging animals in the open sea is one of the major problems confronting scientists concerned with conservation, or rational exploitation, of marine animals. Once released, the animal often disappears from view for prolonged periods and cannot easily be followed.

The advent of various forms of radio telemetry (*e.g.*, the ARGOS system) has improved the ability to track those animals that come to the surface frequently enough, and for long enough, to make radio contact with orbiting satellites. However the power required to communicate with a satellite often means that such devices can be too large for deployment on smaller species of animal. Furthermore, radiotelemetry is inappropriate for those marine animals, such as fish, that rarely come close to the sea surface.

One solution appropriate for animals that return to regular nesting or foraging sites, or for animals that are caught commercially in large numbers, is the use of data storage (archival) tags. These devices record environmental data and store the information in memory for many months, or even years. When the animal is caught, either by commercial fishing, or on return to a nesting site, the devices can be retrieved and the data recovered.

This paper will describe the development at the Lowestoft Laboratory of a family of data storage tags, and their use in studies of the movements of fish in their natural environment. The results show how recording simple, but appropriate, environmental variables such as pressure and temperature, can be used to estimate geographical movements. The paper will describe recent improvements in microelectronics that have allowed our electronic engineers to incorporate additional environmental sensors, and increase available memory considerably, whilst reducing both the size and production costs of the tags. Consideration will be given to current developments (*e.g.*, "pop-up" technology) which could eliminate the need for physical recovery of the tag and, finally, to applications of data storage tag technology relevant to turtle biology.

MARINE TURTLE NESTING AND MANAGEMENT IN FLORIDA'S STATE PARKS

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The Florida State Park system is one of the largest in the U.S.A., comprising nearly 150 parcels and 200,000 ha. This includes 34 parks with 164 kilometers of nesting beach fronting both the Atlantic Ocean and the Gulf of Mexico. In addition, ten parks are part of the Florida Index Nesting Beach Survey program. Annually, these 34 parks account for approximately 6% of the total nesting and 9% of the green turtle (*Chelonia mydas*) nesting recorded statewide.
Management actions include nesting surveys, nest success evaluations, predator removal, screening and caging of nests, controlled public access, and elimination or reduction of lighting disturbances.

UNSCRAMBLING EGGS, REVISITED: USE OF RESTRICTION FRAGMENT LENGTH POLYMORPHISMS TO IDENTIFY SEA TURTLE EGGS TO SPECIES

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One of the many threats to sea turtle populations is the continued take of turtle eggs for consumption or for sale. Prosecution of alleged poachers often requires knowledge of the species of seized eggs. Current methods using fatty acid profiles have not been able to resolve differences between eggs of loggerheads and the two ridley species. In this study, total DNA was extracted from turtle egg albumen by a modified proteinase K extraction method. An approximately 800 bp portion of the mitochondrial DNA was amplified by polymerase chain reaction, and the amplified fragment was digested with each of the restriction enzymes, Msp I and Alu I. The resulting restriction fragment length polymorphism patterns are not only species-specific, but can also be used to tell Atlantic and Pacific green turtles from one another.

THE USE OF WIRE CAGES TO PROTECT SEA TURTLE NESTS: ARE THERE BETTER ALTERNATIVES?

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The city of Boca Raton, Florida (U.S.A.) is located adjacent to 8.05 km of beach, almost half of which is backed by four public parks. The parks attract about 22,500 visitors/month. The beach is also an attractive nesting site for sea turtles. Loggerheads (*Caretta caretta*) deposit between 700 - 1100 nests on the beach each summer. Nest security was thought to be compromised by both human visitors as well as the presence of raccoons, red foxes, and spotted skunks in the public parks. These mammalian predators receive supplements to their natural diets with picnic waste, but during turtle nesting season patrol the beach and attack nests. Since 1988, the City has used square wire cages to protect the nests from both people and predators. We completed a study to determine whether cages were necessary to protect nests from visitors and predators, and how effectively they provided this protection.

Visitor counts were performed to monitor zones of high and low usage. Pairs of caged and uncaged nests were picked in four zones (two high traffic and two low traffic areas). Nests were excavated three days after emergence and nest fate comparisons were made. Data revealed no significant differences between the nest fates of caged and uncaged nests in any of the four traffic zones. We conclude that caging nests is not necessary to protect nests from visitors.

Data collected during the 1994 and 1995 nesting seasons were used to establish high and low predator attack zones. Pairs of caged and uncaged nests in four zones (two high attack and two low attack areas) were monitored on a daily basis. Data revealed that caged nests were attacked significantly more than uncaged nests, and that raccoons were the primary culprit. On average, hatchling production from attacked nests was decreased by nearly 30%.

Decoy cages (identical to those used to protect nests, but not covering a clutch of eggs) were placed in the beach in the high and low attack areas. These cages also attracted predators, demonstrating that cages were used by raccoons to locate eggs.

On the basis of these results, we suggest an alternative management plan, to be implemented over the next 5-7 years. Key elements of the plan are: (1) raccoon control by reducing picnic waste, and by trapping and castration of male raccoons; (2) use of cages only at beach sites where predation remains a problem; and (3) the eventual cessation of cage use after predator populations no longer represent a threat to nests.

SEA TURTLE NEST MONITORING AND HURRICANE IMPACTS WITHIN GULF ISLANDS NATIONAL SEASHORE'S FLORIDA DISTRICT

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This is a summary of the National Park Service's efforts to document sea turtle nesting activity in Northwest Florida from 1994-1996. While this program has been ongoing for several years, it was not until 1994 that a daily documentation of sea turtle nesting activity occurred. Each year the accuracy and efficiency of the patrols has increased, but is still problematic due to a shortage of full time staff.

The monitoring program relies on volunteers to do the majority of beach patrolling, with a typical year involving 20 or more volunteers patrolling over 35 km of beach. During this three year period 120 nests were documented, 104 being loggerhead (*Caretta caretta*), 7 were green (*Chelonia mydas*) and 9 were listed as unknown (Fig. 1). Nesting typically occurs from mid-May until mid-August, with June-July being the most active period. Incubation times range from around 60-80days, with 73 days being the average . Hatching success can vary greatly, depending on factors such as predation, nest site location, tropical weather and above normal tides. Several nests were lost in 1995 from Tropical Storm Dean and Hurricanes Allison, Erin and Opal. Some nests were left vulnerable from morphological changes to the beach brought on by Hurricane Opal. As a result, several nests were inundated by water in 1996. Others were relocated to higher ground within 12 hours of being laid. Hatching success rates for these relocated nests averaged 83%. There was also an unusually high number of false crawls on these hurricane impacted beaches, up 287% from previous years (Fig. 2). Nests are also impacted by predators, with the number one predator being the exotic red fox (*Vulpes vulpes*). Fox depredated 30% of the nests in 1994, 57% in 1995 and 13% in 1996.

When a nest successfully hatches, a large portion of the hatchlings are typically disoriented due to direct and indirect lighting sources from developed areas, such as the City of Pensacola, Pensacola Naval Air Station, Pensacola Beach and Perdido Key. Efforts are directed towards nest sitting at hatch time, but this is unpredictable and very time consuming. In 1996, an increase in efforts to prevent disorientation met with mixed results. There were 13 nest hatches observed by park staff and volunteers, witnessing 1215 hatchlings entering the Gulf of Mexico. Other hatches were missed by just hours or by as much as a night. Without this effort, disorientation would have been allowed to continue on several nests, with high levels of hatchling mortality almost certainly being the end result. This problem will most likely continue as dune regeneration is a slow process and urban development in the area around Gulf Islands National Seashore's Florida District shows no signs of abating.

Figure 1

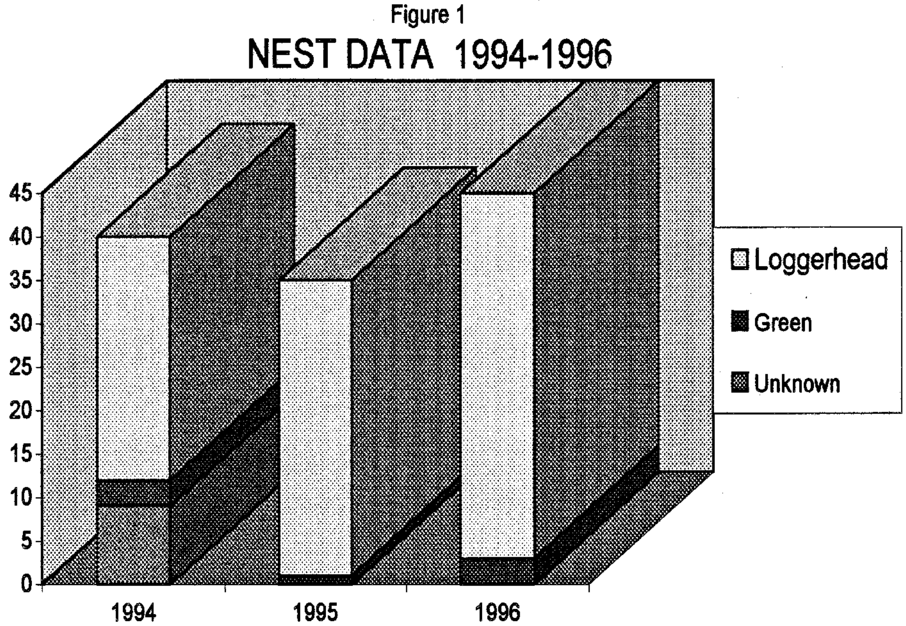
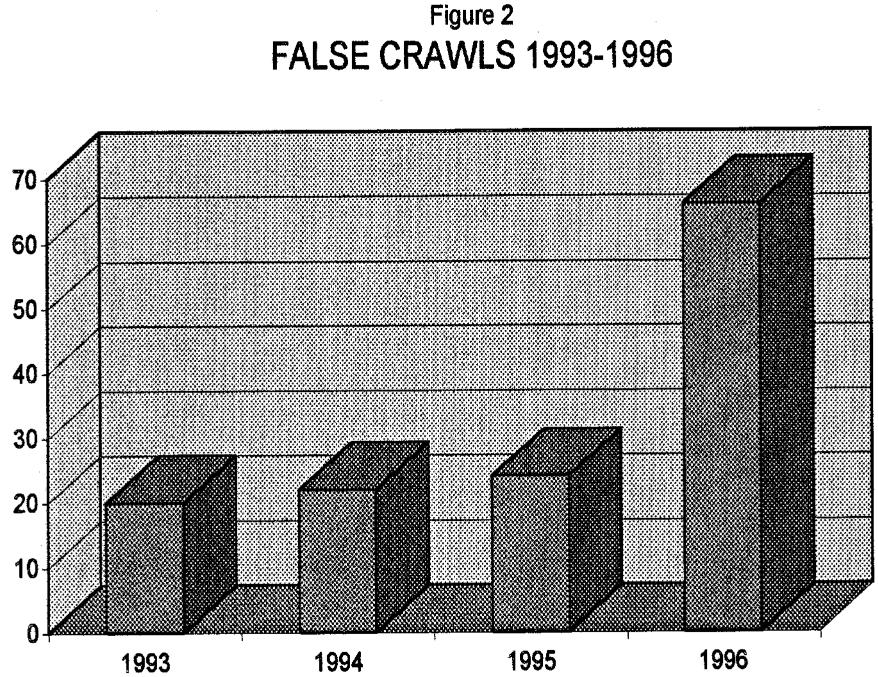


Figure 2



SEA TURTLES, SCIENCE, AND SURFING: RIDING THE INTERNET FROM THE CLASSROOM TO THE FIELD

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ABSTRACT

The Internet can provide a powerful means for biologists to share and communicate their findings with teachers and students. Teachers find that when students have access to "real" data, the students' learning experience is enriched. In this collaborative effort we have made satellite tracking data from a loggerhead turtle available on the Internet and have encouraged teachers to incorporate it into their curriculum. The project has been used across curricula to teach geography, math, biology, and art in several schools around the country. The educational potential for such student-scientist collaboration is without limits.

INTRODUCTION

On the 10th of August 1996 a loggerhead turtle, "Adelita", was equipped with a Telonics ST-3 satellite transmitter and released into the Pacific Ocean off of Baja California. Since that day, her position data have been made available to students and teachers via the Internet. The homepage of the Coastal Conservation Foundation has posted and updated her position weekly along with regular comments on her behavior. A link to the Turtle Trax homepage provides a map depicting her track across the Pacific Ocean. Hundreds of teachers and tens of thousands of school children have joined the project via the Internet. Many teachers have developed creative approaches to integrating this turtle into their curricula.

BIOLOGICAL CONTEXT IN BRIEF

The presence of juvenile loggerhead turtles along the coast of Baja California has long been an enigma: the closest known nesting beach for loggerheads is over 6,000 miles away in Japan. Recently biologists discovered that Baja California's turtles are genetically similar to those from Japan and Australia, thus supporting the theory of a trans-Pacific migration (Bowen *et al*., 1995). Only two flipper tag returns are known that support this theory, one from a turtle released in Japan and found in California (Uchida and Teruya, 1991) and another from a turtle released in Baja California and found in Japan (Resendiz *et al*., in press). In an attempt to shed some light on the trans-Pacific migration of loggerhead turtles we satellite tagged "Adelita". Since her release, "Adelita" has traveled more than 3,000 miles and recently crossed the International Date Line. The full results of this satellite telemetry project will be presented at next year's symposium.

TEACHING APPLICATIONS

By tracking this turtle, students not only learn about sea turtles but about marine conservation, oceanography, charting techniques, data analysis, algebra and a variety of other topics. This collaboration exposes students to the entire scientific process: asking questions, gathering information, developing hypotheses, analyzing data, and learning about uncertainty. Several schools have begun an interdisciplinary study of sea turtles which involves their science, art, geography, language arts, and math classes. This has resulted in a more complete appreciation of the marine environment. Other teachers are using this data to create semester-long Solution-Based Learning projects. Students from all over the planet interact with biologists and each other through e-mail, answering questions and sharing information. The results have been that uninvolved students have become motivated, students are excited about learning, many students stay after school to learn more about biology, and a positive, pro-nature virtual community has been created.

THE FUTURE?

We have plans to increase the number of turtles being tracked by our research program. As that occurs, those turtles' tracks will also be posted on the Internet. Sycamore Junior High School and several other schools have been raising funds to sponsor one of those tags. It is our hope that other scientists will open their projects to teachers for the betterment of education, to help our children explore nature, and in the long run to help conserve sea turtles and their environment.

ACKNOWLEDGMENTS

We would like to thank Antonio and Bety Resendiz for their Herculean efforts to protect the turtles of Baja California, Richard Byles and the USFWS for providing the satellite tag, Bob Snodgrass, Martin Arce, and Dana Lowry for logistical support prior to and during the release, Bill Savary for his technical support, Turtle Trax for mapping "Adelita"'s progress, and the teachers and students who have made this project lots of fun.

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INTERNET SEA TURTLE TRACKING SITES

Turtle Trax <http://www.turtles.org>
Caribbean Conservation Corporation <http://www.cccturtle.org>

APPARENT SEA TURTLE MORTALITY DUE TO FLIPPER TAGS

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ABSTRACT

Plastic flipper tags used to identify black turtles in the central Gulf of California apparently contribute to incidental capture of the tagged turtles in gill nets. This assertion is based on field observations, interviews with local fishermen, and a study on captive tagged and untagged turtles. We recommend discontinuing the use of plastic tags on sea turtles in favor of the closed-loop metal alloy tags or other non-invasive identification techniques.

INTRODUCTION

A variety of methods have been used to mark and/or tag turtles in order to learn about their movement, nesting behavior, population size, growth rates, and age-specific mortality. The most common method of sea turtle identification is flipper tagging. The preferred tags are usually made of metal alloy, however several projects have chosen to use plastic roto-tags due to their superior retention. Many authors have discussed tag retention as a criterion for tag choice (Balazs, 1982; Henwood, 1986; Limpus, 1992; Alvarado *et al*., 1993), however few studies have considered the effect of tagging on incidental capture in marine fisheries.

OBSERVATIONS

In July of 1996, we observed two tagged black turtles at the surface, entangled in monofilament gill nets of 5 cm mesh size. Both of the turtles were especially tangled around the dorsal and ventral portions of the two-part plastic tags. Both of the turtles were tagged on their left and right foreflippers. The turtles were removed from the net, measured and released. The fisherman who owned the nets was contacted and interviewed. The direct observation of these turtles tangled by their tags and the discussion with the fisherman led us to investigate the possibility of tag mediated bycatch of sea turtles in the area.

METHODS

To determine the likelihood that the plastic tags facilitated capture in gill net, we conducted preliminary trials in the sea turtle holding tanks at the Sea Turtle Research Station in Bahia de Los Angeles, Baja California. A four meter segment of gill net was suspended across the middle of the tank. The net used was of the same mesh size (6 inch stretched) and material (monofilament) as those used by fishermen in the bay. The net was equipped with proper float lines (top) and lead lines (bottom) to ensure that it hung in the water in a manner similar to the larger nets used by local fishermen. In a series of 30 minute trials, six tagged and five untagged turtles were introduced to the tank individually. Interactions with the net were recorded and note was taken of number and location of tags on each turtle.

RESULTS

Throughout the trials, captive turtles were extremely adept at swimming backwards in order to remove themselves from nets. Usually, this reverse motion is performed in combination with extension of their foreflippers anteriorly as they reverse. Most entanglements occurred during this movement. It is likely that in the wild a similar reverse motion is performed. It appeared that once the net was wrapped once around the disk or message portion of the tag, the turtle would either have to pull the tag out, drown, or be captured by a fisherman. Of the six tagged turtles, three became permanently tangled in the net. In each case this was due to the presence of the flipper tag. Of the five untagged turtles, none became permanently tangled in the net. Further investigations are being conducted using inconel tags.

DISCUSSION

Based on the results of our brief study, personal observations, and interviews it seems that the two part plastic flipper tag, with its projecting leading edge (top half and bottom half), may make turtles more available to entanglement in a net if they should come into contact with one. Fishermen interview consider a turtle with a plastic flipper tag vulnerable to any net, even those with small mesh sizes. The central Gulf of California is an area where gill nets are particularly abundant. We recommend that further studies be pursued to investigate the effect of tagging on sea turtle bycatch. We also recommend that an alternative to plastic roto-tags be considered by those currently using this style of flipper tag. Standard inconel, titanium, or monel tags all result in a closed, oval loop after application. If the tang (point) of the tag is sealed (bent over) fully as it should be, there is nothing to the tag that can materially contribute to entanglement in a net. While tagging studies can provide invaluable information about a sea turtle population, it is understandable that tagging sea turtles may continue simply as a matter of historical inertia. It is critically important that widespread tagging efforts do not contribute to turtle mortality. It is additionally important to know how tagging methods may have affected the behavior and survivorship of individual animals in studies that model population dynamics and estimate abundance. Tag-less studies utilizing photo identification (McDonald *et al*., 1996) as well as the mapping of permanent, natural abnormalities such as scars and carapace notches combined with PIT tagging (McDonald and Dutton, 1996) should be considered as viable alternatives.

ACKNOWLEDGMENTS

We would like to thank Bety Resendiz, SEMARNAP, INE, Earthwatch, and all of the fishermen of Bahia de Los Angeles for their patient support of our research and conservation efforts.

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PRELIMINARY RESULTS OF TESTS WITH HARD TEDS IN CAMPECHE MÈXICO

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A total of 8 cruises were made between 10 May and 17 November 1996: 6 on commercial shrimp trawlers with quad-rigs, and 2 on a scientific research vessel. Experimental trials were run comparing nets without TEDs to nets with Morrison, Georgia Jumper and Super Shooter TEDs. The results indicate that there is no significant loss of shrimp with any of these TEDs, but that the bycatch is excluded most effectively by the Morrison and least effectively by the Super Shooter. The use of an accelerator cylinder in conjunction with the Super Shooter results in the capture of extraordinarily large amounts of fish fry and juveniles, in addition to the capture of fishes so large that they would normally be excluded by the bar spacing. There were also difficulties with the two hard TEDs filling with mud, weighting down the cod-end and causing problems.

A LIGHTING PLAN FOR A BEACHFRONT DEVELOPMENT

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A lighting plan for a beachfront development in panhandle Florida, was prepared to reduce adverse effects of lighting on nesting and hatchling sea turtles. Since 1991, when monitoring activities began here, 11 loggerhead nests have been identified in the vicinity of the development. Hatchlings form these nests experienced near 100 percent disorientation. The lighting from this development caused the disorientation incidents, because it is the only significant source of beachfront lighting in the area. The lighting plan is divided into two phases. The near-term plan, would reduce light spillover and the far-term plan would eliminate all inappropriate beachfront lighting.

