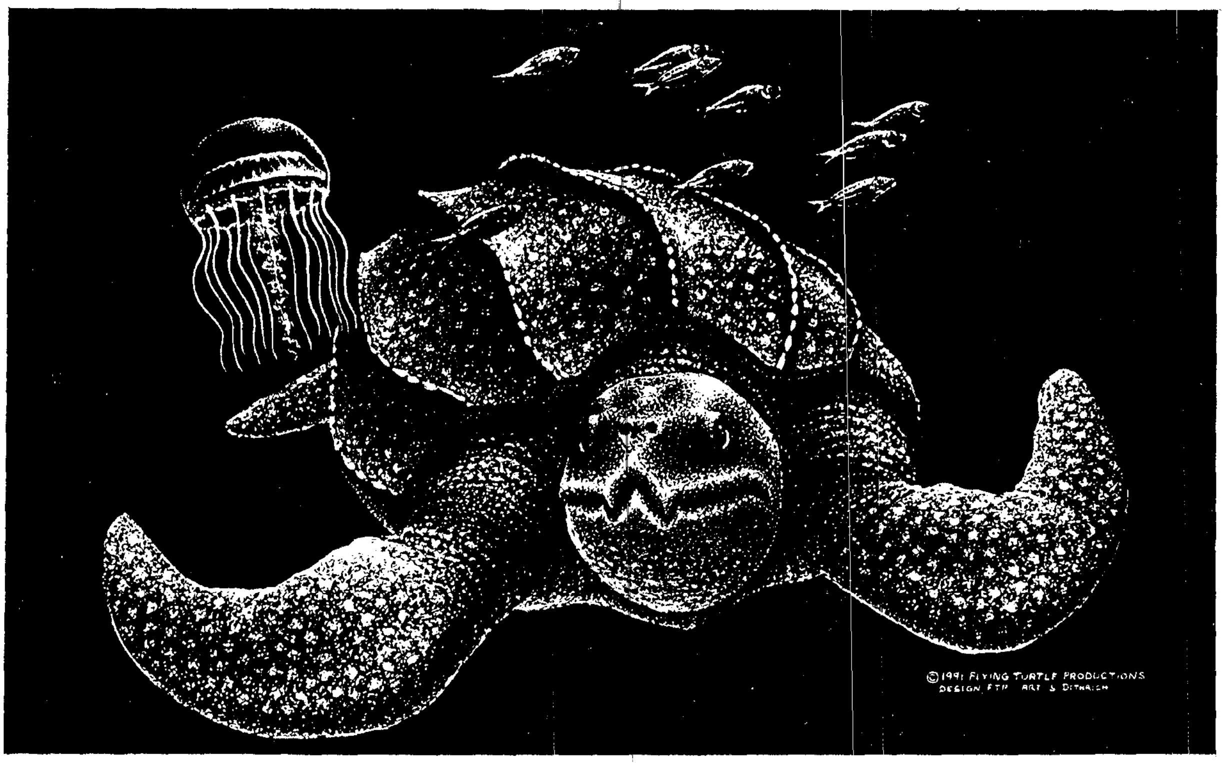
NOAA Technical Memorandum NMFS-SEFSC-302

PROCEEDINGS OF THE ELEVENTH ANNUAL WORKSHOP ON SEA TURTLE BIOLOGY AND CONSERVATION

26 February - 2 March 1991
Jekyll Island, Georgia

Compilers:
Michael Salmon
Jeanette Wyneken

March 1992



U.S. Department of Commerce
National Oceanographic and Atmospheric Administration
National Marine Fisheries Service
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U. S. DEPARTMENT OF COMMERCE
Barbara H. Franklin, Secretary

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
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PART II. POSTER PRESENTATIONS

PREFACE

December, 1991

The Eleventh Annual Workshop on Sea Turtle Biology and Conservation was hosted by the Florida Marine Research Institute of the Florida Department of Natural Resources from 26 February - 2 March 1991 at Jekyll Island, Georgia. The Workshop brought together 500 registered participants representing 17 countries. Seventy-nine technical papers and 34 posters were presented on topics which covered basic biology, ecology, sex ratios, orientation, pelagic, neritic and estuarine populations, migration and movements, international conservation, nesting biology, and mortality and threats. Invited speakers addressed conservation and legislative topics including turtle excluder devices (TEDs), international trade, reauthorization of the U.S. Endangered Species Act, and Critical Habitat.