LEATHERBACK TURTLE (*DERMOCHELYS CORIACIA*) NESTING IN GEORGIA

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Three *Dermochelys* nests and five crawls were documented in Georgia, and an additional nest was documented in South Carolina during summer 1996. This is the second summer on record with documented *Dermochelys* nests in Georgia. The first recorded nestings in Georgia were in 1981. Nests 2 and 3 had clutch sizes of 79, and 103 yolked eggs, with 15, and 12 yolkless eggs respectively. Hatching success was 43% for nest 2 and 73.8% for nest 3 producing 110 hatchlings. A limited amount of information on egg numbers was available for nest 1. A total of 131 hatchlings were produced from the three nests. An aborted nesting attempt from 1996 was less than 600m north of a 1981 nest. Mitochondrial DNA analysis has determined samples from all three nests to be common haplotype A.

INTRODUCTION

Georgia has little or no coast with typical *Dermochelys* nesting beach characteristics such as nearby deep water access (Boulon *et al.*, 1996). The first two nests ever recorded in Georgia were on Cumberland Is. and Blackbeard Is. in 1981 (Ruckdeschel *et al.*, 1982).

METHODS

Dermochelys crawls were detected and monitored by morning beach patrols. Upon hatchling emergence, remaining eggs and fragments were counted and sorted. Tissue samples from dead hatchlings were taken for mtDNA analysis.

RESULTS

The first *Dermochelys* nest in 1996 was detected on 25 April on Sea Is. The body pit was too large to successfully locate a nest cavity, but the amount of time spent between exit and entry crawls, as indicated by tide wash, suggested a nest was probably laid. The crawl was photodocumented. Twelve days later, on 7 May, reports of a *Dermochelys* crawl on St. Simons Is. were confirmed. However, the St. Simons beach is very populated, and the area where the crawl terminated had been cluttered by morning foot traffic. Attempts to find an egg chamber were unsuccessful. On 14 May another crawl was marked on Sea Is., followed by a crawl on Sapelo Is. on or about 24 May. During the night of 13 June a female *Dermochelys* was found during an aborted nesting attempt on Blackbeard Is. The turtle was trapped under an arching limb in the sand and was released (Deb Barnard, pers. com.). More than a month later, on 17 June, South Carolina reported a *Dermochelys* nest (Sally Murphy, pers. com.).

The first nest to emerge was on Sea Is. on 22 July, after an incubation period of 88 days. Of the 92 eggs counted, 21 hatched. There were 71 non-viable eggs from this nest, however, yolked egg number was not counted so an accurate measure of hatching success is not available. Two dead hatchlings were collected. Closely following the hatching of the first nest was the emergence of the second Sea Is. nest on 25 July. The emergence prompted infiltration of the nest cavity by a number of ghost crabs (*Ocypode* sp.) so the remaining eggs and hatchlings were removed and counted. Ninety-four eggs were deposited, 15 were yolkless. Hatching success was 43% after an incubation period of 73 days. Six dead hatchlings were in the nest area. The nest on Sapelo Is. emerged on 6 August. Inspection of the nest cavity revealed 115 total eggs, of which 12 were yolkless. Hatch success was 73.8 % following an approximately 74 day incubation period. One dead hatchling was found in the egg chamber, along with 4 live hatchlings that were released that night. The crawl area on St. Simons Is. was monitored closely as the expected emergence date approached. No sign of a depression or hatchling emergence was ever detected.

Mitochondrial DNA analysis has been initiated with samples of dead hatchlings from each of the 1996 nests. Haplotype A, which predominates in the western Atlantic nesting populations, was found in all three samples (Peter Dutton, pers. com.).

DISCUSSION

The 1996 *Dermochelys* nestings came 15 years after the only other recorded event of its kind in the state. Immediately there was speculation that the nests of 1996 were being deposited by progeny of the 1981 nests. Unfortunately, specimens from the Blackbeard nest of 1981 have been preserved in formalin rendering them useless for determining relationships between the two nesting years (Peter Dutton, pers. com.). However, determining if all nests from 1996 were deposited by the same female may be possible following microsatellite analysis (Peter Dutton, pers. com.).

The temporal spacing between crawls and nesting events on the Georgia coast in 1996 leaves some question as to the number of *Dermochelys* depositing nests. Internesting periods in Costa Rica of 9.4 and 9.3 days were calculated for 93-94 and 94-95 seasons, respectively (Steyermark *et al.*, 1996). Boulon *et al.* (1996) reported a 9.6 day internesting period for St. Croix *Dermochelys*, while Girondot and Fretey (1996) noted intervals ranging from 6-15 days. Considering the St. Simons Is. crawl to be a dry run produces a 17 day internesting period. However, if there was indeed a nest on St. Simons that was inundated by extreme high tides (Hurricane Bertha) and never hatched, the internesting period would be 12.75 days, a much more reasonable calculation given the known parameters on popular *Dermochelys* nesting beaches. Nests may have also been undetected (there are some small beaches inaccessible to daily patrols).

It is interesting to note the locations of both *Dermochelys* encounters on Blackbeard Is. The false crawl from 1996 was approximately 586m north of the nest site from 1981. Could this have been the same female returning after a 15 year absence? The nesting *Dermochelys* from 1981 measured 163cm CCL (Ruchdeschel *et al.*, 1982), while the animal encountered during the false crawl in 1996 was estimated to be 153cm CCL (Deb Barnard, pers. com.).

ACKNOWLEDGMENTS

Special appreciation goes to Barb Zoodsma and Carolyn Belcher for their support and insight, and to Dr. Peter Dutton for his advice and genetic work. Thanks are extended to members of the DNR's Nongame program, Sally Murphy, Deb Barnard, John Robinette, Michael Krough, Carol Ruckdeschel, and Bob Schoop.

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LEATHERBACK TURTLE (*Dermochelys coriacia*) STRANDINGS IN GEORGIA: 1982-1996

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A total of 110 leatherback sea turtles (*Dermochelys coriacia*) have been documented along the Georgia coast since the inception of Georgia's Sea Turtle Stranding and Salvage Network (STSSN). Peak stranding periods have occurred from March-June (84.5%), and again from October-December (14.5%). Spring migration periods (March-June) in 1987 and 1991 accounted for 51.8% of historical *Dermochelys* strandings. Mean curved carapace length was 151.4cm. Propeller strikes, commercial fishery interaction, and rope entanglement have been suggested causes of death. Two stranded *Dermochelys* carried tags applied on French Guiana nesting beaches, adding to the number of tag recoveries from this country along the southeastern U.S. coast. Stomach contents from two recent 1996 *Dermochelys* revealed ingestion of *Stomolophus* meleagris just prior to death.

INTRODUCTION AND BACKGROUND

Dermochelys migrations through southeastern United States waters have been documented for some time (Lazell, 1980). Aerial surveys off the southeastern U.S. coast have revealed aggregations of *Dermochelys* moving northward from Florida typically in March, entering Georgia waters (Bill Brooks, pers. com.). These concentrations pass into South Carolina during the middle of June (GA-DNR unpub. data). During most of spring, when *Dermochelys* are found in waters off Georgia, state waters (out to 7.6km) are closed to commercial shrimping. However, shrimping is allowed in Federal waters outside of the state boundary. *Dermochelys* are present in and adjacent to state waters again in October through December, a period accounting for 14.5% of total strandings. Commercial shrimping vessels are usually operating during this time in state and Federal waters.

There were no documented *Dermochelys* strandings in the state before 1982. However, from 1982-1996 there were 110 strandings, with substantially elevated levels in 1987 and 1991. Seventeen *Dermochelys* strandings in May 1987, and 13 strandings during a four day period in 1991 on Sapelo Is., presented resource managers with strong evidence that these animals were at times, in need of protection from commercial fisheries while passing through state and adjacent waters. Effective 16 October 1995, the National Marine Fisheries Service (NMFS) finalized a rule stating aerial surveys were to be conducted for *Dermochelys* during the period that peak concentrations were moving through state waters. Consecutive day surveys observing 10 or more *Dermochelys* within a 50 nautical mile trackline would result in closure of shrimping activities in the area for 2 weeks (Final Rule, Fed. Reg. 14 Sept. 1995).

FINDINGS

Two stranded *Dermochelys* had been tagged during nesting events in French Guiana. The first, a 171cm female stranded on 17 February 1989, 9 months after its last observed nesting on 14 May 1988. This female's ovaries contained small follicles (~1mm in size) and one shell fragment ~2cm in diameter (Scott Eckert, necropsy report 1989). The second tagged *Dermochelys* stranded on 12 April 1992. This 164cm female died 10 months after its last nesting date in French Guiana on 27 May 1991 (Girondot, 1996). In November 1996 a 164cm female that stranded on Wolf Is. contained hundreds of egg follicles measuring approximately 3cm in diameter, indicating she may have been ready to nest in 1997 or 1998 (David Owens, pers. com.).

Investigation of gastrointestinal contents of one female (the Feb. 1989 tagged animal) revealed 2 *Scyphozoa* sp. and 6 small *Libinia* sp. (Scott Eckert, necropsy report 1989). The above mentioned 1996 female had abundant *Stomolophus meleagris* present in her gastrointestinal tract indicating she had recently been feeding. *S. meleagris* were also found in the gastrointestinal contents of a male stranding measuring 149cm on 3 December 1996.

Concurrently, Department of Natural Resources bycatch assessment observers aboard commercial fishing trawlers reported large numbers of *S. meleagris* being caught. Numerous spider crabs, *Libinia dubia* (a species commensal with *S. meleagris*), and a 15cm long piece of wood were also found upon necropsy (Austin Williams, pers. com.). In April 1991, necropsy of a 170cm female revealed an esophagus containing shrimp and fish, not common diet items (Ernst *et al.*, 1994).

One tagged *Dermochelys* that stranded in 1989 exhibited propeller wounds that were either the cause of death or occurred shortly after death (the turtle was in fresh condition upon stranding). One 1992 stranding was also probably the result of a boat strike, or was struck soon after death. An unknown percent of *Dermochelys* strandings likely were the result of incidental entanglement in commercial fishery gear, in addition to strandings whose cause of death was most likely boat strike. In October 1990 a 152cm male *Dermochelys* was recovered alive by the U.S. Coast Guard in the St. Simons shipping channel. It died soon after it was brought to shore. Inspection of the animal found fresh, bleeding wounds where catfish spines were penetrating the soft skin of the neck, and flippers, and also the carapace.

SUMMARY

- There are no records of *Dermochelys* strandings in Georgia previous to 1982.
- From 1982 through 1986 there were occasional strandings, but a substantial spike in stranding levels occurred in 1987.
- Evidently there are multiple factors involved with spring migrations and the subsequent strandings:
    - Shrimp landings in 1989 were actually greater than in the high stranding year of 1987, yet 18 fewer *Dermochely*s stranded. Four *Dermochelys* stranded in 1995 when shrimp landings for the spring were at an all time high. Shrimp landings are the only available source of data to indicate shrimping effort previous to 1996.
    - Spring sea surface temperatures during the elevated stranding period in 1991 were substantially higher than the previous years, and shrimp landings were three times the mean for the previous 9 years.
- There is a tremendous amount of information with conservation and management implications that can be learned from stranded and migrating *Dermochelys* in the waters off the Georgia coast.

ACKNOWLEDGMENTS

Special appreciation goes to Barb Zoodsma and Carolyn Belcher for their support and insight, and to Dr. Peter Dutton for his genetic work and advice. Thanks are extended to all members of the DNR's Nongame Program, STSSN associates, Austin Williams for identification of crab species, Alex Ottley for providing *S. meleagris* specimens, and David Owens.

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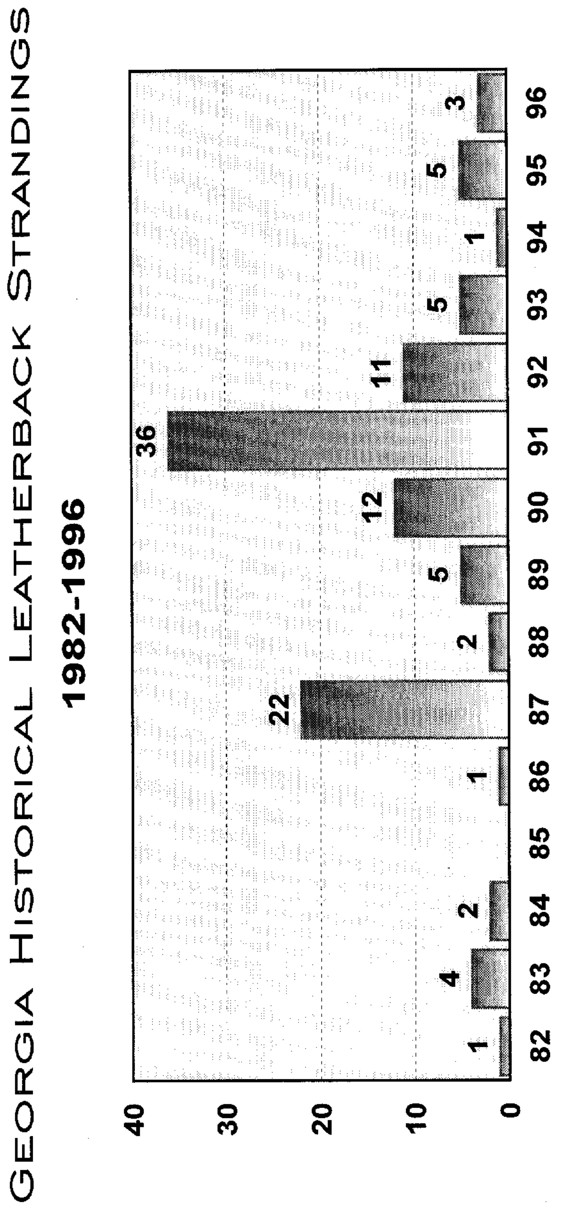
GEORGIA HISTORICAL LEATHERBACK STRANDINGS
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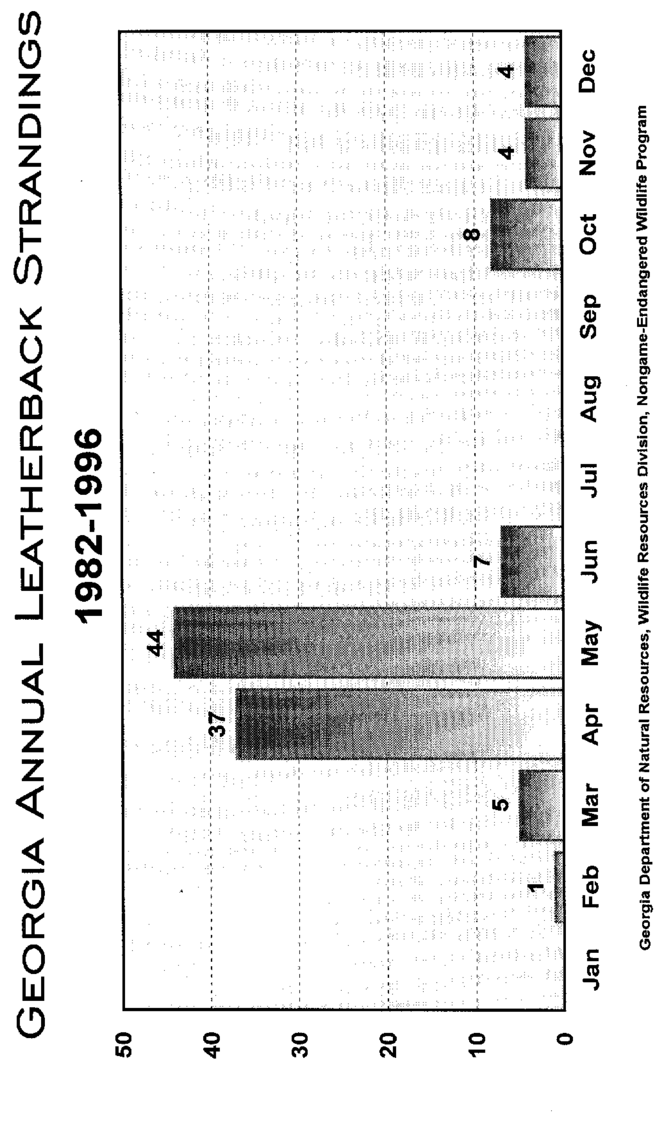
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Georgia Department of Natural Resources, Wildlife Resources Division, Nongame-Endangered Wildlife Program

MALAYSIA'S TURTLE ISLANDS PARK: NESTING TRENDS AND THEIR IMPLICATIONS FOR MANAGEMENT

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Possibly less well-known than the leatherback nesting beaches in Trengganu, a small Park in Sabah, off the coast of East Malaysia in Borneo supports a large population of Green turtles and a moderate number of Hawksbills. Nesting trends over the past decade indicate a slight increase in numbers although marking efforts and tag-loss rates are unknown rendering the trend questionable. What is fact is that more than one thousand different turtles are tagged each year, suggesting either an extremely large population base, or a large tag-loss rate. Although little evidence points to tag-loss, current practices such as the use of only one tag and positioning on the front flipper suggest this may be a significant factor.

The Malaysian nesting beaches are protected through research and monitoring efforts undertaken by Sabah Parks, who tag nesting females and collect basic morphometric data while transferring all eggs to a hatchery to avoid all forms of predation. These efforts have been underway since 1966, during which more than six million hatchlings have been released.

The turtles have now been awarded even further protection through the establishment of the world's first trans-boundary marine park, in the establishment of the Turtle Islands Heritage Protected Area, straddling the Malaysian/Philippine border. On the 31st of May 1996, this protectorate came into effect with the signing of an agreement between the two counties' Foreign Ministers. As such, the three islands that constituted Sabah's Turtle Islands Park and six islands in Philippine waters are now protected, as are the waters and coral reefs that lie within the outer perimeter of the whole group of islands.

In the development of a comprehensive management scheme for the TIHPA, the fate of adult turtles will be investigated as deleterious effects such as trawling and human consumption are common in the region. A worrying trend that has recently come to light is the lack of large numbers of returns from previous years, suggesting dramatic rate of 'removal' from the nesting population.

MULTIANNUAL SAND TEMPERATURES COLLECTED AT CAPE CANAVERAL, FLORIDA AND RELATIONSHIPS TO CENTRAL FLORIDA SEA TURTLE SEX RATIOS

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Sand temperature data were collected at middle nest depth for *Caretta caretta* (30 cm) at Cape Canaveral, from 1986-1995. These data were used to determine annual temperature variability over the decade in relation to a previous five-year study which indicated a strong female bias (Mrosovsky and Provancha, 1992). They collected hatchling turtles, over three nesting seasons (1986-88). Nest distribution data for each season yielded estimates of 92.6-96.7, 94.7-99.9 and 87.0-89.0% of hatchlings being female, in each respective year.

Seasonal mean sand temperatures over the decade ranged from 29.6 to 31.3 (ºC), with most biweekly means above the pivotal temperature for *Caretta* (29.4ºC) suggesting a continued female bias. Annual variation during the decade was not statistically significant, however, the 1988, 1991, and 1992 nest seasons had lowest temperatures, closest to the pivotal. A notable portion of nests were incubated during an early season "cool" period in 1988 and 1992. All sea turtle sex ratio studies have occurred during the warmest period of the century and are likely influenced by global warming.

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THE EFFECTS OF HURRICANES BERTHA AND FRAN ON SEA TURTLE NESTING ACTIVITY ON TOPSAIL ISLAND, NORTH CAROLINA

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INTRODUCTION

It is documented that hurricanes cause mortality in sea turtle nests, both from drowning and changing beach topography (Shaw *et al*., 1994). Hawksbill turtles exhibited lower nest site fidelity and increased false crawl ratio after Hurricane Hugo hit Buck Island National Monument, US Virgin Islands (Starbird and Hillis, 1992). During the 1996 nesting season two hurricanes made landfall on Topsail Island, N.C.: Hurricane Bertha (Fig. 1), a category 2 storm with a 6 foot storm surge on 12 July and Hurricane Fran (Fig. 2), a category 3 storm with a 10-12 foot storm surge on 5 September. In this paper we examined nesting activities in response to these two storms on Topsail Island, N.C.

METHODS

Nesting activities were reported by volunteers with the Topsail Turtle Project along the entire length of Topsail Island from 1 May to 15 September 1996. Data on nesting activities and hatchling success from previous nesting seasons (1990-1995) were used as baseline data to compare with the 1996 nesting season. Nests that were not washed out by Hurricane Bertha were analyzed 3+ days after emergence.

RESULTS

Eight of the 57 (14%) nests laid before Bertha survived, although with a lower emergence rate (52%) compared with previous years (87-91%; Beasley *et al*., in press). The remaining 49 nests were washed out by Bertha despite 28 (49%) being relocated prior to the storm. Temporary dunes were created by bulldozing after Bertha. Sixty-six nests occurred after Bertha. Forty-seven (71%) of these nests were relocated to higher ground although all were washed out by Hurricane Fran's storm surge which covered the beach for approximately 2 hours and caused extensive overwash and dune destruction.

Nesting activity appeared to increase after Hurricane Bertha compared with previous seasons. Nesting activities following Bertha occurred at a rate twice that for previous years (Fig. 3 and 4). There were no activities recorded 3 days prior to Bertha (9-11 July) probably because of extreme high tides before the storm.

DISCUSSION

Even though most of the natural dune system was intact before Bertha, only 8 nests survived. Six of these were partially washed out. The nests lost appeared to be eroded away. Because of beach erosion most of the nests laid after Bertha had to be relocated. Even though these nests were relocated, the 10-12 foot storm surge from Hurricane Fran washed out all of the 66 remaining nests.

The increase in nesting activity was probably caused by turtles from adjacent Onslow Beach where much of the beach had been eroded. The first green turtle nest was confirmed on Topsail between Bertha and Fran which was possibly from Onslow Beach where green turtles have been previously tagged.

Early season hurricanes such as Bertha are very rare in NC. Most NC hurricanes occur in early fall after all nests are laid therefore only effecting hatchling success. Bertha provided a chance to observe effects on nesting behavior as well as hatchling success. It is also very rare to have two hurricanes make landfall on the same beach in one season. Only 6 weeks apart, the timing of these two storms was devastating to the 1996 nesting season.

ACKNOWLEDGMENTS

We would like to thank the many volunteers of the Topsail Turtle Project , the staff at the National Weather Service in Wilmington, NC and George Elliot, Chief Meteorologist,
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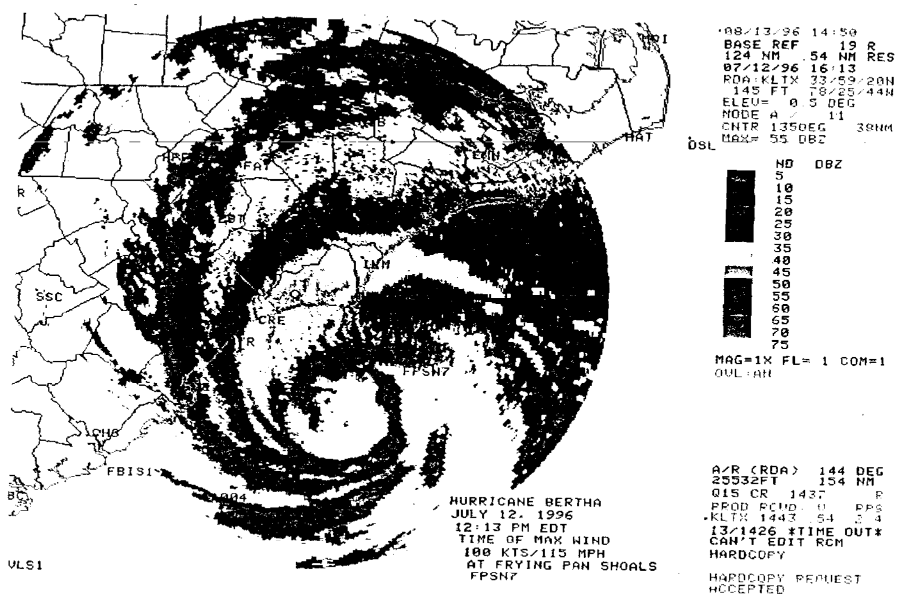


Figure 1. Doppler radar image of Hurricane Bertha at 12:13pm on 12 July, 1996.

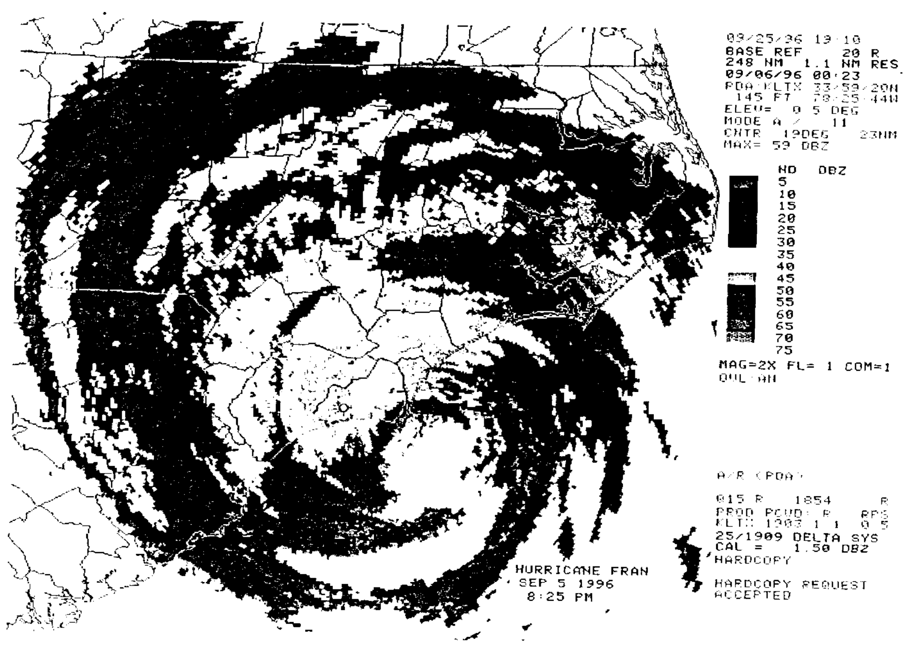


Figure 2. Doppler radar image of Hurricane Fran at 8:25pm on 5 September, 1996.

Figure 3. Nests by two-week intervals on Topsail Island, NC.

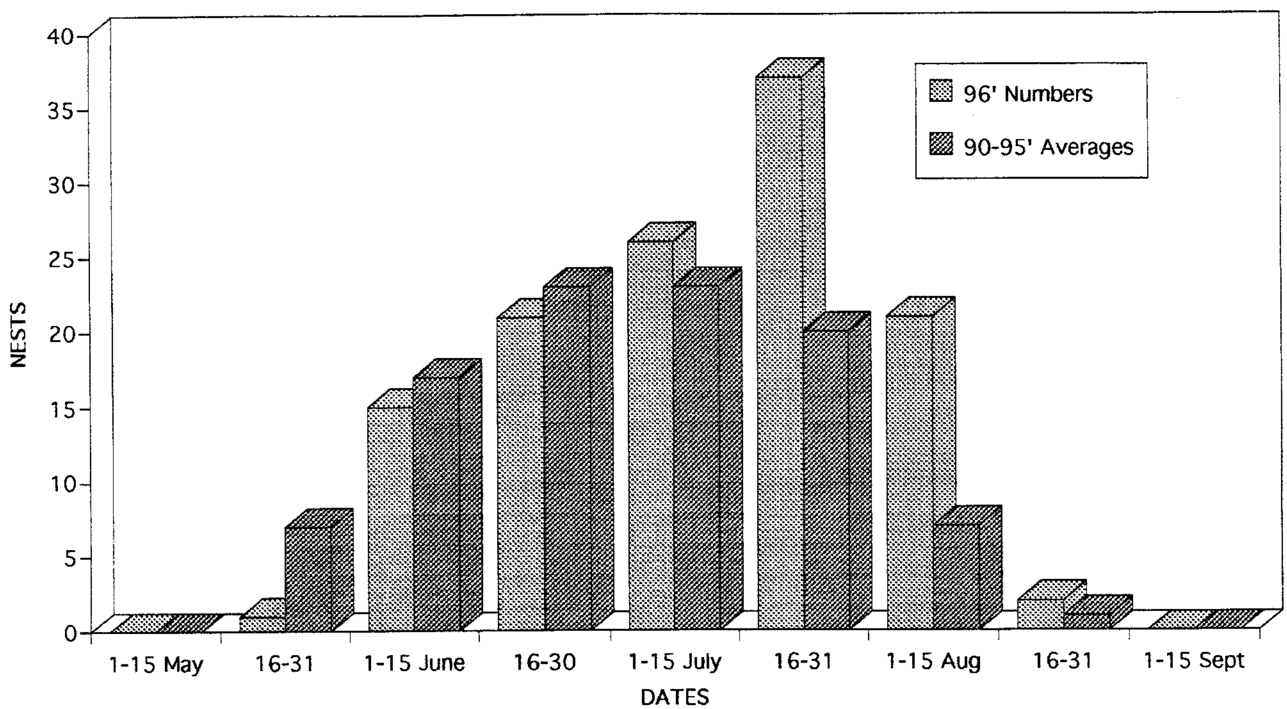
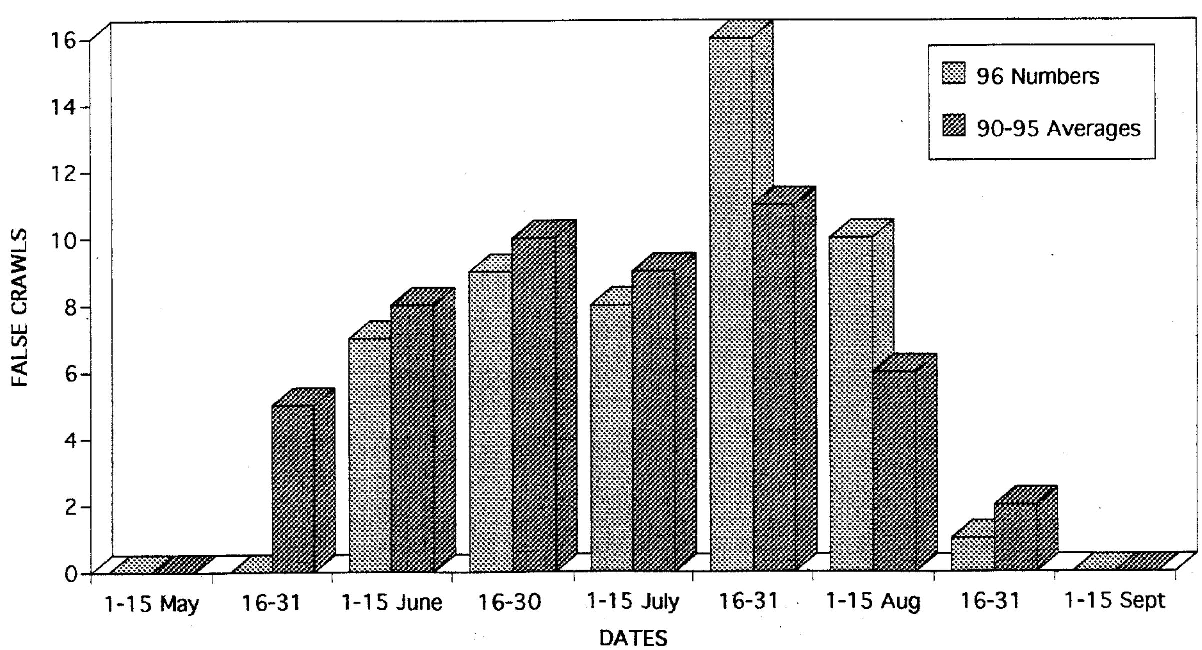


Figure 4. False crawls by two-week intervals on Topsail Island, NC.



COMPUTER-AIDED 3D RECONSTRUCTION OF A SEA TURTLE SALT GLAND

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Valuable histological and structural information can be gained from serial sections of biological tissue. In this study, a new computer program, "Imod" was used to reconstruct the internal duct arrangement of a salt gland from the green sea turtle *Chelonia mydas*. In addition to creating accurate, three dimensional visualisation of internal features, the program also permits morphometric measurements of surface area and volume.

The salt gland is a highly efficient extra-renal salt secreting tissue which permits sea turtles to maintain water balance when excreting large quantities of salt. The three dimensional structure and arrangement of the ducts which transport secreted fluid in the gland has not been previously described. This poster describes the method by which computer-aided reconstruction can be used to visualise the internal duct arrangement of the gland. Reconstruction of serial sections shows that the canals from secretory lobes join and drain into a common collecting duct. The collecting duct is quite large and drains via a duct which folds underneath it and runs anteriorly to the posterior canthus on the surface of the eye. The collecting duct is situated at the posterior end of the gland and canals run from lobes anterior to it to drain primarily into its anterior end. An anterior view of the ducts shows that they run from the lateral regions of the gland as well and so form a network which converges from a wider lateral and dorsal area into a relatively narrow collecting duct. A small number of ducts enter the dorsal surface of the collecting duct directly, presumably from lobes positioned directly above it. Some run from the posterior end of the gland and join other ducts at the anterior part of the collecting duct. The reconstructed region had a volume of 2.9x108 μm3 and the surface area was 11.4x106 μm2. The main collecting duct comprised 72% of volume and 39% of total surface area.

ONE-WAY TRANSPACIFIC MIGRATION OF LOGGERHEAD SEA TURTLES (*CARETTA CARETTA*) AS DETERMINED THROUGH FLIPPER TAG RECOVERY AND SATELLITE TRACKING

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The presence of loggerhead turtles, *Caretta caretta*, in the Gulf of California and eastern Pacific has been considered enigmatic. No nesting is known to occur, however genetic affinities have been established among eastern Pacific loggerheads and those nesting in Japan and Australia. In July of 1993, a flipper tagged loggerhead turtle was released into the eastern Pacific Ocean and recovered 478 days later in Japanese waters. In August of 1996, a second loggerhead was equipped with a satellite transmitter and is currently within 350 miles of the

Hawaiian Islands. Evidence from these two turtles suggests that loggerheads may commonly traverse the Pacific Ocean.

WILD CAPTURES OF SEA TURTLES IN NEW YORK: SPECIES COMPOSITION SHIFT EXAMINED

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Sea turtle incidence is seasonal and considered common for the temperate waters around Long Island. Sea turtles regularly caught in commercial fishing gear (pound nets) were the loggerhead, *Caretta caretta*, Kemp's ridley, *Lepidochelys kempii*, and the green turtle, *Chelonia mydas*. These captures were part of a cooperative program with commercial fisherman between 1986 and 1996. Upon capture, straight carapace length, width, and weight were recorded. Each animal was then tagged with either a Monel flipper tag or Passive Integrated Transponder (PIT) tag.

Sea turtles taken in pound net captures in 1996 included 31 original captures and 5 recaptures. The 31 original captures included 7 greens, 12 ridley's, and 12 loggerheads. The recaptures included 3 greens, 1 ridley and 1 loggerhead. In all years except 1992, the total number of sea turtle captures was greater than the number recovered in 1996. The pound net recovery program was initiated in 1986. Between the years of 1986-1989 the numbers of turtles recovered were influenced to an unknown degree by effort. As a result the numbers of animals recovered during this time is difficult to correlate to the current numbers of recoveries.

In all years until 1996, loggerheads were the dominant species captured. From 1986 to 1995 the number of loggerheads recovered represented from 48% to 78% of total captures. The data revealed a significant decrease of loggerheads for 1996 compared to previous years. The number of loggerheads recovered for 1996 was 12. The decrease of total sea turtles captured in 1996 is largely accounted for by the decrease in the number of loggerheads recovered. In all years except 1990, the total number of loggerheads recovered was greater than either greens or ridley's. The mean number of loggerheads per year for all years is 19.54 (sd ±10.24) and the twelve loggerheads recovered in 1996 is significantly lower. The decrease in loggerhead and total sea turtles was also observed in the stranding records for New York State during 1996.

Concurrent with the decrease in loggerhead captures was an increase in the percentage of green sea turtles recovered. The percentage of green turtles captured in 1996 was 22%. The mean percentage for all previous years was 17%. With the exception of 1994, the number of green turtles recovered remained relatively stable from 1985 to 1996 with a mean of 6.36 (sd ±5.6) and 7 were recovered in 1996. The seven original captures in 1996 are not significantly different than the mean and again the increase in the percentage of green is related to the decrease in loggerhead recoveries.

Turtle captures in the waters of eastern Long Island have shown similar patterns from 1986 to 1995. In 1996, however, turtles were recovered in western Shinnecock Bay and Peconic Bay. The Peconic Bay recoveries were due to a newly introduced fishing method in the Peconic system known locally as ‘fish pots.' These pots are very different in design than pound nets since the entire structure is submerged. The structure of these traps would prevent entrapped sea turtles from surfacing to breathe, something a pound net does not do. Although both turtles caught in these "pots" were alive, they were likely only recently trapped. This fishery could cause mortality, something we have not seen yet in pound nets for New York.

The decrease in the number of loggerheads observed is not well understood at this time. The 1996 summer was slightly cooler than recent years and it is possible water temperatures effected the distribution of this species to the region. Unfortunately, data on temperatures in earlier years was not available for complete analysis and further examination may elucidate what effect, if any this had. It is also possible that the local pound net fishing effort may have effected the capture of this species. The recent New York State regulations regarding take of bluefish, *Pomatomus saltatrix*. has been reported by the fisherman to cause them to both shorten their season and reduce the numbers of nets they are fishing. We are presently attempting to quantify this. However, it involves somewhat subjective data since the effort of each individual has not been quantified in previous years and is solely based upon reports of the number of nets set. Although there was a significant increase in the number of cold-stunned sea turtles in 1995 (Fig 1.), it is unlikely this has effected the number of loggerheads recovered in 1996. Standard carapace length measurements for all years and 1996 are quite similar with a very small standard deviation (1986-1995 mean 50.07 sd ±6.44; 1996 mean 49.79 sd ±5.57). This indicates that turtles found here are largely a single year class, and subsequent year classes recoveries would not be effected by the previous years cold-stunning.

It is also possible that some factor outside the New York region has caused a decrease in the number of loggerhead recovered. This could include various populations parameters or changes in Gulf Stream eddies. These were not examined for this study.

Continuation of the monitoring of sea turtle populations in New York will enable a better understanding of the distribution and habitat usage's of these species. It will also assist in identifying sources of mortalities not seen in other areas. The long term nature of this study is unique for the Northeastern United States and provides important information of sea turtle movements in northern waters that may be part of developmental habitats.

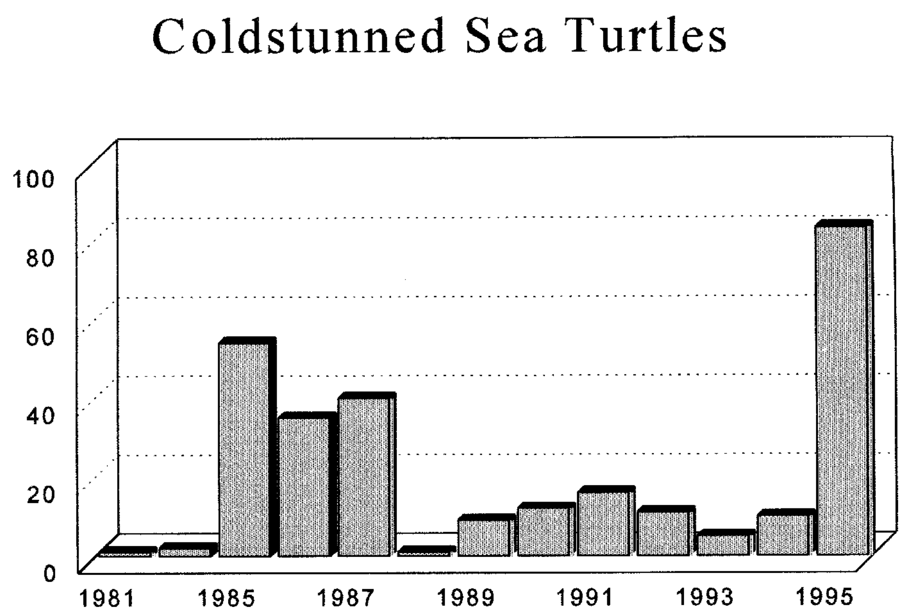

Figure 1. Total numbers of cold-stunned sea turtles for all species in New York State from 1981 through 1995. Note large increase in 1995 and previous peak in 1985.