Fifty-three papers and 24 posters have been compiled in these Proceedings. The extended abstract format allows the dissemination of more complete information than simple abstracts. While some authors have provided extended abstracts, others have chosen to provide traditional abstracts. In either case, the format involves limited editorial control. The content of these Proceedings does not necessarily reflect the views of the compilers, the Florida Marine Research Institute of the Florida Department of Natural Resources, or the National Marine Fisheries Service.

Many individuals worked very hard to make the Eleventh Annual Workshop a great success. Among these are the Workshop Planning Committee: Lew Ehrhart, Terry Henwood, Alan Huff, Earl Possardt, Erik Martin, Anne Meylan, Barbara Schroeder, Jamie Serino, Blair Witherington, and Jeanette Wyneken. Ed Drane and Project Turtle Watch expertly handled all of the finances involved with the meeting. Jim and Thelma Richarson once again took on the task of coordinating foreign travel and maintaining the Workshop mailing list. Allen Foley, Ron Mezich, J.B. Miller, and Sue Peck of the Florida Department of Natural Resources helped out whenever needed, both before and during the meeting. Marge McLean of Applied Biology, Inc. assisted with all the mailings. The workshop logo was designed by Jamie Serino and Flying Turtle Productions. Mike Salmon and Jeanette Wyneken took on the enormous task of compiling these Proceedings. I am indebted to Rod Mast for his superb job as auctioneer; to Lloyd Logan and the evening refreshment crew; to Charles Warnock and Michael Payne who were indispensable throughout the Workshop; and to Patricia Ernest and Bob Ernest for all of their help before and during the meeting. Mike Harris and Charles Maley of the Georgia Department of Natural Resources gave of their time and assisted with many of the local arrangements on Jekyll Island. Coffee breaks were graciously sponsored by the Campbell University Biology Club, Greenpeace Southeast, Luginbuhl Research Institute, WIDECAST, and World Wildlife Fund. Thanks also to the U.S. Fish and Wildlife Service and the National Marine Fisheries Service for providing mailing and xeroxing services. The publication of the Eleventh Annual Workshop Proceedings was made possible through the efforts of Wendy Teas and Nancy Thompson of the National Marine Fisheries Service, Southeast Fisheries Center, Miami Laboratory. The staff of Villas-by-The-Sea were enormously helpful in planning the Workshop and providing logistical assistance. DeRevere Travel once again assisted with travel arrangements especially for our foreign participants. Many other individuals helped out in innumerable ways. Finally, I offer my most sincere appreciation and gratitude to the following individuals without whom the Workshop would never have happened: Denise Blanton, Candy Martin, and Erik Martin.

Barbara Schroeder
1991 Workshop Coordinator

PART I. PAPER PRESENTATIONS

CONSERVING SEA TURTLES WHILE BUILDING AN ECOTOURISM INDUSTRY IN GUINEA BISSAU, WEST AFRICA

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The Bijagos archipelago of Guinea Bissau is an area of great ecological importance to the West African region. The archipelago, comprised of some 20 large permanently-inhabited islands, 26 seasonally-inhabited islands, and 37 uninhabited islands and islets, has many outstanding characteristics.

Like the Galapagos Islands (Broadus, 1985), the Bijagos archipelago is an area of high terrestrial and marine diversity, immense productivity, complex marine dynamics caused by the confluence of currents, unusual biogeographic affinities, large habitat diversity, critical importance to many threatened organisms, relatively pristine quality, and scientific and management importance. This rich ecosystem contains 94,000 hectares of intertidal areas, 76,000 hectares of highly productive mudflats, 35,000 hectares of mature mangrove forests, and over 150 kilometers of beaches (Methot, 1990). Unlike the Galapagos, however, little international interest has focused on preserving these islands and the sustainable ways of life of inhabitants until recently.

Several researchers have alluded to significant stocks of sea turtles utilizing the nearshore and beach environments of the Bijagos (Campredon, 1989; International Union for the Conservation of Nature, 1990; Methot, 1990; NMFS, 1985). However, until the preliminary survey undertaken by Benoit Limoges and Marie-Josee Robillard in 1990, little was known about what species were in the area. Based on their survey, interviews with fishermen, a review of government agency records (Guinea Bissau Ministries of Artisanal and Industrial Fishing), and my own investigation, it is clear that five species of sea turtle utilize the area: Chelonia mydas, Caretta caretta, Eretmochelys imbricata, Lepidochelys olivacea, and Dermochelys coriacea. The green turtle population in the Bijagos area is thought to be the largest in West Africa, and may be the most significant colony in the eastern Atlantic Ocean. On Pailao, the southwestern-most island in the chain, over 100 green turtles lay their eggs each night at the peak of nesting (Limoges, 1991).