EVALUATION OF RACCOON CONTROL AS A METHOD OF IMPROVING SEA TURTLE HATCH SUCCESS IN THE TEN THOUSAND ISLANDS OF SOUTHWEST FLORIDA

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Predation by raccoons (*Procyon lotor*) is the primary factor in nest success for sea turtles in the Ten Thousand Islands archipelago. Eight islands within or adjacent to the Ten Thousand Islands National Wildlife Refuge (TTINWR) have been surveyed for sea turtle nesting activity from 1991-96. Raccoon trapping was conducted during the 1992 nesting season and in 1995-96 from January through April, removing 21, 15 and 2 raccoons, respectively. Removals in 1992 (21) resulted in continued high predation, indicative of a high raccoon population and insufficient removals (nests= 42, 95% predation). Although fewer raccoons were removed prior to the 1995 and 1996 nesting seasons (15, 2), no nest predation occurred during either year (1995, nests= 41; 1996, nests= 62). Trap-nights equaled 726 (2% trap success) and 167 (1.2% trap success), respectively for 1995 and 1996. These figures are in contrast to 76-100% nest predation the previous four years. Nine raccoons were also trapped, tagged and released on Gullivan Key in 1995 (276 trap-nights, 3.2% trap success). The following year only one raccoon was trapped and removed (114 trap-nights, 0.9% trap success) resulting in no significant decrease in nest predation (nests= 33, 97% predation). Raccoons on Gullivan Key may have become sensitized to live trapping experiences. Numerous other researchers have attempted to control raccoon depredation of sea turtle nests with varying degrees of success (Hopkins and Murphy, 1983; Lewis *et al*., 1994; Andre and West, 1981; McMurtray, 1986; Ratnaswamy, 1995; Klukas, 1967). However, the results from the Ten Thousand Islands indicate that raccoon removal may be an effective management tool for increasing sea turtle nest success on relatively remote barrier islands, although some raccoons may become "trap-shy" if exposed to traps prior to removal work. More work is needed to provide conclusive evidence that sufficient and cost-effective trapping and removal can be conducted on these barrier island beaches in order to increase sea turtle hatching success.

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GLOBAL POPULATION STRUCTURE OF GREEN SEA TURTLES (*CHELONIA MYDAS*) USING MICROSATELLITE ANALYSIS OF MALE-MEDIATED GENE FLOW

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Much of the life history strategies of green sea turtles remain a mystery. Because of the difficulty in observing sea turtles during the majority of their life cycle, most classical studies have gained insight from tag-recapture evaluations of nesting females. Many questions remain, however, concerning male life histories and male-mediated gene flow. Females exhibit natal site philopatry, creating evolutionarily distinct units in terms of mitochondrial DNA. Whether male sea turtles follow a similar pattern is still unclear. This study is currently making use of recently developed microsatellite DNA markers in an analysis of 256 individual green sea turtles from 15 sites worldwide.

RETURN OF THE BEETLES: OBSERVATIONS AT LA ESCOBILLA

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INTRODUCTION

La Escobilla, in Oaxaca, México, is one of the most important mass-nesting (“arribada”) beaches for olive ridley turtles (*Lepidochelys olivacea*) in the world. Most nesting on this 20 km beach is concentrated in an area 7.5 km by 20 m. Since 1987, alarmingly high embryo and hatchling mortality have been reported for ridley nests, both *in situ* and in hatcheries; the cause has been attributed to predation by beetles, first reported as “*Trox omorgus* subspecies *Fabricius*” and “*Trox suberosus* subspecies *Fabricius*,” (López *et al*., 1994), although apparently only one species was being alluded to. During the 1990-91 nesting season, embryo mortality was reported to be 78.3%, ascribed uniquely to *Trox suberosus* subspecies *Fabricius*; in May 1996 it was reported that these insects reached concentrations of 800/m^3 (López and Olivera, 1996). Hence, there has been great concern about eliminating beetles from La Escobilla, and a number of control measures have been attempted (Aragón *et al*., 1993; López *et al*., 1994; López and Olivera, 1996). While sampling sand, serendipitous observations were made on the beetles, and to understand better their impact on turtle eggs and hatchlings, a series of opportunistic observations were made. The work was carried out with permissions from the appropriate authorities at the Centro Mexicano de la Tortuga (CMT), Instituto Nacional de la Pesca, Secretaria de Medio Ambiente, Recursos Naturales y Pesca, and the Instituto de Ecología (IE) of the Universidad del Mar.

METHODS

Eleven visits were made between 23 August and 25 October 1996, and casual observations by colleagues were made on 15 November 1996 and 25 January 1997. Sand samples were taken from each of 12 different beach sectors, in the area of most intense nesting between kilometers 0.7 and 6.9. Three sampling stations were in each sampled sector: intertidal zone, about 20 m from the high water mark (HWM) and about 38 m from HWM. At each station, triplicate samples of sand were taken at two different depths: 5 to 10 and 45 to 50 cm. Sampling was done during the day, between 8:00 and 18:00 hrs; no soil samples were collected during the night.

Complementary observations were made on the beach beetles, between km 0.7 and 3.2. This includes the area that has been reported to be the most infested by *Trox* (*i.e.*, km 1.5 to 2.8; López *et al*., 1994). Observations were made from the surface down to 50 cm, and occasionally to 80 cm deep. A total of 34 sites were examined: 25 egg chambers; 2 excavations by dogs; 3 excavations presumably by egg poachers; and 4 prospective holes made by the investigators. All of these sites were carefully examined, and in many, the soil was sieved (4X4 mesh/ inches^2) to check for the occurrence of beetles. C. Deloya López made preliminary identifications of beetles.

RESULTS

Number of species, or forms: Seven different morphological types of beetles were observed at La Escobilla; these have been tentatively described as species "A" to "G," although "F" and "G" could be the same species. There are two species of Heteroceridae, one species of Histeridae, two species of Tenebrionidae, and two forms (one or two species) of Trogidae.
Activities: Species C, D and E were observed only during daylight hours, while the remaining four forms (A, B, F and G) were observed at night and early morning. There were indications of seasonal and spatial stratification between the species (Table 1). Species F and G were remarkably abundant at the surface in mid-October.
Condition of substrate: None of the three diurnal forms (C, D and E) were found in association with eggs. In contrast, the four nocturnal forms were in ridley nests with eggs (n = 5), but not in freshly made nests holes in which there were no eggs (n = 20). Species F and G were found inside both rotten eggs as well as eggs with apparently intact shells and live embryos.
Relative abundance: Tentative estimates of relative abundance are shown in Table 1. Diurnal species (C, D and E) were not recorded during November. The two Trogidae species were notably abundant at night, particularly in mid-October.
Nomenclatural and taxonomic considerations: Previous work at La Escobilla has named, apparently for the same species, both "*Trox omorgus* subspecies" and "*Trox suberosus* subspecies *Fabricius*" (López *et al*., 1994); however, more recently, only the latter name has been used (López and Olivera, 1996). In the first place, Fabricius is the name of the authority, not the subspecies. Secondly, *Omorgus* is the name of a genus in the family Trogidae, not a species of *Trox*. Finally, *suberosus* is a species of both *Omorgus* and *Trox* (Lago, 1995; Johnson 1996; Deloya, pers. com.).

DISCUSSION

The coleopteran fauna at La Escobilla is more complex than was formerly thought. In the first place, there is confusion about the correct name of the beetle which has previously been reported. From the present study, it appears that two species of *Trox* (or *Omorgus*) - not one - are abundant. Additionally, five other beetle "species," not previously described, have been found in the sand, in the nesting zone. There are some indications of diurnal and spatial separation of beetles, but it is unclear how these "species" interact with each other, and how they are partitioning resources on the beach. Also unclear is where these beetles came from, and why La Escobilla has this singular coleopteran fauna. More importantly, it is not clear if *Trox* or the other species of beetles are obligate egg predators, as has been claimed in the past. At least some of the beetles at La Escobilla may be carrion or detritus eaters, that specialize on rotting or damaged eggs. Regardless of whether or not beetles are egg predators or scavengers, there are other sources of embryo and hatchling mortality at La Escobilla; density-dependent nest destruction by nesting turtles may be by far the most important source of mortality under certain conditions (Ruiz and Hernández, 1988; Rosano *et al*., 1996).

CONCLUSIONS

Until scientific information is available, it is unwise to assume that all beetles at La Escobilla are egg and/or hatchling predators, and thus are threats to hatchling recruitment. Hence, it is risky to design and implement control measures for the beetles before knowing what their ecological roles are, for certain management activities could have disastrous effects on the ecology of the beach, and consequently on hatchling recruitment and the future of the La Escobilla ridley population.

ACKNOWLEDGMENTS

E. Albavera and J. Vasconcelos (CMT) gave permission to visit La Escobilla; C. Tovilla (IE) provided facilities to make the 11 visits to La Escobilla. Mr. Luis García Castillo (PROFEPA) helped with visits to the field station. Biol. Cuahutémoc Deloya López (Instituto de Biosistemática de Insectos, Instituto de Ecología, A. C., Xalapa, México) provided expert advice on the preliminary identifications of beetles. Biol. Samantha Karam Martínez and Homero Argüelles helped with field work, and Biól. Daniel Pérez Bouchéz made valuable comments on beetle biology. Partial funding was provided by Universidad del Mar, as well as by the authors.

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Table 1. Observations on 7 forms of coleopterans at La Escobilla, September to November 1996.

"SPECIES"	ACTIVE	SUBSTRATE		ABUNDANCE[α] MONTH[χ]		
Name (Family)	Time	Depth (cm)	Eggs[β]	Sep.	Oct.	Nov[δ]
A(Heteroceridae 1)	night	5 - 60	always	4	2	4
B(Heteroceridae 2)	night	5 - 60	always	4	1	4
C(Histeridae {?})	day	surface	never	1	1	?
D(Tenebrionidae 1)	day	surface	never	3	3	?
E(Tenebrionidae{?} 2)	day	surface	never	2	2	?
F(Trogidae 1)	night	surface - 60	common	1	4	1
G(Trogidae 2)	night	surface - 60	common	1	4	1

[α]) Relative abundance scales, increasing from 1 to 4: 1 = an estimated zero to one beetle per 100 g of sand; 4 = an estimated 5 to 6 beetles per 100 g of sand.
[β]) Association with turtle eggs (TE): always = only found in association with TE; common = commonly found in association with TE; never = never found in association with TE.
[χ]) No systematic observations were made on beetles during August.
[δ]) In November one, casual visit, during the night was made; no daytime observations were made.

TOOLS AND TOYS: PROMOTING BIOREGIONAL EDUCATION THROUGH INTERACTIVE TRAVELING KITS

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If sea turtles, countless other endangered species, and indeed entire ecosystems are to survive, we must place the highest priority on education that will foster true ecological literacy. The relationship between human behavior and long-term sustainability is best introduced at a young age through a celebration of the natural world and corresponding development of values concerned with the well-being of all inhabitants; children putting themselves ***into*** nature rather than ***on top of*** it.

Traveling educational kits containing animal puppets, children's books, models, and interactive games can easily be transported to schools and community centers by field researchers and Peace Corps volunteers, or loaned to local teachers. Children are mesmerized by the colorful contents of the kits, and the day becomes a special event. This represents the perfect atmosphere for instructors to begin talking with students about important ecological concepts. Such materials developed by Columbus Zoo education staff have been successful in Peten, Guatemala, and Uganda. Sea turtle kits have recently been completed for use in Venezuela and on the south coast of Guatemala.

MARINE TURTLE NEST MONITORING ON FOUR BEACHES ON THE YUCATÁN PENINSULA, MÉXICO. SEASONS 1990-1996

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[2] Secretaria de Medio Ambiente Recursos Naturales y Pesca. Del. Yucatán. C-47 # 415-A x 52 y 54 Tizimin, Yucatán, México
[3] Secretaria de Medio Ambiente Recursos Naturales y Pesca. Del. Campeche. Av. Circ. Baluartes por Nicaragua, Altos del Banco Nal. De Comercio Interior. 2o. Piso. CP. 24000, Campeche, Camp., México

In this poster we will present some results about hawksbill, green turtle and loggerhead nesting monitoring in four beaches of de Yucátan Peninsula. The camps are El Cuyo and Celestún in Yucátan, Isla Holbox in Quintana Roo and Chenkán in Campeche, the tree first camps are in Reserves or Protected Areas. The field work is based on the patrol of 20 to 28 kilometers depending on the beach. Data describe the six nesting seasons since 1990 on the four camps: density for season, fecundity, and basic statistics about hatching success on nests incubated *in situ* and translocated. We will list different pressures as well as needs to investigate presently existing in each site.

TURTLE CONSERVATION, EDUCATION, AND RESEARCH AT XCARET PARK

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Xcaret Park, located on the east coast of the Yucatán peninsula, is a private park with ecological and archeological attractions, such as Mayan ruins, subterranean rivers, a butterfly pavilion, zoo exhibits of regional species and a tropical aquarium. The aquarium includes the sea turtle project which has three main focusses - conservation, education and research. Xcaret provides a hospital and a “half-way house” for sea turtles to be returned to the ocean. The park participates in alive tagging project, and provides personnel to protect the nesting sea turtle populations on several beaches between Playa de Carmen and Tulum. The facility provides a unique opportunity for research on sea turtle biology and behavior.

MARINE TURTLE NESTING BIOLOGY ALONG EGLIN AIR FORCE BASE ON SANTA ROSA ISLAND AND CAPE SAN BLAS, FLORIDA 1994 TO 1996.

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In 1994, we began a three year project to monitor marine turtle nesting along Eglin Air Force Base (EAFB) on Santa Rosa Island and Cape San Blas, Florida. From 15 May to 1 October 1994 to 1996, we conducted daily surveys on foot or all-terrain vehicles. Nests were marked and success evaluated after hatching or 85 days incubation. We calculated average emerging success (AES) and emergence success (ES) as defined by Ehrhart and Witherington (1987). On Santa Rosa Island in 1994 and 1996, the number of green turtle nests remained consistent, however, productivity (AES and ES) decreased. Although the percentage of nests directly affected by storms and erosion decreased from 1994 to 1996, the percentage of nests affected by predation increased. No green turtles nested in 1995. Loggerhead turtles nested on Santa Rosa Island in 1994, 1995, and 1996. There were fewer nests in 1995 than in 1994 and 1996. From 1994 to 1996, there was a net decrease in AES and a net increase in ES which may be the result of a mild storm season in 1996, and relocating mores nests in 1996 than in 1994 or 1995. In 1995, the percentage of nests directly affected by storms and erosion was greater than 90%. In 1994 and 1996, a lower percentage of nests were affected by storms and erosion than in 1994 with the smallest percentage in 1996. The number of nests affected by predation increased dramatically in 1996. Raccoons (*Procyon lotor*) were the primary predator of 1994, whereas coyote *(Canis latrans*) and red fox (*Vulpes vulpes*) were the primary predators in 1995 and 1996. On Cape San Blas, there were fewer loggerhead nests recorded in 1996 than in 1994 and 1995, however, productivity (AES and ES) increased during the three years of the project. The number of nests lost to storms and erosion decreased in 1995 and 1996, but coyote predation of nests increased each year. Throughout the study, coyotes were the primary predator along Cape San Blas.

ACKNOWLEDGMENTS

We would like to thank Eglin Air Force Base for cooperation and funding throughout the study. Special thanks to Debby Atencio at EAFB. David Heutter, Greg Altman, Eric Egensteiner, Shawn Diddie and Rudy Martinez assisted in data collection. The Cooperative Fish and Wildlife Research Unit works cooperatively with the U.S. Fish and Wildlife Service, Florida Game and Freshwater Fish Commission, the Wildlife Management Institute and the University of Florida.

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EFFECTS OF GHOST CRAB (*OCYPODE QUADRATA*) INVASION ON LOGGERHEAD SEA TURTLE (*CARETTA CARETTA*) NESTS AT HILLSBORO BEACH, FLORIDA

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The Broward County Sea Turtle Conservation Project has used nest relocation to protect sea turtle eggs from the negative impacts associated with incubating and hatching on highly urbanized beaches. Since 1991, the hatching success of nests relocated to large open beach hatchery sites on Hillsboro Beach has averaged about 5 to 15 percent lower than for in situ nests. Burrowing ghost crabs have been accused of substantial egg predation, but their invasion of turtle nests can escape detection, because of the small size of their burrows. In the summer of 1994, a study was conducted to assess the extent and effects of ghost crab predation to determine if this could be partially responsible for the reduced hatching success of these relocated nests.

Weekly surveys of the three Hillsboro Beach hatchery sites were conducted and each nest was inspected for evidence of ghost crab infestation. When burrows over nests were found the nest number was recorded. Several days after hatching, these nests were excavated by Broward County Sea Turtle Conservation Project workers. The number of empty shells, dead hatchlings, pipped eggs and unhatched eggs with and without visible development were recorded. The emergence success and percentages of dead hatchlings, pipped and unhatched eggs in crab-invaded and uninvaded nests were plotted and compared with the Mann Whitney U Test.

Fig.1 shows the distributions of emergence success and the unemerged categories. The incidence of ghost crab predation was low in the open beach hatcheries. Only 23 out of a total of 1085 nests were invaded by adult crabs. However, median emergence success (Fig. 1A) was significantly lower in egg chambers penetrated by adult crabs. This was primarily due to higher proportions of unhatched eggs with (Fig. 1B) and without signs of visible development (Fig. 1C) in the invaded nests. Ghost crab predation did not significantly alter the proportions of pipped eggs (Fig. 1D) or dead hatchlings which failed to emerge from the nests (Fig. 1E).

The low incidence of crab predation indicates that large numbers of ghost crabs were not attracted to the hatchery sites in order to feed on turtle eggs. However when nests were invaded their median mergence success was significantly lower than
in uninvaded nests. Ghost crabs do not appear to invade hatching nests in order to feed on hatchlings emerging from their shells.

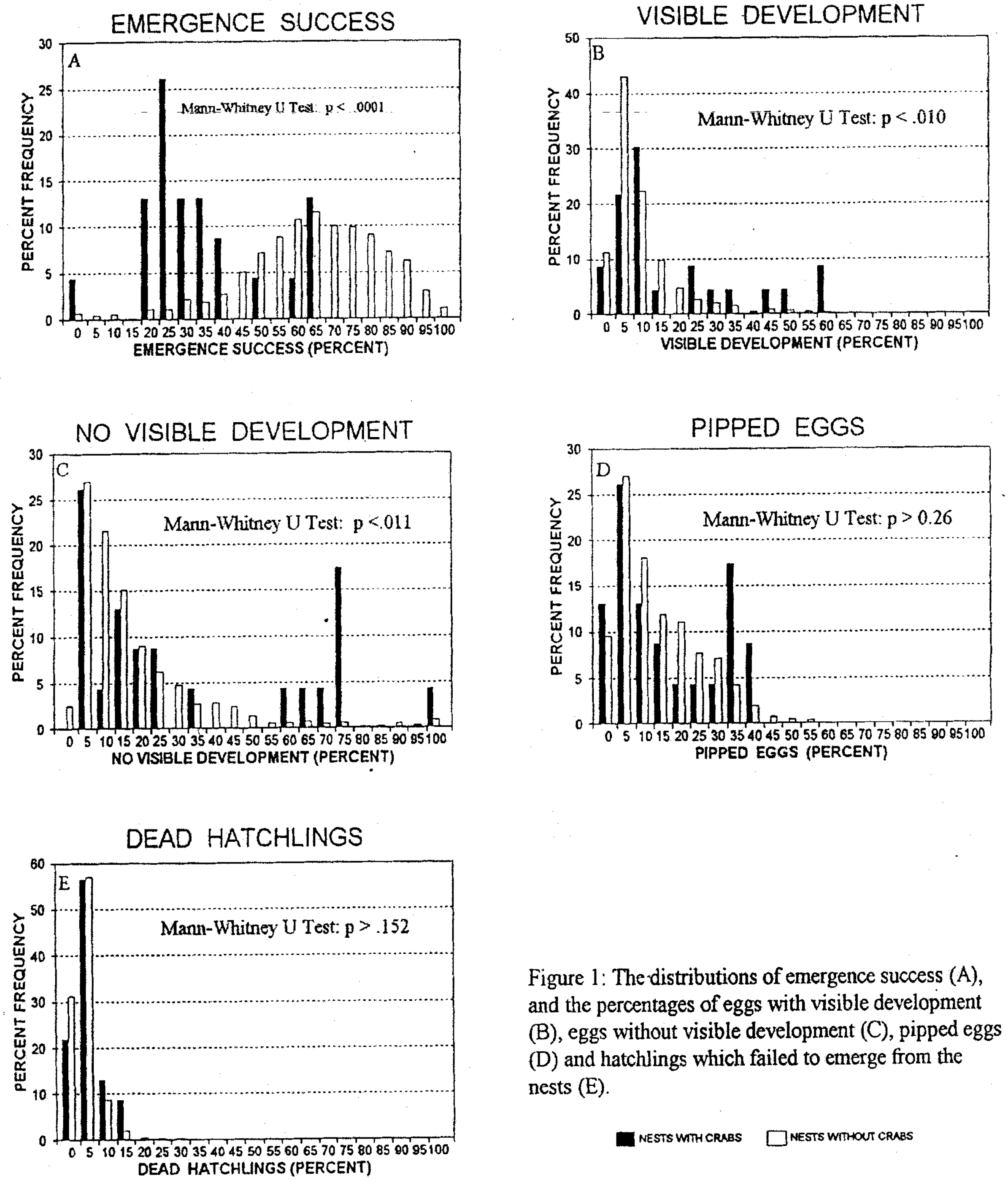

Figure 1: The distributions of emergence success (A), and the percentages of eggs with visible development (B), eggs without visible development (C), pipped eggs (D) and hatchlings which failed to emerge from the nests (E).

ECOLOGY OF MARINE TURTLES IN FLORIDA BAY: POPULATION STRUCTURE, DISTRIBUTION, AND OCCURRENCE OF FIBROPAPILLOMA

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INTRODUCTION

Four species of marine turtles regularly occur in the near-shore and lagoonal waters of Florida - the loggerhead (*Caretta caretta*), green turtle (*Chelonia mydas*), hawksbill *(Eretmochelys imbricata*), and Kemp's ridley (*Lepidochelys kempii*). Although multiple life history stages of these species are widely represented throughout Florida waters, there are few areas around the state where marine turtles in the water have been studied in detail. We recognized Florida Bay a shallow embayment between the Florida Keys and the southern tip of the Florida peninsula as one area where information on marine turtles was sparse. Marine turtle studies there seemed imperative given that the health of the Florida Bay system has recently attracted an intense research effort to elucidate problems with nutrient loading, turbidity, hypersalinity, and seagrass dieoffs. This abstract summarizes part of an ongoing effort begun in 1990 to study the ecology of marine turtles in Florida Bay. Although we have recorded all four of the species known from shallow Florida waters in the Bay, this summary includes only information gathered from the two most common species, the loggerhead and the green turtle. We focus on their distribution within the Bay, movements of individual loggerhead turtles, size-class structure of captured turtles, and the occurrence of the disease fibropapillomatosis.

METHODS

This summary represents information from turtles that were captured, sighted, and tracked, between July 1990 and December 1996. We captured turtles as part of an irregular (quarterly to monthly) capture-and-release sampling effort. Turtles were captured by one of three techniques: (1) anchored, straight-set, large mesh tangle nets, (2) drifted large-mesh tangle nets, and (3) hand capture. Pertinent to this study, captured turtles were measured for standard straight-line carapace length (SCL), tagged with plastic, inconel and PIT tags, externally examined, and photographed prior to release. We attached VHF-radio and sonic transmitters to nine, hand-captured, loggerhead turtles to determine their range of movements within Florida Bay. The sonic tags were attached to the dorsal surface of the posterior marginal flange of each turtle's carapace with two nylon electrical ties which were wrapped around each end of the cylindrical tag and run through two holes drilled into the carapace margin. Electrical ties were sheathed in latex surgical tubing to keep them from chafing the drilled holes. The VHF-radio transmitters were attached using a tethered-float rig made of balsa wood sealed with polyester resin and painted with anti-fouling paint. We attached the float-transmitter to the turtle by an 800 mm rubber tether which was fastened to the posterior-most marginal flange of the carapace in a manner similar to the sonic tag attachment. The total weight of the transmitter, float, and tether was 434 g which was less than one percent of the weight of the smallest turtle.

RESULTS AND DISCUSSION

We attempted to locate tagged turtles at approximately one-month intervals and obtained multiple positions for each turtle with tracking periods that ranged from 45 to 211 days. Although turtles appeared to remain within the same localized area where they were originally captured, some turtles may have left the area undetected by us. Indeed, the period we were able to monitor each turtle may have been shortened by their movement outside the area where we searched and could detect them (principally a 16-25 NM circle centered at Rabbit Key Basin). We believe that many of the tagged turtles were eventually lost to us when their radio tags became prematurely detached. Two detached radio tags were recovered after the nylon tie had broken. One of these tags showed marks where another turtle had bitten the float. We found similar bite marks on a malfunctioning radio tag that remained attached to the turtle. Carr (1987) brought together thirty years of mounting evidence that the size distribution of loggerheads regularly encountered in the eastern Atlantic fill a conspicuous size/age-class "gap" between post-hatchlings and the smallest subadult loggerheads observed in western Atlantic waters. The four size/age-class groups identified by Carr include "post-hatchlings" or "lost-year" turtles, Azores (east Atlantic), nearshore/inshore southeast United States, and breeding adults. We note three smaller gaps among the four identified size/age-class groupings (Fig. 1). The first gap, evident at approximately 10-15 cm SCL likely comprises small pelagic-stage juveniles that are "traveling" in the north Atlantic gyre but have not yet reached the eastern Atlantic where they could be documented as incidental captures in various fisheries (the principal source of population structure data in this region). The second gap is evident at approximately 40-50 cm and likely comprises turtles that are migrating "back" to nearshore western Atlantic waters where they are not observed by researchers. The third gap, evident at approximately 75-85 cm is the one that is most relevant to the population that we are studying in Florida Bay The loggerheads that we observe in Florida Bay (mean = 80.1 cm SCL, range = 48.9-98.7 cm) appear to fill this gap. This size class comprises a median group that is just nearing maturation. We hypothesize that Florida Bay may represent yet another developmental habitat in the unfolding picture of the ecological geography of the loggerheads that originate from nesting beaches of the southeast United States.

Green turtles ranged in size from 25.5 to 2.9 cm SCL with a mean of 46.2 cm; no adults were captured or sighted. The size class distribution of Florida Bay green turtles in similar to that described for other nearshore developmental habitats in the southeast United States. One of the indicators that we use to evaluate the health status of marine turtles in Florida Bay is the occurrence of green turtle fibropapilloma (GTFP). This potentially fatal disease is characterized by tumors present on the skin, scales, scutes, eyes and surrounding tissues, and viscera. The disease has been documented as being principally an affliction of green turtles. Our data show that 62% of the green turtles captured in Florida Bay between 1990 and 1996 exhibit GTFP. Although this is a high rate of affliction, it is not unique among green turtle populations. Conversely, few areas world wide have reported GTFP in loggerheads and where it has been reported, prevalence is generally low. Our records show that approximately 11% of the loggerheads captured in Florida Bay are afflicted with GTFP, a rate that is apparently unprecedented in this species. The occurrence of GTFP relative to size class in Florida Bay green turtles is generally consistent with trends reported from study sites elsewhere in Florida and in Hawaii, where GTFP is least common in the smallest and largest turtles, and most common in the intermediate size classes. A similar trend is seen in loggerheads. Trends in either species suggest that new recruits to the foraging habitat acquire the disease only after an extended residency, and that the oldest members of the assemblage have passed through a disease phase and have recovered or have died.

ACKNOWLEDGMENTS

Our research is funded by the Florida Bay Program of the Florida Department of Environmental Protection and the Non-Game Program of the Florida Game and Fresh Water Fish Commission, and the National Marine Fisheries Service. Everglades National Park and the U.S. Fish and Wildlife Service provided equipment, personnel, and logistic support during the early years of the project. Our project has benefitted from the assistance of Derke Snodgrass, Nancy Diersing, Dave Eaken, Derke Snodgrass, John Hunt, Skip Snow, Hunter Sharpe, Jay Liggett, Larry Ogren, Lew Ehrhart, George Balazs, Bruce Peery, Jonathan Gorham, Carrie Crady, and Layne Bolen.

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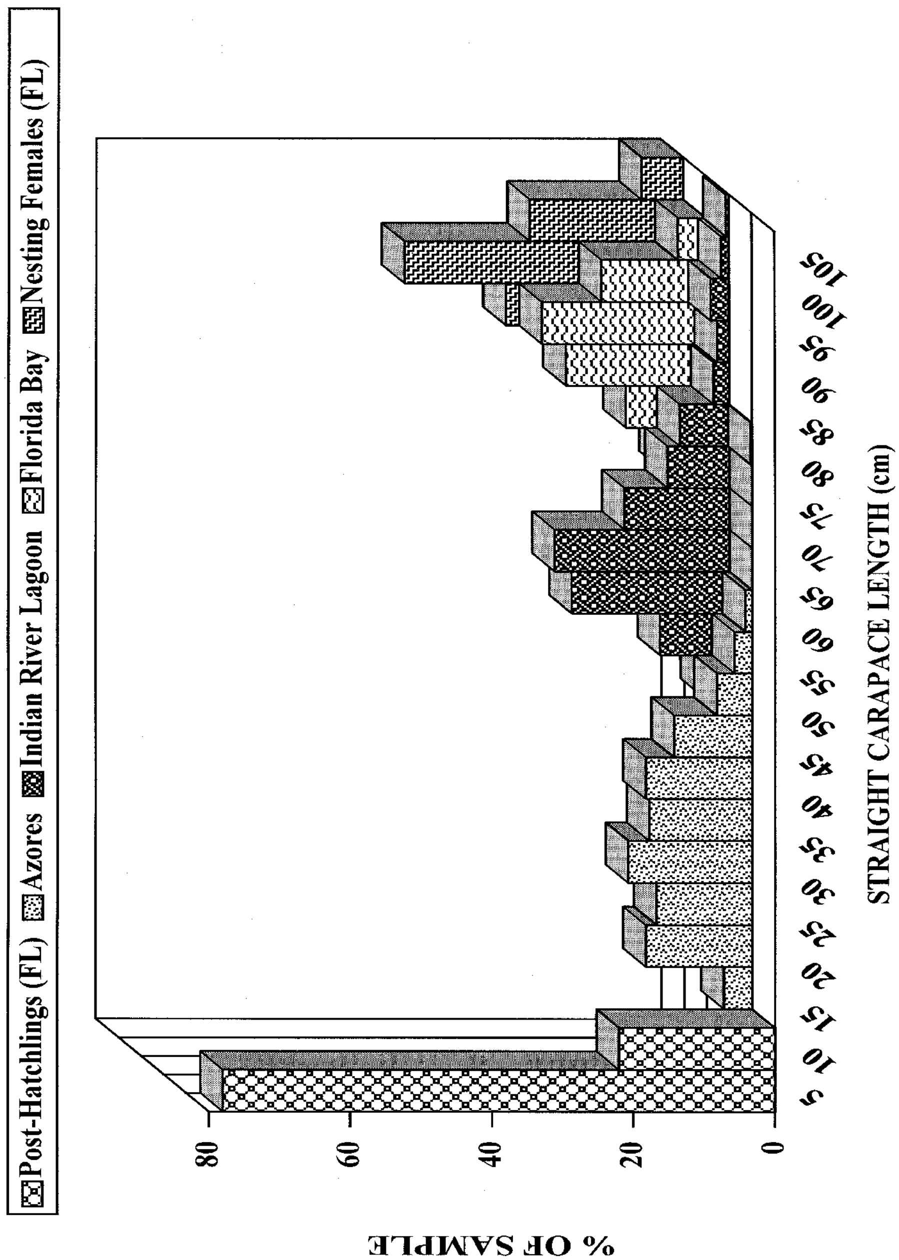

Figure 1. Comparison of size structure of loggerheads from five study sites in the Atlantic Ocean and Gulf of Mexico.

VITELLOGENIN LEVELS IN GREEN TURTLES (*CHELONIA MYDAS*)

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INTRODUCTION

Over the past 10 years green turtles (*Chelonia mydas*) captured in the Indian River Lagoon in Florida have showed around a 50% prevalence of green turtle fibropapillomatosis (GTFP), whereas the Reef population less than 1km away and the nearby Trident Basin population have had 0% prevalence. The area adjacent to the Lagoon sampling site is in extensive industrial and agricultural use. Trident Basin is located in a national wildlife refuge. The high prevalence of GTFP in the Lagoon habitat compared to the Reef and the Trident Base habitat may be an indication that contaminants from agricultural and industrial activities play a role in the pathogenesis of GTFP.

Many environmental pollutants, including pesticides and industrial chemicals have estrogenic activity in animals. Estrogen is the sole inducer of vitellogenin production. Vitellogenin is a complex protein that is produced by the liver as a yolk precursor in response to estrogen stimulation in oviparous vertebrates, *i.e.,* it is normally only found in egg-producing females and not in juveniles and males. However, the liver of juveniles and males is capable of synthesizing and secreting vitellogenin in response to exogenous estrogens or estrogenic compounds. Therefore, vitellogenin may be useful as indicator of exposure to estrogenic contaminants.

A serologic assay to detect vitellogenin levels in green turtles was developed. The test was used to measure vitellogenin levels in plasma samples of juvenile green turtles with and without GTFP from high incidence and zero incidence habitats to examine the relationship between vitellogenin levels and GTFP, in order to assess a possible role of xenobiotic estrogens in GTFP pathogenesis.

MATERIALS AND METHODS

Blood samples from green turtles from Indian River Lagoon, Reef and Trident Basin habitats in Florida (U.S.A.) were collected into lithium-herparinized tubes from the dorsal cervical sinus. One green turtle egg was collected from Melbourne Beach, Florida.

Vitellogenesis was induced in two 2-year old, captive-reared juvenile green turtles ranging in weight from 5.5 to 8.1 kg by injecting 1 mg/kg of estradiol-17 (10 mg/ml dissolved in corn oil plus ethanol) in the shoulder (combined intramuscular and subcutaneous) once per day for seven days and then once a week for three to four weeks. A control turtle received 1 mg/kg of cholesterol (10 mg/ml dissolved in corn oil plus ethanol) in the same sites and on the same schedule. Blood samples for plasma collection were collected periodically.

A monoclonal anti-green turtle vitellogenin antibody (Mab HL1248) was produced by injecting mice with a green turtle yolk preparation and, following a routine protocol, selecting a clone that reacted by ELISA and Western blot with both the yolk preparation and vitellogenin-rich green turtle plasma.

Green turtle vitellogenin was purified from vitellogenin-rich plasma from an estradiol-17 inoculated green turtle by ion exchange chromatography (Biocad Sprint perfusion system and porous 20 HQ column anion exchange). A protease inhibitor cocktail (10 kIU/ml Aprotinin, 10 mM PMSF) was added to the plasma. Vitellogenin was purified using stepwise elution starting with 20 mM Tris, 150 mM NaCl, pH 9 to 1500 mM NaCl. Protease inhibitor was added to the fractions. Fractions were examined for vitellogenin content by Western blot using the monoclonal anti-green turtle vitellogenin antibody. A modified Bradford protein assay was used to determine vitellogenin concentration.

Western Blots were performed to demonstrate the specificity of the monoclonal anti-green turtle vitellogenin antibody (Mab HL1248). Briefly, green turtle yolk, plasma and purified vitellogenin were separated by SDS-PAGE under reducing conditions using a precast 8% Tris-glycine gel. The proteins were then electrophoretically transferred to a nitrocellulose membrane. After the transfer the membrane was blocked, washed, and incubated with Mab HL1248. After another washing step the membrane was incubated with alkaline-phosphatase conjugated rabbit anti-mouse IgG whole molecule antibody. Following a final washing step the blot was developed with nitroblue tetrazolium chloride (NBT) and 5-bromo 4-chloro 3-indolylphosphate p-toluidine salt (BCIP).

Competitive inhibition ELISAs were used to quantitate vitellogenin in turtle plasma. First, various dilutions of plasma samples (unknowns) and known amounts of pure vitellogenin (for standard curve), respectively, were incubated overnight with monoclonal anti-green turtle vitellogenin antibody Mab HL1248. Residual Mab HL1248 activity was then assayed by ELISA as follows. Samples from the overnight incubation were transferred to a 96-well microtiter plate coated with green turtle vitellogenin. After 1 hr incubation at room temperature the plate was washed and incubated for 1 hr with an alkaline-phosphatase conjugated rabbit anti-mouse IgG whole molecule antibody. Following a final washing step the plate was incubated for 45 min in the dark with p-nitrophenyl phosphate disodium. The optical density of each well at 405 nm was measured using an automated ELISA plate reader. Vitellogenin concentrations in the plasma samples were calculated by comparing their optical density values to the values of the vitellogenin standard curve. Since there was interference at the plasma dilution used in the competition ELISA, vitellogenin concentrations are reported in arbitrary units (AU).

Four groups with a total of forty juvenile green turtles ranging in weight from 4.2 to 22.0 kg and in carapace length from 32.1 to 49.9 cm were examined for plasma vitellogenin levels. The average vitellogenin concentrations of the four groups were compared using an unpaired t-test. A $p < 0.05$ was considered significant.

Animal experiments and sample collections were conducted under permit # 086 issued by the Florida Department of Environmental Protection.

RESULTS

The monoclonal antibody (Mab HL1248) that was developed against green turtle yolk was effective in detecting purified green turtle vitellogenin and vitellogenin in plasma of an estrogenized green turtle. Green turtle vitellogenin eluted off the anion-exchange column with 20 mM Tris, 800 mM NaCl, pH 9. The molecular weight of green turtle vitellogenin was found to be approximately 200 kDa.

The competitive inhibition ELISA using Mab HL1248 detected significantly higher mean vitellogenin (VTG) levels in fibropapilloma-bearing turtles from the Lagoon than in turtles without fibropapillomas from Lagoon ($p = 0.041$), Trident Basin ($p = 0.01$) and Reef ($p = 0.006$). Mean VTG levels in turtles from Trident Basin were significantly higher than in Reef turtles ($p = 0.033$) (Fig. 3). There was no significant difference between VTG-levels in Trident Basin turtles and tumor-free Lagoon turtles ($p = 0.67$) and between Reef turtles and tumor-free Lagoon turtles ($p = 0.069$).

DISCUSSION

The finding that vitellogenin levels were significantly higher in the turtles with GTFP than in tumor-free turtles suggests that there may be a connection between plasma VTG concentration and GTFP. However, if the levels of estrogenic contaminants in the Lagoon were high enough to induce vitellogenesis both, the tumor-bearing and the tumor-free turtles from that site should have similar vitellogenin levels and both should be different from the levels in the Trident Basin and Reef turtles. There are various possible explanations for the reported results.

Although it is unlikely that the difference was an effect of the age of the turtles and/or season when the samples were taken, since the four sample groups were matched for weight, carapace length, and sampling date, the sample size from each site may not have been large enough to eliminate this possibility. More samples from different areas with various GTFP prevalences need to be examined.

Vitellogenin levels need to be correlated with water- and sediment quality analyses. It is not known for green turtles how high the concentration of exogenous estrogen needs to be and for how long the turtles must be exposed for induction of vitellogenesis. The levels of exogenous estrogens in the Lagoon site may be below that effective concentration. In that case the findings of this preliminary study point to the possibility that in the examined green turtles vitellogenin may not be an indicator of exposure to exogenous estrogens but rather a result of a disruption of the endocrine system in turtles with GTFP.

KNOWN LIFE SPAN OF A CAPTIVE MALE LOGGERHEAD SEA TURTLE, *CARETTA CARETTA*

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A male loggerhead sea turtle, *Caretta caretta*, born July 1968, following incubation of an egg collected from a nest being laid on Emerald Isle, North Carolina, lived 29.1 years prior to death 9 August 1996. Straight line carapace length (SCL), tail length, and total weight relationships were best expressed using logistic equations. All data fitted predicted values. SCL and Weight curves were asymptotic at about age 20, while the tail length data approached asymptotic at age 29. Long term studies are recommended to resolve aspects of loggerhead biology.

BEACH RENOURISHMENT AND LOGGERHEAD TURTLE REPRODUCTION: A SEVEN YEAR STUDY AT JUPITER ISLAND, FLORIDA

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The effects of beach renourishment on the reproductive success of a major sea turtle rookery were studied over seven nesting seasons. This made possible a long-term comparison of reproductive success on several plots between those renourished at different times, and a control beach that had never been renourished. Hatchling emergence success on the renourished and control beaches did not differ between the two sites. However, nest densities over the years at the renourished beaches were significantly lower than at the control beach. On the renourished beaches the proportion of abandoned nesting attempts ("false crawling") was higher, and positively correlated with greater compaction shown by fill sands. Compaction, as well as steep escarpments (or berms), gradually decreased with time. After about two years, renourished beaches became as suitable for nesting as the natural beach. However, nest density on the renourished beaches soon declined again as erosion narrowed the beach. From a turtle's perspective, renourished beaches cycle between relatively long, unattractive states, and relatively short, attractive states. Continued coastal development and armoring accentuate erosion rates. These changes threaten to degrade the few remaining natural nesting beaches into sites which can only be maintained by continued renourishment. Our studies indicate that the reproductive success of sea turtles will be compromised at continually renourished beaches.