Sea turtles in Guinea Bissau are threatened, and there is some indication that their numbers are declining locally. Incidental catch of adult turtles, especially those moving from nesting/breeding areas to feeding areas, is undoubtedly a significant cause of mortality. Anecdotal information from the industrial fishing observer program suggests over 1000 adult turtles are killed in the shrimp fishery each year (R. Shotton, pers. comm.). Some adult and subadult turtles are taken in the artisanal fisheries, particularly the shark fishery undertaken by Nyominka fishermen, though these numbers appear to be at least an order of magnitude fewer than those of the commercial fisheries. Inhabitants of the archipelago, including Nyominkas and non-seafaring Bijagos, do occasionally harvest nesting adults or their eggs for subsistence, although this mortality appears insignificant. In a survey of villages, Robillard found 37 green turtle carapaces, 6 hawksbill, and 2 olive ridley, and many of these were weathered suggesting they had been obtained many years previously (Robillard, pers. comm.). In my own interviews with both Bijagos and Nyominkas, I sensed little interest in sea turtles as an important source of food or trade.

Natural predation of eggs and hatchlings is rampant on many of the nesting islands, including Pailao, Orango, and Orangozinho (Fig.1). Ghost crabs (Ocypode spp.) and two species of monitor lizard (Varanus niloticus and Varanus exanthamaticus) are the major predators, although mongoose and feral animals may contribute to nest loss. Predator satiation probably reduces percentage loss of eggs and young during the peak of nesting/hatching, but before and after peak nesting most nests are likely predated.

Due to the preliminary nature of the surveys and the scant information available on sea turtles in Guinea Bissau, the status of these populations as residents or transients cannot be ascertained. Interviews with fishermen suggest that green turtles of adult and subadult sizes occur in these waters throughout the year, so they may well be residents. However, the distance between West Africa and northern South America is not vast, and hawksbill, loggerhead and green turtle transatlantic migrations have all been recorded (Bolton, et al., 1990; Marcovaldi et al., 1991) indicating interchange between these areas may occur. This question clearly needs to be addressed in a systematic way.

Although development of the Bijagos archipelago has been minimal and inconsequential to sea turtles thus far, plans to develop the islands for large-scale tourism do potentially threaten local turtle populations. Economic development is a top priority for the country, and the government is considering making the archipelagic area a Duty Free Zone to stimulate development and investment. This year, at least twelve proposals for tourist hotels, ranging in size from 6 to 300 rooms, have been approved. All are on or in the proximity of nesting beaches.

Tourism development and sea turtle conservation do not have to conflict, however (Boo, 1990). Due to the unique nature of the archipelago and its abundance and diversity of wildlife, the potential for "ecotourism" development is immense. Inhabitants of the archipelago can be convinced that living sea turtles are an important asset if a small scale tourism industry is directed at conservation of nesting / incubating turtles. The predation problem could also be solved if eco-tourist groups were trained to trap ghost crabs and monitor lizards off of critical nesting beaches. Care will have to be taken that the carrying capacity of the archipelago, both physical and social, not be approached too rapidly (Lindberg, 1991). Yet the opportunities suggest a note of optimism for sea turtles in Guinea Bissau, if government agencies and international investors can be persuaded.

LITERATURE CITED

Bolton, A.B., H.R. Martins, M.L. Natali, J.C. Thorne, and M.A. Marcovaldi. 1990. Loggerhead released in Brazil recaptured in Azores. Marine Turtle Newsletter 48: 24-25.

Boo, E. 1990. Ecotourism: Potentials and Pitfalls. World Wildlife Fund / U.S.. Wash., DC.

Broadus, J. 1985. A special marine reserve for the Galapagos Islands. Proceedings of Coastal Zone 1985. Sea Grant, Wash., DC.

Campredon, P. 1989. The Bijagos archipelago: Case study for the Workshop on Coastal Biosphere Reserves. 14-20 Aug 1989, San Francisco, CA.

International Union for the Conservation of Nature. 1990. Conservation du milleu et utilisation durable des ressources naturelles dans la zone cotiere de la Guinee-Bissau. Rapport d'Activite Decembre 1989 - Novembre 1990. Bissau.

Limoges, B. 1991. Preliminary report on sea turtles in the Bijagos archipelago. Unpub. Report. CECI, Bissau.

Lindberg, K. 1991. Policies for maximizing nature tourism's ecological and economic benefits. World Resources Institute. Wash., DC.

Marcovaldi, M.A. and A Filippini. 1991. Translatlantic movement by a juvenile hawksbill turtle. Marine Turtle Newsletter 52: 3.