PRESENT STATUS OF THE OLIVE RIDLEY SEA TURTLE, *LEPIDOCHELYS OLIVACEA* (ESCHSCHOLTZ) ALONG THE ANDHRA PRADESH COASTLINE, INDIA

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INTRODUCTION

Sea turtles are an ancient group of animals which have been surviving more than a hundred million years. These oldest reptiles are valuable resources to many people of the Indian Ocean (Frazier, 1980), for nutritional, economic and cultural fabric of the region. However, despite the long standing value of this resource, its future is in jeopardy and many turtle populations have declined to the point where they are no longer significant resources, either materially or culturally. This is mainly due to indiscriminate exploitation largely at breeding stages. India with its 7,500 km of shoreline has drawn five species of Sea turtles. The leather back (*Dermochelys coriacea*); the loggerhead (*Caretta caretta*); the green turtle (*Chelonia mydas*); the hawksbill turtle (*Eretmochelys imbricata*); and the olive ridley (*Lepidochelys olivacea*). All five species of sea turtles face depletion of their population mainly duke to poaching of the turtles and their eggs. Now most of the nesting colonies of the turtles have disappeared from India’s mainland beaches, the olive ridley turtles being the main exception.

STUDY AREA

The coastline between Kalingapatnam in the North and Hope Island in the south has been selected for the present investigation. This area has a coastline of 286 km that runs through Srikakulam, Vizianagaram, Visakhapatnam and East Godavari districts of Andhra Pradesh and situated between 16°50' and 18°25' latitudes and 82°10' and 84°10' longitudes (Fig. 1). The study area was divided into seven major zones. A-Visakhapatnam, B-Konada, C-Kalingapatnam, D-Dibbapalem, E-Pentakota, F-Uppada, G-Hope Island (Fig. 1).

RESULTS

The status of the olive ridleys along the Northern Andhra Pradesh coastline is alarming, as the exploitation increases largely on breeding populations. The data from the fishermen reveal ridleys occurring commonly in this region from onset of Monsoon (June-July) until the end of winter (February), the peak season December-February. During the survey period, a total of 648 olive ridleys were captured in gear while another 170 were captured on the shore during the nesting activities. Of the 648 olive ridleys caught in fishing gear and brought to shore by the fishermen, 211 were recorded during the first year of the study 1983-84, while 212 and 225 were caught during 1984-85 and 1985-86, respectively. Zones A and D have showed higher percentages of catches while Zones B and F recorded a minimum. The difference between the successive years of the study was minimal and negligible, while the number of sea turtle caught in gear at all the zones ranged between 200 and 225 (Table 1). Besides the live turtles captured by human, as many as 577 carcasses of olive ridleys found washed ashore or killed by predators, were recorded during the survey. In 1983-84, 39.34% of these were recorded while 34.66% and 26.00% were recorded during 1984-85 and 1985-86, respectively. Zones G and E have maximum records while Zones A and B, the least (Table 2). The status of the olive ridleys along the defined coastline was also evident from the disturbance or destruction of the nests and nesting habitats. During the survey period, as many as 929 nests of olive ridleys were observed of which 805 were disturbed either by human or subjected to predation. Of the total nests, 40.15%, 32.19%, and 27.66% were observed during 1983-84, 1984-85, and 1985-86, respectively. Of the disturbed nests, 54.19% and 45.09% were destroyed by humans and predators, respectively. Zone G and A recorded maximum number of olive ridley nests observed in the study area during 1983-84 (Table 3).

DISCUSSION

Despite the wide distribution of the olive ridleys, they receive little attention and until the seventies, no effort was made to assess their status. Now they are threatened with extinction in many parts of the world (Subba Rao *et al*., 1983). The status of olive ridleys is considered to be grave and has been listed in the IUCN Red Data Book of Threatened and Endangered Species. In India, the olive ridleys are protected under Schedule I of the Indian Wildlife (Protection) Act, 1972 and killing traded or any activity that harms the species is banned. The status of the India sea turtles was well described by Davis and Bedl, 1978; Bhaskar, 1978; Kar and Bhaskar, 1982; Subba Rao *et al*., 1983; Silas and Rajagopalan, 1984. All the authors saw a bleak future for the sea turtle and feel that unless the large scale commercial exploitation and slaughter is stopped, the species may soon be in peril of extinction. Despite the highest protection under the Indian Wildlife (Protection) Act, 1972, the slaughter of sea turtles continue to go unchecked in India. Most of the fishermen interviewed have expressed the sentiment that turtle fishing is their birth right and their livelihood, but none of them were involved in large scale commercial exploitation; it was only ‘subsistence hunting’.

ACKNOWLEDGMENTS

The author is highly thankful to the University Grants Commission and the Ministry of Environment & Forests, New Delhi for granting financial assistance. The author acknowledges the Andhra Pradesh Forest Department for encouragement and sincere thanks to Sri D.S. Gangakhedkar, D.F.O., (Wildlife wing) for his unrelenting co-operation and encouragement during the study period.

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Table 1. Olive ridley turtle, *Lepidochelys olivacea*, caught alive in fishing gear while nesting during 1983-1986.

ZONES	Turtles caught in gear			(%)	Turtles caught in nesting			(%)
	1983-84 I Year	1984-85 II Year	1985-86 III Year		1983-84 I Year	1984-85 II Year	1985-86 III Year	
A	52	41	35	19.75	12	9	11	18.82
B	23	24	21	10.50	9	6	8	13.53
C	27	30	35	14.20	7	6	7	11.76
D	28	41	22	15.59	15	9	12	21.18
E	26	29	38	14.35	8	4	6	10.59
F	13	15	27	8.49	10	7	8	14.71
G	42	32	37	17.12	7	4	5	9.41
TOTAL	211	212	225	-	68	45	57	-

Table 2. Carcasses of the olive ridley turtle, *Lepidochelys olivacea*, found at different zones during 1983-1986.

Zone	I Year	II Year	III Year	(%)
	1983-84	1984-85	1985-86	
A	28	16	9	9.18
B	24	19	14	9.88
C	31	27	24	14.22
D	29	32	22	14.38
E	37	44	26	18.54
F	36	21	22	13.70
G	42	41	33	20.10
Total	227	200	150	-

Table 3. Status of the olive ridley turtle nests along the northern coast of Andhra Pradesh during 1983-1986.

Status of Nests	I Year		II Year		III Year	
	1983-84		1984-85		1985-86	
	(n)	(%)	(n)	(%)	(n)	(%)
Undisturbed	22	(17.74)	36	(29.03)	66	(53.23)
Human disturbed	204	(46.15)	151	(34.16)	87	(19.69)
Predator disturbed	147	(40.15)	113	(31.13)	103	(28.37)
Total	373	(40.15)	300	(32.29)	256	(27.56)

ARCHIE CARR NATIONAL WILDLIFE REFUGE: ACCOMPLISHMENTS AND CHALLENGES

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Archie Carr National Wildlife Refuge was established in 1990 to protect the nesting habitat for the largest population of green turtles (*Chelonia mydas*) in the United States and the largest population of loggerheads (*Caretta caretta*) in the western hemisphere. Refuge land acquisition is a partnership venture between the U.S. Fish and Wildlife Service, the State of Florida, Brevard and Indian River Counties, and the Mellon Foundation. The goal of acquiring 9.3 miles of oceanfront is halfway complete. Challenges remain in acquiring undeveloped parcels as building increases.

THE LOGGERHEAD TURTLE POPULATIONS OF THE SOUTHWEST BEACHES OF TURKEY AND PROTECTION STUDIES

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INTRODUCTION

The importance of the Mediterranean coast of Turkey for the breeding success of endangered marine turtles has been stressed by previous survey (Baran and Kasparek, 1989). As a result of this study, 17 major nesting grounds were determined. Of these beaches, some of them (Dalyan, Patara, Fethiye, Belek) were examined in terms of population during one or several breeding seasons, and the results were presented with the data reported in the previous years.

MATERIALS AND METHODS

The study was carried out on the different beaches of Turkey during various years. These beaches are Dalyan, Fethiye, Patara and Belek (Fig. 1). Our investigation was carried out during the marine turtle breeding seasons (Mid-May to mid-October, except for 1996) without interruption. We were not able to start our project until the 20th of July due to late financial support in 1996. Beaches were patrolled continuously by groups of 2-3 people between 2100 at night and 800 in the morning. During night patrols, after sea turtles had completed their nesting process, body measurements were taken and turtles tagged with metal tags on the right front flipper. Carapace lengths and widths (curved and straight) were measured using tape and a wooden compass. When we found an opportunity to observe turtles without disturbing them, eggs were counted while laying.

During morning patrols, the emergences resulted in nests were marked. The locations of the nests were confirmed by carefully probing with a metal stick (with care being taken not to break any eggs) and then marked. Tracks with no nests were counted as non-nesting emergence (False crawls). Nests near the influence of human activities were protected by wire cages placed on the surface of the sand. In the cases of partial animal predation, the nest chamber and surrounding area were cleared of destroyed eggs and fully covered with moist sand. All destroyed eggs and egg shells were also counted and then buried elsewhere. For all insitu nests, where pressure from land predators such as the fox was severe, a protective metal grating (70X70 cm with 7 cm in mesh size) was placed over the eggs.

During hatching season, the number of hatchling tracks coming from each nest were counted, and by following them, the number of hatchlings reaching the sea were determined. When tracks were interrupted by such predator tracks as fox, dog, bird or crap we assumed that the hatchlings were taken by those predators. After 8 or 10 days from the first emergence of hatchlings, nests were opened and checked. The number of retained hatchlings, empty egg shells, unfertilized eggs, and dead-in-shell embryos were counted and the total number of eggs in the clutch determined exactly. Some nests at risk for inundation or nests constructed on the beach vehicle path were relocated within the first 24 hours after oviposition.

RESULTS AND DISCUSSION

Dalyan beach is situated at the intersection point of the Mediterranean and Aegean Sea and 4.5 km in length. The number of loggerhead nests per season varies from 52 to 269 during the years from 1988 to 1996 (Baran, 1993a, 1993b; Baran *et al*., 1992, 1994, 1996; Canbolat, 1991). The mean hatching success during these seasons was 36 %. This low hatching success was mainly due to fox predation. This was increased to 54 % by relocating and caging 27 nests in the season of 1996.

Fethiye beach is about 8 km in length. The number of loggerhead nests per season varies from 88 to 191 during the years from 1993 to 1996 (Baran *et al*., 1992, 1996; Baran and Türkozan, 1996; Türkozan and Baran, 1996). The mean hatching success was 70 % during these years. This high hatching success, compare to other beaches, was obtained by caging around 20 nests each year. The photopollution was the main problem on this beach. For example, a total of 1412 hatchlings (18 %) were disorientated and subsequently died or were eaten by predators in the season of 1996.

Patara beach is 12 km in length, and bisected by Esen River. In this study, the eastern part of the beach was 7 km and only 1 km of the western part of the Esen River was considered. The number of loggerhead nests per season varies from 35 to 85 during the years from 1990 to 1996 (Baran, 1993b; Baran *et al*., 1992, 1996; Kaska, 1993). The mean hatching success was 48 % during these years. By relocating and caging 10 nests in 1996, the hatching success was increased to 59%. Beach erosion and subsequently inundation was one of the main reason for low hatching success. Behind the beach, a fence is erected for forestation purposes. In summer, off shore winds blow sand up the beach piling it against the fence and eroding the sand depth close to the sea. In winter, on shore winds would normally blow sand back, restoring the depth at the shore, but the fence reduces this effect with the overall result being that sand depth close to the sea has been reduced (Kaska, 1993).

Belek beach is about 17 km in length, and our investigation was carried out only in a single breeding season in 1996. A total of 153 loggerhead nests were recorded, of these nests 65 of them were caged. The hatching success was 55 %. Like Fethiye beach, a total of 781 (14%) hatchlings were disorientated and died in the season of 1996.

All four beaches are designated as "Specially Protected Area". Belek and Fethiye beaches have some tourist development. Nest densities were estimated 12-60 nests/km for Dalyan, 11-24 nests/km for Fethiye, 411 nests/km for Patara, and 9 nests/km for Belek beaches. These four beaches may hold up to 700 nests per season. Using the assumption that each female nests an average of 3 times in a season every 2-3 years (Groombridge, 1990), this means that approximately 110-223 *Caretta caretta* nest annually on these beaches.

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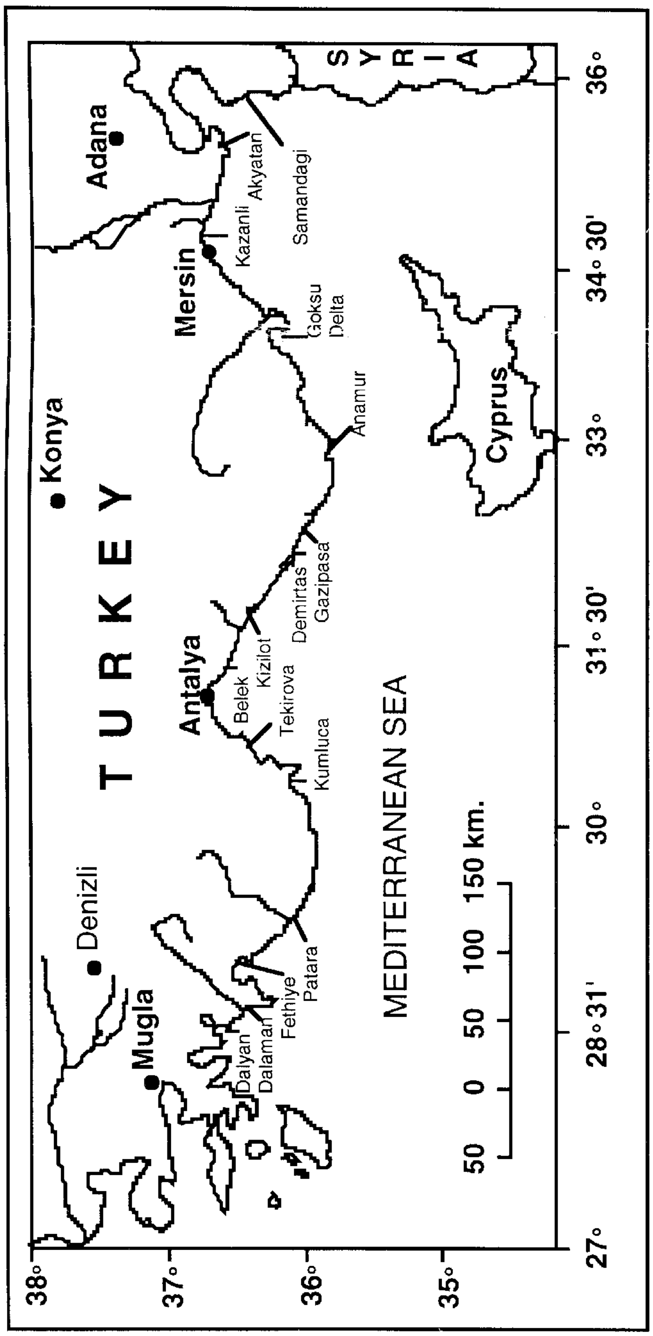

Figure 1. The nesting grounds of sea turtles in Turkey.

STATISTICAL METHODS FOR GREEN TURTLE NESTING SURVEYS IN THE HAWAIIAN ISLANDS

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SURVEY STRATEGY

Since 1973, annual nesting surveys have been conducted at East Island, French Frigate Shoals, in the Northwestern Hawaiian Islands, to monitor the status of the threatened population of green turtles, Chelonia mydas. French Frigate Shoals is part of the Hawaiian Islands National Wildlife Refuge, managed by the U.S. Fish and Wildlife Service. The surveys are a cooperative project between the NMFS Honolulu Laboratory and the FWS.

In spring or early summer, adult green turtles migrate to East Island from inshore foraging pastures throughout the Hawaiian Islands. The females emerge at night to dig nests and deposit eggs in a series of distinct multi-night nesting episodes over the course of the summer breeding season. While ashore the nesters are counted by field personnel and tagged for later identification. Typically, partial-season surveys are conducted. These cover a few weeks during peak nesting activity and are designed to monitor all nesters coming ashore. Until recently, these partial-season surveys produced only simple annual indices of the nesting population size. During a series of saturation surveys in 1988-92, however, complete coverage of the nesting season at East Island was achieved. The saturation surveys provided detailed information about nesting emergence patterns. As described below, such data led to rigorous statistical methods to estimate the nesting population each year on the basis of partial-season survey data (Fig. 1).

NESTING POPULATION ESTIMATORS

Assume that N turtles emerge to nest over a complete nesting season. During a partial-season nesting census the total number of nesters emerging, C, is observed. In addition, the number of individual nesters emerging during the survey, M, is determined by applying unique flipper tags to each nester upon her first observed emergence. The partial-season nesting census provides sample statistics which are raised to estimate N. Two estimators, N1 and N2, are employed:

Method 1: $N1 = C/U$
where U = expected number of emergences per nester during the partial-season survey;
Method 2: $N2 = M/P$
where P = probability that a nester emerges and is sighted ashore at least once during the partial-season survey.

The parameters U and P for a specified partial-season survey schedule depend on nesting emergence patterns, as determined by nightly emergence probabilities. The latter were estimated from the 5-yr series of saturation surveys, in which virtually all turtles coming ashore to nest were identified.

Applied to historical survey statistics, the estimators yield similar results, but Method 2 has generally given slightly lower estimates; statistical and systematic biases of each estimator are the subject of ongoing research. Both estimators, however, show an encouraging upward trend in the nesting population which we attribute to protection of green turtles throughout the Hawaiian Islands under the U.S. Endangered Species Act (Fig. 2).

EMERGENCE TIME MODEL

Saturation survey data also enabled modeling of the probability distribution of nesting emergence time and component stochastic processes. In particular, parsing of emergence histories for 1,115 nesters over 145 nights led to estimates of the probability distributions for nesting frequency, nesting episode duration, and internesting interval. These three processes combine in complex ways to determine the probability that a nester will be present on the nesting beach and resighted on a given night after her initial emergence at East Island. The latter probabilities also were estimated each year directly from saturation survey tag resighting data. A fourth component of the emergence time model is the probability distribution of the arrival time, the date a nester comes ashore to begin her first nesting episode of the season. Assuming the arrival time is a random variate with a gamma distribution, we derived a statistical model of the expected number of nesters ashore on each night of the season, conditional on the resighting probabilities. Then we estimated the arrival distributions for 1988-92 by fitting the expected nester counts to annual survey observations by least squares (Fig. 3 shows results for the 1990 survey).

SURVEY DESIGN

The precision of each nesting population estimator, as measured by its coefficient of variation (CV), depends largely on U and P, and thus on the survey schedule. We estimated bootstrap CVs of N1 and N2 by resampling the saturation survey nesting histories under various combinations of survey start date and survey duration (Fig. 4). We determined that satisfactory precision in N1 and N2 can be achieved by conducting a 30-night survey at East Island beginning about June 1 of each nesting season.

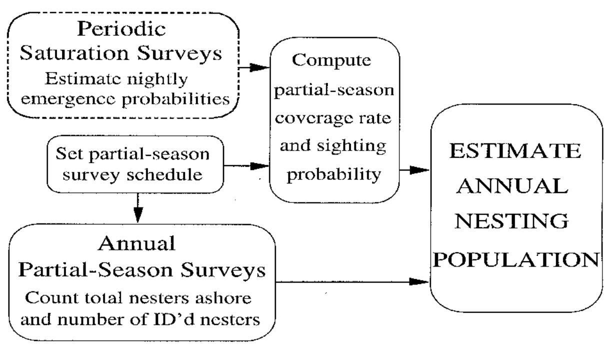

Figure 1. Strategy for monitoring the nesting population.

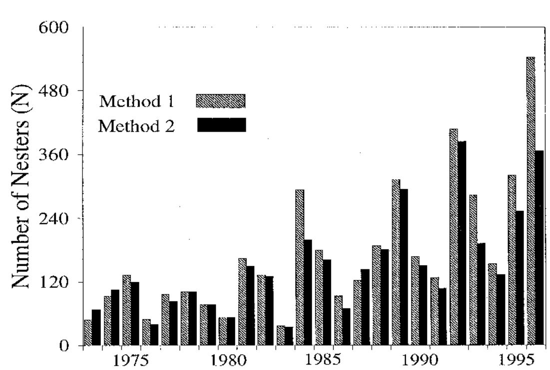

Figure 2. Estimates of East Island green turtle nesting population, 1973-1996.