Methot, S. 1990. Etude preliminaire de l'archipel des Bijagos en vue de la creation d'une aire protegee. CECI, Bissau.

NMFS. 1985. Status Report on Sea Turtles. U.S. Department of Commerce. Wash., DC.

Robillard, M. and B. Limoges. 1990. Proposal for coastal planning. Canadian Centre for Research and Education, Bissau.

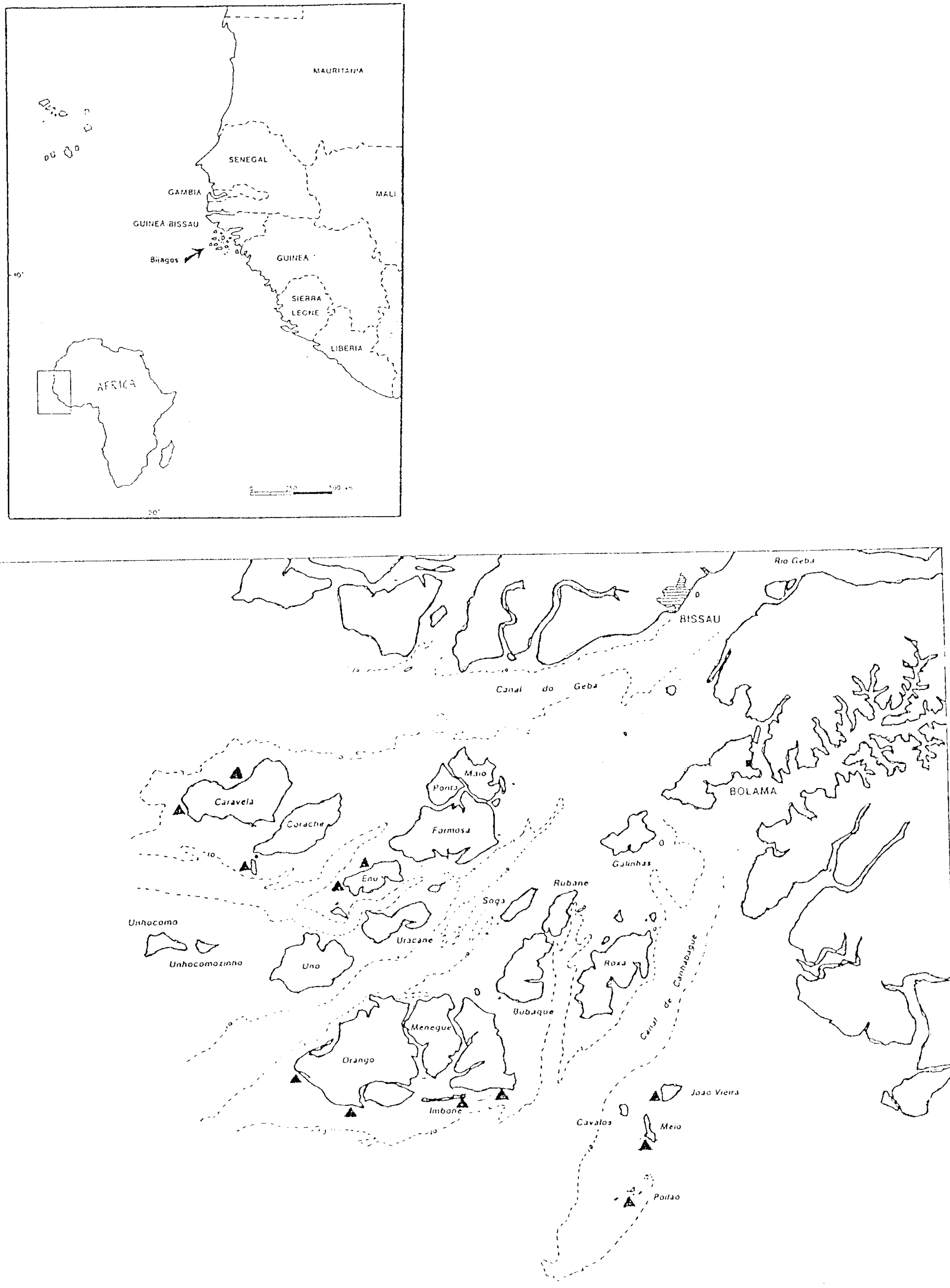

Figure 1. Major green and olive ridley turtle nesting beaches in the Bijagos archipelago, Guinea Bissau, indicated by ▲.