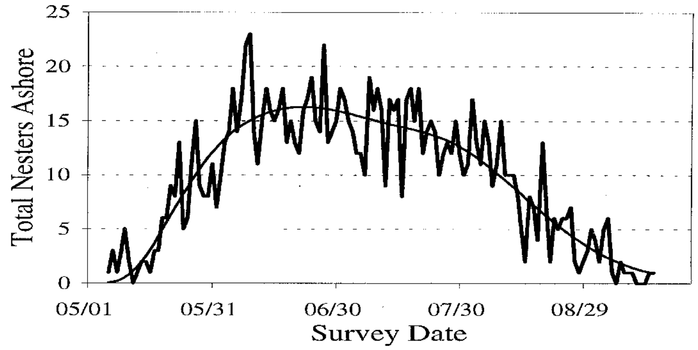

Figure 3. Observed number of nesters ashore and fitted model for the 1990 saturation survey.

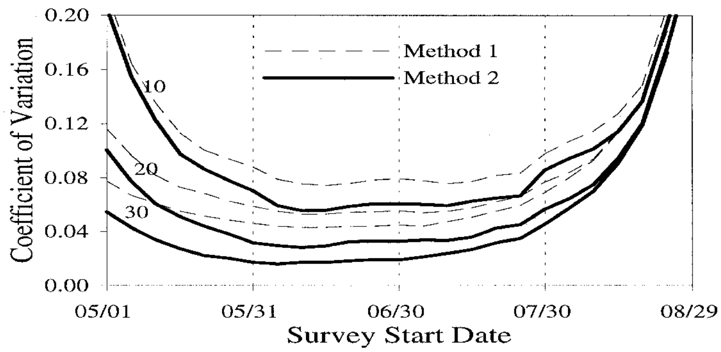

Figure 4. Coefficient of variation of nesting population estimates for surveys with various start dates and durations of 10-30 nights (assumes nesting population of 200 turtles).

STATUS OF THE DEVELOPMENT OF A MULLERIAN INHIBITING HORMONE SEXING TECHNIQUE FOR HATCHLING SEA TURTLES

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INTRODUCTION

Like many other reptiles, sea turtles possess temperature-dependent sex determination in which the incubation temperature of the egg determines the sex of the hatchling (reviewed by Mrosovsky, 1994). This type of sex determination can result in biased hatchlings sex ratios, and previous studies suggest that such biases could significantly alter the effectiveness of sea turtle conservation programs (Mrosovsky and Yntema, 1980; Morreale *et al*., 1982; Mrosovsky, 1983). As such, it is advantageous to monitor sex ratios produced in conservation programs. However, sexing hatchlings sea turtles presents a logistical problem. Historically, it has required the killing of the hatchling so that the gonad can be examined histologically (Yntema and Mrosovsky, 1980). More recent studies have begun to examine sex specific hormone levels as possible indicators of sex in hatchlings (Gross *et al*., 1995). The purpose of the current study is the development of a practical and nonlethal technique which clearly indicates the sex of hatchlings based on the levels of mullerian inhibiting hormone (MIH) in the blood. Over the past two years we have been developing a sexing technique which is based on an "enzyme linked immuosorbent assay" (ELISA) for MIH. In vertebrates, both male and female embryos develop mullerian ducts which form the oviducts in females (*i.e.*, fallopian tubes and uterus). Male vertebrates begin producing MIH during late embryonic development and this hormone stimulates the degeneration of the mullerian ducts (Donahoe *et al*, 1987; Josso *et al*., 1991). The gene for MIH has previously been cloned in several mammals and in the chicken (Cate *et al*., 1986; Eusebe *et al*., 1996). Further, previous studies indicate that MIH levels are high in young males. For example, in humans, MIH in males is extremely high at birth and remains high for six years or more, whereas levels are very low or nondetectable in females (Hudson *et al*., 1990).

MIH CLONING AND EXPRESSION FOR ANTISERA PRODUCTION

To develop the MIH-based ELISA sexing technique, we needed both turtle MIH protein and MIH antibodies. A PCR-based strategy was used to clone fragments of turtle MIH cDNA. Adrenal/kidney/gonad tissue was dissected from turtle embryos during the period of mullerian duct regression. Total RNA was isolated using Trizol Reagent (Gibco BRL). cDNA template for the PCR was generated from the total RNA using a Superscript first strand synthesis kit (Gibco BRL). A wide variety of primers were utilized in the PCR. Primers design was based on conservative regions of the MIH gene in chicken and mammals. Hundreds of PCRs were conducted with various primer combinations and PCR conditions. Fragments amplified in the PCR were initially screened by size. Fragments of the appropriate size were screened by PCR using the original primer set as well as internal primer sets. Fragments of interest were then cloned into pGem T vector (Promega) and sequenced with Sequenase II DNA sequencing system (U.S. Biochemical). The sequence data from cloned fragments were compared to MIH sequences of other vertebrates. In order to produce recombinant MIH and MIH antisera, a pET expression vector was utilized in combination with our turtle MIH clones.

HATCHLING BLOOD SAMPLING

Validation of a hatchling sexing technique requires blood samples from hatchlings of known sex. To obtain such samples, one hundred and sixty loggerhead eggs were collected from eight freshly laid nests (20 eggs per nest) on the Archie Carr National Wildlife Refuge near Melbourne Beach, Florida. The eggs were brought back to the University of Alabama at Birmingham and were randomly selected for incubation at one of four temperatures: 26°, 27°, 32° or 33°C. These temperatures were specifically selected to ensure male (26° and 27°C) or female (32° and 33°C) differentiation, since the pivotal temperatures reported for loggerheads are approximately 29° to 30°C, (reviewed by Mrosovsky, 1994). Constant incubation temperatures were maintained in custom incubators which held the selected temperatures to within + 0.2°C. A variety of blood sampling techniques were evaluated for hatchlings. Heparinized 1 cc tuberculin syringe with 25 ga needles were used for sampling. Samples were transferred to microcentrifuge tubes, spun in a tabletop centrifuge, and the plasma frozen at -80°C.

RESULTS AND DISCUSSION

<u>Blood Sampling</u> We evaluated several blood sampling techniques for hatchlings and were able to obtain 100% sampling success in the laboratory. Several different sampling locations on the dorsal portion of the neck proved optimal, with minimal stress and no mortality associated with the procedures. Further we have utilized these same techniques successfully on the nesting beach for obtaining hatchlings blood samples.

MIH Sexing Technique Development Initially, a 226 bp fragment from the 3' region of exon five was cloned and sequenced. The data from this clone was used to generate reverse primers used to clone a 267 bp fragment which was continuous with the original fragment. Most recently, a 1038 bp fragment has been cloned and sequenced which includes both of the original fragments. As with the first two fragments, the 1038 bp fragment was originally screened with internal primers designed from conservative regions of MIH in chicken and mammals. The contiguous 1038 bp region of turtle MIH shows high homology to chicken MIH. Further, the sequence of the 1038 bp clone indicates that it is MIH and not from a closely related gene such as TGF- or inhibin. We have successfully cloned the large MIH fragment into a pET 15b expression vector (Novagen, Inc) and transformed it into specific expression host cell (BL21,DE3, pLYSs from Novagen, Inc) in order to produce MIH protein for ELISA and antisera development. We are currently titering and evaluating four different MIH antisera in ELISAs in our laboratory.

ACKNOWLEDGMENTS

This research was supported through funding provided by Mississippi-Alabama Sea Grant Consortium (grant # NA56RG0129) and University of Alabama at Birmingham.

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TWENTY-FOUR YEARS OF LOGGERHEAD SEA TURTLE CONSERVATION ON WASSAW NATIONAL WILDLIFE REFUGE, GEOGIA

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INTRODUCTION

The Caretta Research Project (CRP) is a hands-on research and conservation program involving the threatened loggerhead sea turtle (*Caretta caretta*) and is conducted on the beaches of the Wassaw National Wildlife Refuge, GA. The refuge is comprised of Wassaw, Pine and Little Wassaw Islands, a series of barrier islands just east of Savannah, GA. The CRP is based on the largest of these islands, Wassaw Island, where turtle activity has historically been the highest. The 1997 season will mark the 25th consecutive season of this project.

The primary objectives of the CRP are to 1) learn more about population levels, trends and nesting habits of loggerhead sea turtles; 2) enhance the survival of eggs and hatchlings on a nesting beach where loss to predators and beach erosion have been high; and 3) educate the public and involve interested individuals in the research and conservation efforts of the CRP.

METHODS

The Caretta Research Project is conducted by an island leader, at least one assistant and up to six volunteers for one week intervals from mid-May through mid-September. Nightly patrols of Wassaw Island begin in mid-May and continue through the beginning of August. Pine Island is also patrolled from May through mid-August. For both false crawls and nests, information regarding date, time, weather conditions, and length and location of crawl are recorded. If a turtle is observed, crews record any existing flipper or PIT tag numbers, unusual markings, abnormalities and carapace measurements if circumstances permit. Turtles are placed into one of four categories: 1) Neophyte: a turtle which has not been recorded or identified to have been previously tagged (although she may have nested before); 2) Remigrant: a turtle which has been tagged on Wassaw Island during previous years; 3) Immigrant: a turtle which was previously tagged on another beach; or 4) Unknown: a turtle which possesses tag scars but the history cannot be traced.

Historically, turtles were tagged with plastic tags on the rear flippers. However, the turtles are now tagged with both inconel tags on each front flipper and a Trovan PIT tag in the right flipper. If no tags are present or a tag is missing from one of the front flippers, the turtle is tagged appropriately. Nests are either left in situ, relocated to a safe zone and screened for protection, or transferred to one of the hatcheries. After emergence, nests are excavated and the contents are examined. Recorded data include the number of live and dead hatchlings and the number of unhatched eggs remaining. Hatching success of the nest is then determined. If live hatchlings are found they are immediately released, allowing them to crawl down the beach. Any live hatchlings found during daylight hours are kept in a dark, quiet area until nightfall when they are released.

The presence of any stranded turtles found dead on the beach (DOB) during patrols are recorded on data sheets provided by the Sea Turtle Stranding and Salvage Network (STSSN) based in Miami, FL. Recorded data include species of turtle, probable cause of death, and curved carapace length and width of each dead turtle.

RESULTS AND DISCUSSION

Tagging data indicate that approximately 848 documented individuals have utilized Wassaw Island since 1973. Of these, 791 were classified as neophytes and 57 were individuals originally tagged on other nesting beaches. Ninety-eight turtles had existing tag scars indicating that they were previously tagged, and no history could be determined for 10 of the recorded turtles .

The population structure each year has consisted of an average of 74% neophytes, 11% remigrants, 5% immigrants and 10% unknown. The consistently high number of untagged turtles and low number of remigrants observed each year is surprising considering the length of duration of this project. Other long-term tagging projects report between 30-40% neophytes each season (Richardson, 1982) while the average on Wassaw Island from 1973-1996 is 74%. However, accurate population structure and nesting statistics are difficult to determine for a number of reasons including possibility of high recruitment, frequent tag loss, missed turtles during beach patrols (Bjorndal, 1980), or occurrence of inter-island shifting .

There are a number of turtles demonstrating nest-site fidelity to Wassaw Island. Over the last 23 years, there have been 84 individuals that have come back to Wassaw Island repeatedly to nest. Two individuals have a documented nesting history of greater than 10 years and have each been observed on Wassaw Island during six seasons. One turtle was originally tagged in 1975 and last seen in 1987, the other was originally tagged in 1978 and last seen in 1994. Although some turtles demonstrate instances of nest-site fidelity, tag returns since 1973 have shown that inter-island shifting is common. Although most turtles have been observed on the Georgia barrier islands, including Little Cumberland, Cumberland, Ossabaw, Jekyll, and Tybee Islands, some females are encountered farther away from the original tagging site than expected. Since the beginning of the project in 1973, Wassaw turtles have been documented on nesting beaches as far north as Nags Head, NC to as far south as Cape Canaveral, FL. It has been well documented that Richardson's (1977) theory of "inter-island shifting" is common along the Georgia/South Carolina coast, however the scope of this shifting may be more extensive than originally believed.

SUMMARY

To date, the project has:

1) documented more than 3000 accounts of loggerhead turtle nesting activity on Wassaw Island 2) added 791 turtles to the tagged loggerhead population
3) monitored over 1500 nests containing more than 182,000 eggs
4) released over 108,000 hatchlings into the ocean
5) trained eight interns who have gone on to other environmental / educational programs
6) involved over 1800 volunteer participants
7) conducted an endangered species survey on Williamson Island

ACKNOWLEDGEMENTS

The CRP and the Savannah Science Museum would like to thank the following people and institutions for their support and assistance during the 1996 season:
-Directors and Island Leaders : John Crawford, Michael Frick, Todd Gedamke, Robert Graham, Andy Meadows, Patti Mouchet, Win Seyle, Charles Warnock, Kris Williams, Gerald Williamson, and especially Robert Moulis for organizing the initial compilation of the data from 1973-1992 -The Interns and Assistant Island Leaders
-The Savannah Science Museum's Board of Trustees for their support -Members of the Wassaw Island Trust for their continued support which makes this possible -Randy Isbister, Charles Warnock, John Robinette, Mark Musaus, Sam Drake, and the rest of the USFWS personnel for assistance with all necessary permits and for their continuing advice and support. - GA DNR personnel for assistance with the necessary permits, stranding reports, obtaining information on turtle activity and providing advice throughout the season. -All of the boat captains for consistently providing transportation for our research crews and volunteers -All of the volunteers that have helped the project both on and off WNWR.

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TRACKING OF KEMP'S RIDLEY (*LEPIDOCHELYS KEMPII*) AND GREEN (*CHELONIA MYDAS*) SEA TURTLES IN THE MATAGORDA BAY SYSTEM, TEXAS

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In 1996, a cooperative study was undertaken by the National Marine Fisheries Service (NMFS) Galveston Laboratory, Texas A&M University at Galveston (TAMUG), the U.S. Environmental Protection Agency (EPA) and Formosa Plastics Corporation (FPC) to determine potential impacts of an increased industrial discharge from the FPC Point Comfort plant on sea turtles within Lavaca Bay, Texas (Fig. 1). A portion of this research effort was to determine the distribution and movements of sea turtles within the Matagorda/Lavaca Bay complex. Collection of data on the historical distribution of sea turtles within the area and entanglement netting were conducted by TAMUG. Movements of turtles captured by TAMUG were determined through radio and/or satellite tracking conducted by NMFS.

METHODS

Eleven sea turtles were captured by TAMUG during 497.12 netting hours at Magnolia Beach, Texas from May until October 1996 (L. Kenyon, TAMUG, pers. communication, January 1997) . Straight and curved carapace measurements and weights for each turtle were recorded. Each turtle was tagged on both front flippers with an inconel tag and a Passive Integrated Transponder (PIT) tag was injected into the right front flipper. Six subadult (31.5 - 43.9 cm SCL) Kemp's ridleys (*Lepidochelys kempii*) and two subadult (29.9 and 37.5 cm SCL) green sea turtles (*Chelonia mydas*) were radio and sonic tagged. One 58.4 cm SCL Kemp's ridley and two subadult greens (35.0 and 36.3 cm SCL) were outfitted with satellite transmitters. Radio transmitters and satellite transmitters were attached to the second neural scute using fiberglass cloth and resin. Sonic tags were attached through a small hole drilled through the posterior most marginal scute. Turtles were released within 1 km of their capture site. Movements and diving patterns of the radio-tagged turtles were monitored for two weeks out of every month from May until November. Turtle locations were determined through visual sightings or sonic telemetry and were recorded using a Global Positioning System (GPS). Positions were triangulated from shore on days in which weather or vessel malfunction prevented being on the water. Data were also recorded on water depth, salinity and temperature, cloud cover, sea state, and wind speed and direction. Data transmitted from the satellite tags were received through Service ARGOS and included latitude and longitude, date and time of transmission and cumulative surface time.

RESULTS AND DISCUSSION

Five of the six radio tracked Kemp's ridleys stayed within 2.5 km of the shoreline of western Matagorda Bay (Fig. 1). Kemp's ridley 4811 was located within Powderhorn Lake from 27 - 31 July, but returned to Matagorda Bay on 01 August. Kemp's ridley 5601 moved slightly further south than the others to 1 km northeast of Port O'Connor. Of the six radio tracked Kemp's ridleys, two (4391 and 5801) were located in Lavaca Bay on 28 occasions. Both were found on the southern or western boundary of the bay and not on the eastern shore near the FPC Point Comfort Plant. One Kemp's ridley (4191) moved 40 km east into Tres Palacios Bay after spending four days in Caranchua Bay.

Radio tracked green 5201 showed similar movement to the ridleys. The second radio tracked green moved into Powderhorn Bayou two days after its release in June and remained there until last contact in early November. The turtle was consistently located along a 200 m stretch of shoreline within 50 m of the shore.

Mean submergence durations for the radio tracked turtles were 6.3 ± 0.2 minutes for the Kemp's ridleys and 1.8 ± 0.8 minutes for the greens. Mean surface duration for the Kemp's ridleys was 0.46 ± 0.02 minutes and 0.08 ± 0.003 minutes for the greens. Percent submergence time was 92.9% for the Kemp's ridleys and 96.1% for the green sea turtles.

Contact was maintained with satellite tracked green sea turtle 8009 through the end of January 1997 and as of March 1997, transmissions were still being received from satellite tagged green 7299. Latitude and longitudes placed the turtles within Lavaca Bay on 6 occasions; however, location reliability codes indicated that an error of greater than 1 km was possible. Both turtles remained on the central Texas coast until the passage of a cold front on 11 January at which time they both moved approximately 180 km to the south. In mid-February, 7299 began moving north again and had returned to the Matagorda Bay area by late March. No data were received from the satellite tracked Kemp's ridley. The absence of data could be due to transmitter failure, loss of the transmitter or death of the animal.

Results from this study suggest that there are at least 2 species of sea turtles present in the bay that may be at risk from potential toxicants from an increased wastewater discharge from the FPC plant. Four of the ten sea turtles tracked were located in Lavaca Bay, but none were found in close proximity to the FPC plant. In order to assess the impacts of an increased wastewater discharge on sea turtles within the bay, studies of the distribution of turtles throughout the bay should be supplemented with studies on the distribution and movement of prey items and the concentrations of potentially harmful substances in their tissues. The level of risk posed to the two species of sea turtles tracked may be different because of their differing diets. In a comparison of the organochlorine levels in loggerheads and greens, Rybitski *et al*. (1994) hypothesized that higher concentrations found in the primarily carnivorous loggerheads could be due to bioaccumulation. Little research has been done to determine the baseline levels and physiological effects of pollutants such as organochlorines and heavy metals in sea turtles (Witkowski and Frazier, 1982, McKim and Johnson, 1983). A biopsy technique for sampling depot fat in loggerhead sea turtles was developed by NMFS Galveston in 1996 (A. Cannon, pers. communication, March 1997) , but had not yet been implemented at the time of this study. Blood samples were collected from the turtles and will be analyzed by TAMUG in order to determine levels of heavy metals (L. Orvik, TAMUG, pers. communication, March 1997). The temporal distribution of turtles within Lavaca Bay needs to be studied further to determine if the presence of sea turtles within the bay is based on specific seasons or size classes. The activity of the two turtles tracked during the winter months suggest that turtles relocate from inshore to offshore habitat when bay water temperature drops below 17ºC. Turtles may return inshore in the spring when water temperature reaches 20ºC. Similar overwintering behavior of Kemp's ridleys was described by Renaud *et al*. 1994, 1995. Despite the fact that few of the sea turtles tracked frequented Lavaca Bay with any regularity, more sampling and tracking would greatly increase our knowledge of the distribution of turtles in the area and how they could be impacted by human activities.

ACKNOWLEDGMENTS

The authors would like to acknowledge the following people who assisted in conducting this research: USCG Pt. O'Connor, Travis Hanna, Lisa Clyne, Eric Huckzermeyer, John Boyd, Mike Harrelson and Andy Schiro

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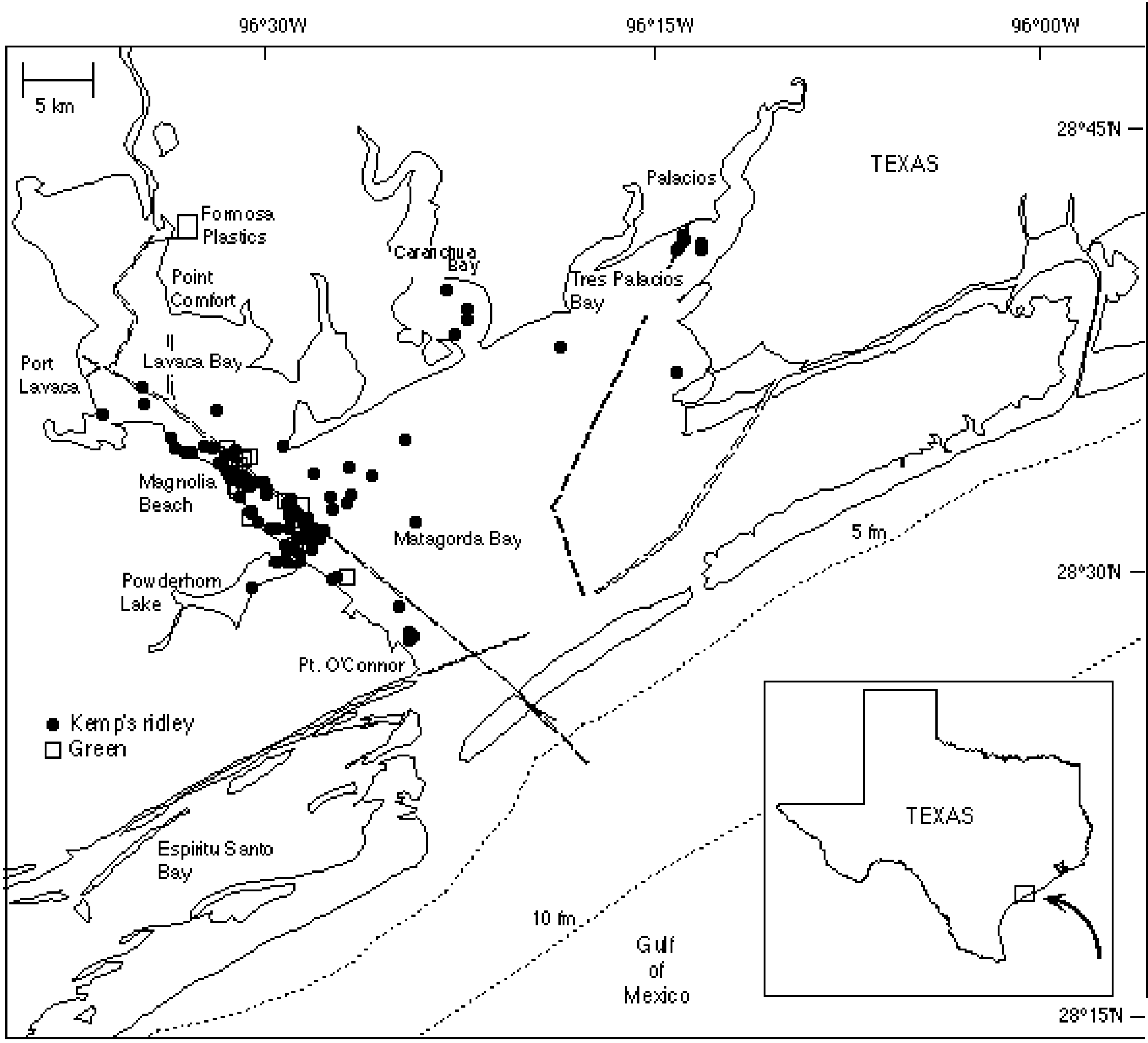

Figure 1. Map showing Lavaca / Matagorda Bay study site and distribution of radio-tracked turtles.

RESULTS OF EXTERNAL FIELD EXAMINATIONS OF STRANDED LOGGERHEAD SEA TURTLES (*CARETTA CARETTA*) ON THE GEORGIA COAST FROM 1989-1996

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This paper summarizes the results of external examinations of 1,193 loggerheads found stranded on the Georgia coast between 1989-1996. Size class, spatial, and temporal distributions are presented. Potential causes of mortality based on the descriptions given by the Sea Turtle Stranding and Salvage Network participants on the stranding forms are presented and discussed. Necropsies were performed on 35% (417) of the stranded loggerheads during this period, results of those internal examinations are not presented here.

ABSTRACT

Data from the Georgia Sea Turtle Stranding and Salvage Network from 1989 through 1996 were analyzed for physical indications of possible mortality causes. Loggerheads made up 74.3% (n=1193) of the total 1,606 strandings of all species. External damage as a possible cause of death was recorded for 51.6 % (n=586) of the loggerhead strandings, 48.4% (n=550) exhibited no external damage. For those with external damage, 47% (n=278) had some combination of flippers and/or head missing. Boat damage accounted for 27.5% (n=161), unknown carapace damage 16.4% (n=96), 4.8 % (n=28) were partial carcasses, and 4.4% (n=26) had distinct signs of mutilation. Carcass damage attributed to boat collision increased from 4% to 15% over the period. Shark sign was recorded on 7.8% of the total loggerheads (n=93) and 33% of those carcasses missing appendages. Size class distribution showed that of 6 size classes, 41.6% of measured strandings fell within 60.01 cm - 70.00 cm curved carapace length. The size class parameters were: 1. <60.00 cm (n=226); 2. 60.01-70.00 cm (n=426); 3. 70.01-80.00 (n=123); 4. 80.01-90.00 (n=49); 5. 90.01-100.00 (n=118); and >100.01 (n=83). No statistically significant changes were evident for any of the size classes for the period examined. Mean curved carapace length was 61.8 cm. Temporal distribution showed peak strandings in June and July, with 91% of the strandings occurring from April through October. Spatial distribution of loggerhead strandings for 12 barrier islands was not uniform (range = 26-427), with 36.7% (n=427) recorded from Cumberland Island. Total strandings per island were: Tybee 27, Wassaw 34, Ossabaw 73, St. Catherines 61, Blackbeard 46, Sapelo 95, Little St. Simons 26, Sea 58, St. Simons 120, Jekyll 146, Little Cumberland, 50, and Cumberland 427. Average standings per kilometer of beach shows a disproportionately higher number of turtles stranded per kilometer of St. Simons Island than on any other island.

METHODS

Daily beach surveying effort for stranded turtles was consistent on twelve of Georgia's barrier islands, representing 125.5 kilometers, or 85% of the coast, from the 1989 loggerhead nesting season through the 1996 nesting season. This area includes part of STSSN statistical zone 32, all of zone 31, and part of zone 30. A minimum of weekly surveys for stranded turtles was conducted throughout the cooler months of the non-nesting season of 1989 through 1996. Strandings were reported by phone to the Georgia stranding coordinator within 24 hours of discovery. Sea Turtle Stranding and Salvage Network (STSSN) forms were completed and faxed (when possible), or mailed to the coordinator.

All data were entered into a dBase for Windows file according to STSSN guidelines set by the national stranding coordinator. Stranding forms for the period were reviewed and checked against the Georgia database for uniformity and accuracy. Potential cause of death for loggerheads was examined. Combinations of any missing appendages including the head and all flippers (STSSN codes 18 and 88) were grouped together as "Missing Appendages". Clearly described propeller strikes were grouped with well defined boat impact wounds (codes 18 and 88) and reported here as "Boat Damage". "Unknown Cause" carapace damage (code 54) and partial carcasses (code 98), were reported separately. Reports of shark inflicted carcass damage were taken from the comments section of the stranding forms. Mutilation sign (STSSN code 26), bullet wounds (code 30), and cut flippers (38), were grouped as "Mutilation". Recognized forms of damage were not exclusive, with more than one condition possible for each carcass.

RESULTS AND DISCUSSION

Just over half (51.6%) of the loggerhead carcasses had some kind of external damage. We do not know what percent of that damage contributed to the mortality of the turtles. Just under half (47%) of the damaged turtles were missing heads and/or flippers. While shark sign was described on only one third of the carcasses with missing appendages, STSSN participant ability to recognize shark marks, especially on the severely decomposed turtles, could have contributed to the low number of shark bites reported. We consider most missing appendages to be post mortem shark damage. Intentional mutilation of flippers, where the flesh and joint had been cleanly cut were recorded four times for the period.

The percent of carcasses with injures believed to be due to boat collision has risen to 15% in 1996 from 4% in 1989. This could be an indication of more turtles in the area to be hit, or an increase in recreational and commercial boat traffic in coastal waters. Recreational boating permit statistics prior to 1994 were not available. We consider most boat impact damage to be ante-mortem, and the prime cause of death for strandings exhibiting potentially lethal strikes. Carapaces with unrecognizable impact damage made up 16.4 % of the damaged carcasses. Stranded turtles with clearly defined signs of mutilation made up 4.4% of damaged strandings. This is probably an underestimate of the actual mutilations, but is not considered to be a major cause of mortality for the turtles in Georgia waters.

Just under half of the loggerhead strandings (48.4%), showed no signs of external damage. The carcasses were most often reported in good external physical condition, with less than 1% showing signs of emaciation and or heavy barnacle loads. Stranded turtles that drown, or are caught in shrimp seines do not show physical signs of trauma (Caillouet *et al*., 1996).

Juveniles between 60.01 and 70.00 cm curved carapace length made up 41.6% of all stranded loggerheads. Large juveniles are the size class most frequently found stranded on the southeast coast (Crouse *et al*., 1987). Of note are the 49 loggerheads that measured between 80.01 - 90.00 cm, representing only 4.8% of the strandings. Assuming that the cumulative strandings are representative of the size class distribution of living turtles in Georgia waters, then we have either a severe recruitment problem into the breeding size class >90 cm, or the 80.01-90.00 cm turtles are not on the Georgia coast during this growing stage. It is interesting to note that there has not been a statistically significant change in stranding numbers from 1989 through 1996, and that the annual variation in the percent of each of the size classes do not show any significant changes either.

Spatial distribution of loggerhead strandings, when corrected for the length of each island, show the number of strandings per kilometer for most of the southern islands, at more than double the average for the five islands north of Sapelo. And, St. Simons Island, with only 3.7 km of beach, had an average of 32 loggerhead strandings per kilometer. This compares to the next highest stranding rate on Cumberland where an average of 15 carcasses were found for each of the 28 km of beach. We do not know why the stranding rate on St. Simons is so high.

ACKNOWLEDGMENTS

The data presented here were collected with considerable effort by the following Georgia STSSN participating organizations and individuals: Personnel from the City of Tybee, U.S. Fish and Wildlife Service, Savannah Science Museum, St. Catherines Island Foundation, Georgia Southern University, Little St. Simons Island, Sea Island Corporation, Jekyll Island Authority, and the National Park Service. Special thanks goes to the long-term conservation efforts of Rebecca Bell on Little Cumberland Island, and Carol Ruckdeschel on Cumberland. Thanks to the continuing support of Nongame Program biologists mike Harris, Barb Zoodsma and Steve Pete.

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CAUSES OF GREEN TURTLE (*CHELONIA MYDAS*) MORBIDITY AND MORTALITY IN HAWAII

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Since at least the mid-1980s, green turtles in the Hawaiian Islands have increasingly been found afflicted with fibropapillomatosis (FP), a disease first described in green turtles from Florida. Most studies on marine turtle mortality and morbidity have either focused on particular diseases or epizootics. Surveys to identify general causes of mortality in green turtles are relatively few. Yet, such surveys could provide valuable clues to relative impact of different causes of mortality on green turtle populations. From 1993-1996, we conducted systematic pathologic exams on 49 dead or moribund green turtles from various islands in Hawaii. Fibropapillomatosis (FP) was the most common cause of morbidity/mortality in Hawaiian green turtles followed by trauma and miscellaneous diagnoses. Internal tumors were seen in 38% of FP afflicted turtles and FP afflicted turtles were severely hypoproteinemic and anemic.

Seven of 49 turtles had to be frozen after being found dead; the remainder were moribund animals humanely euthanized with lethal injection due to poor prognosis. Prior to euthanasia, blood was procured from the heart and placed in heparin or serum separator tubes. We obtained hematocrit and estimated total solids according to standard methods.

Each turtle underwent a complete external and internal exam of all major organ systems. We recorded sex, straight carapace length, weight, and quantified and measured all tumors. Representative tissues were fixed in 10% formalin and processed routinely for histopathology. Where applicable, special stains were made to identify fungi, connective tissue, and sulfated mucopolysaccharides, respectively. Select tissues were cultured for bacteria and fungi on agar media and for viruses on green turtle embryo cell lines.

Animals were grouped into diagnostic categories according to the most significant pathologic findings. These included 1)fibropapillomatosis for those animals with skin, eye, internal or oral tumors; 2) Trauma for animals with no tumors and gross lesions of hemorrhage and fractured shell/bones or foreign body ingestion; 3) Miscellaneous for all other diagnoses and 4) Undetermined for those animals for which cause of death could not be discerned.

Straight carapace length, hematocrit and estimated total solids of moribund and healthy turtles were compared using t-test (α=0.05). Fibropapillomatosis was the most common diagnosis (73%). External tumors were seen on the eyes, glottis, cloaca and skin and classified as fibropapillomas. Twenty eight percent of animals in this group had internal tumors most commonly in the lungs followed by kidney, skeletal muscle, heart, liver, spleen and bone. Based on staining and morphology, tumors in the lungs, liver, spleen and kidneys were classified as fibromas or myxofibromas. Tumors in the skeletal muscle, heart and bone were classed as fibrosarcomas of low grade malignancy. Condition of the animals ranged from emaciated to excellent.

Trauma made up 10.2% of diagnoses. Two turtles died from known forced submergence in gill nets. Two others were hit by watercraft. One turtle died from intestinal perforation accompanied by severe peritonitis secondary to fishing line ingestion. Miscellaneous diagnoses (8.2%) included one animal with severe bacterial pneumonia, one turtle with presumptive myocarditis of unknown origin, one turtle with severe egg yolk peritonitis, and one turtle with severe vascular trematodiasis and bacteremia secondary to massive vascular trematode infection. Almost all animals in all categories had varying degrees of vascular trematode infection. For the remainder of the turtles, cause of death could not be determined because lesions encountered were very mild or no lesions indicative of cause of death were noted.

Hematocrit and estimated total solids of stranded turtles were significantly lower ($P<0.0001$) than those of free-ranging healthy turtles. Straight carapace lengths between the two groups did not differ significantly ($P=0.64$). Thirty four animals were immature, 10 subadults and five adults. FP is the most common cause of morbidity and mortality in free- ranging green turtles in Hawaii, and appears to affect mostly immature animals. Animals afflicted with FP are severely hypoproteinemic and anemic, but not all are necessarily emaciated. Some internal tumors of FP-afflicted animals appear locally invasive, particularly those within skeletal and heart muscles. Prevalence of vascular trematode infection in free ranging green turtles is close to 100%. In some cases, infection is severe enough to cause mortality, especially in conjunction with FP. Future research needs to focus on elucidating the etiology of FP and life cycles of vascular trematodes.

THE NESTING OF SEA TURTLES IN ANAMUR, SOUTHEAST TURKEY: A PRELIMINARY STUDY

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INTRODUCTION

Approximately 2000 female loggerhead turtles nest in the Mediterranean Sea. Most of them nest in Greece, Turkey and Northern Cyprus (Groombridge, 1990). The green turtle is less abundant. It is estimated that 300-400 females nest every year in the Mediterranean. Turkey's Mediterranean coastline measures more than 1500 km and covers major nesting areas for both species (Baran and Kasparek, 1988). The distribution of the green turtle and the loggerhead turtle in Turkey is unequal. Greens nest only in the warmer eastern parts of Turkey. The area of Anamur in southeast Turkey belongs to the Alanya-Mersin region at the foot of the Taurus mountains. The coast has a length of 12 km and consists mostly of sandy beaches which are backed by dune fields but also by holiday homes, taverns, bars and camping sites. The width of the beaches ranges from 10 to 40 metres.

MATERIALS AND METHODS

The aim of the study was to assess the nesting activity of sea turtles in Anamur and to identify the main threats. Regular surveys were conducted from early June until late August 1996. The beach was divided into four sectors which were surveyed by foot regularly in the morning in teams of two or three volunteers. In each section tracks and nests were counted and predation and hatching was recorded. Nests were excavated after hatching in order to estimate clutch size.

RESULTS

During the survey a total of 187 nests has been recorded on the 12 km long beach. All nests were made by *Caretta caretta*. The allover nesting density was 15.6 nests/km. Nesting was not evenly distributed along the beach. Section three (1.5 km) was by far the most frequented area in the region of Anamur hosting 49 % of the total number of nests. Nesting success ranged from 10.2 % to 27.3 % with an allover nesting success of 18.4 %. During the study period 79 nests (42.2 %) were recorded as hatched and at least 50 nests (26.7 %) were recorded as predated either by foxes or stray dogs. 26 nests (13.9 %) were monitored from oviposition until the appearance of hatchlings. They showed a mean incubation period of 51.3 days (sd = 5.59). 20 of these nests were excavated and showed a mean clutch size of 89 eggs (sd = 20.9).

DISCUSSION AND RECOMMENDATIONS

With 187 nests the beach of Anamur is an important nesting habitat of *Caretta caretta* in Turkey. Estimating the population size by dividing the total number of nests recorded by three (Groombridge, 1990) gives a total number of 62 female loggerhead individuals nesting in the Anamur area. In sectors two, three and four, stretching over 6 km, the most nesting activity occurred (90 %). In these sectors predation by stray dogs and foxes (at least 30 %) as well as human impact have been assessed the major problems. 34 % of predated nest were predated on the first day of hatching. Therefore it is recommended to protect all nests with fences or metal grids in these sectors in order to offset the loss of hatchlings. Public awareness activities should be carried out regularly. Tourists in this area were mainly Turkish and showed a positive attitude towards sea turtles. Inundation of nests by high tides was considered a minor problem but relocation of nests which are laid close to the surfline is suggested.

The allover nesting success of 18.4 % is considered very low. In sectors two and four lights and noise seemed to be the most disturbing factors whereas beach or sand parameters in sectors one and three seemed to reduce nesting success. Further investigations especially concerning sand parameters should be carried out. The calculated mean incubation period of 51.3 days is shorter than the mean of 55.5 days in the Peloponnesus, Greece (Margaritoulis, 1989) and 57 days in the Goeksu delta (Van Piggelen and Strijbosch, 1991) and higher than 47.9 days on Northern Cyprus (Godley and Broderick, 1993). With 89 eggs/nest the calculated clutch size differs considerably from clutch sizes mentioned in the literature. Baran *et al*. (1992) found an average clutch size of 75.1 eggs/nest in the same area. The mean clutch size of *C. caretta* in N. Cyprus is 75.7 eggs/nest (Godley and Broderick, 1993) and 119.9 eggs/nest on the Peloponnesus (Margaritoulis *et al*., 1993).

For the next seasons it is recommended to monitor sectors two, three and four (6 km) regularly at night in order to obtain information about size and other characteristics of the loggerhead population in this area. Further house building and tourist development activities especially in these sectors must be reduced. Although sand extraction from the beaches is forbidden by law it is regularly done. Therefore great emphasis should be put on the prevention of sand extraction by legal enforcement. On 17th and 18th of August subadult female green turtles (twelve and six individuals) have been observed approximately 150 m offshore in front of a drainage channel in sector four. One of the turtles was foraging in 5-6 m depth. Later in the season the presence of several green turtles in the same area was confirmed by other volunteers of the project. The seaground in this area is covered with patches of seagrass and it can be assumed that the Anamur area is used as foraging ground by immature green turtles. Therefore the reduction of fishing activities in this area should be considered.

ACKNOWLEDGMENTS

This study was supported by the Turkish Ministry of Environment and partially funded by the Aktionsgemeinschaft Artenschutz (AGA), Germany and GULET Reisen, Austria. We would like to thank all Turkish and Austrian volunteers for collecting data as well as Dr. Michael Stachowitsch from the University of Vienna for coordinating the project in Austria.

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THE NATION'S FIRST SEA TURTLE HABITAT CONSERVATION PLAN UNDER THE ENDANGERED SPECIES ACT

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In 1996, USFWS issued a permit for sea turtle deaths resulting from beach driving in Volusia County, Florida. A Habitat Conservation Plan (HCP) was requested to minimize and mitigate the deaths to the maximum extent practicable. The poster presentation will identify problems in sea turtle conservation on Volusia beaches, the solutions suggested in the public comments, the steps taken (if any) in the HCP to address the problems, and the prospect for effective sea turtle conservation with the HCP in place. Photographs and videotape will document beach conditions and problems. Individuals involved in Volusia issues will be present for discussion.

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