THE ASSOCIATION OF SEA TURTLES AND OTHER PELAGIC FAUNA WITH FLOATING OBJECTS IN THE EASTERN TROPICAL PACIFIC OCEAN

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Yellowfin tuna, Thunnus albacares, are the target of one of the most important fisheries of the eastern tropical Pacific (ETP); they are caught by purse seiners, longline vessels, and bait boats from Baja California to Ecuador and from the coast to almost 150 W. They are frequently associated with dolphins, and also with a wide variety of floating objects. Both these associations include a variety of pelagic species. The tuna-dolphin association usually involves yellowfin tuna, several species of dolphins and seabirds, sharks, billfishes, and other fauna. Sea turtles also associate with dolphins, but are more frequently found near tunas associated with flotsam.

In 1987 the Inter-American Tropical Tuna Commission (IATTC) started a study of the communities associated with floating objects in the ETP, among whose objectives are to study the association of young yellowfin tunas and other species with floating objects in relation to possible migration cycles and drift patterns in the ETP, and to investigate the pelagic ecology of sea turtles in the ETP, about which very little is known. Observers aboard tuna vessels record data on the shape, size, and nature of the flotsam, and estimate the abundance (in numbers, biomass, or catch) of target and non-target species.

In this study, the nature of the floating objects and the species composition of flotsam-associated fauna from 1987 to 1989 were analyzed. The data source is limited to presence/absence data, one type of purse-seining, the range of the tuna fishery, and seasonal spatial components within that range. First the data were tabulated to determine the percentage composition of the fauna by species and the frequency, by type and characteristics, of the floating objects. In a second stage, the data were classified into two sets by the presence or absence of sea turtles in the observations. The species compositions and type of floating objects for each data set were computed and compared. Results indicate that the community associated with flotsam is diverse, and includes most of the epipelagic fauna of the ETP. Sea turtles, mostly (75%) olive ridleys, Lepidochelys olivacea, are present in 15% of observations. The species most frequently found are sharks, mostly Fam. Carcharhinidae, (in 65% of observations), triggerfish (Fam. Balistidae) and small baitfish (60%), dorado, Coryphaena spp., (55%), and yellowfin and skipjack, Katsuwonus pelamis, tunas (45%). Most floating objects are trees or parts of trees; the number of objects classified as man-made (which includes trees bearing marks of human intervention) is about the same as that of objects of natural origin.

In Table 1 the characteristics of floating objects in both data sets are compared. Observations of sea turtles associated with man-made objects are significantly more frequent than those of turtles associated with natural objects: this may be because of the greater proportion of man-made objects along shipping lanes or in fishing areas, but may also be related to the turtles' affinity for three-dimensional objects. Turtles show a preference for objects floating horizontally and nearly submerged, and are strongly attracted to brightly colored objects. Table 2 compares the proportions of fauna found associated with floating objects in both data sets. Sea turtles are found most frequently associated with some shark species, marlin, and frigate birds, and slightly less frequently with triggerfish. Some of these associations may result from geographic correlations of the distribution of species with similar habitat requirements, while others are probably the product of trophic interactions.

The analysis also revealed that observations of sea turtles are most frequent between 11 am and 1 pm, which may indicate a basking behavior around noon; that aggregations of sea turtles, sometimes numbering more than a hundred animals, were observed as far offshore as 120^{o} W; that turtles start to aggregate near the nesting beaches two months before the beginning of the nesting season; and that turtles were observed mating in the open ocean, hundreds of kilometers from the coast.

The association of sea turtles with floating objects may be dependent on the age and size of the turtle and the type of floating object. This behavior should be viewed on two scales: on the small scale, turtles and other fauna, as well as kelp patties and assorted flotsam, may aggregate, actively or passively, in oceanographic discontinuities such as fronts and driftlines. Young sea turtles may find food and/or protection in these areas. On the large scale, the association may benefit turtles of all sizes; floating objects may act as indicators of habitat quality: they enter the ocean at the mouths of tropical rivers, drift mostly along the coastal zones, and eventually converge in frontal areas of the region, all of which are areas of high productivity. Adult turtles may also use flotsam as clues by which to orient themselves during migrations over featureless expanses of the ocean.

These results are preliminary, but they show that floating objects may play an important role in the pelagic ecology of sea turtles. We propose to continue the research to establish the relationships and interactions of sea turtles of various ages and sizes with floating objects and with other fauna in the ETP. A quantitative analysis of the data over time and space, including seasonal variation in flotsam production and turtle abundance, would help to determine patterns of behavior for migration and breeding.

TABLE 1. FLOATING OBJECTS (% counts) AND SEA TURTLES

	SEA TURTLES PRESENT	SEA TURTLES ABSENT	
TYPE			
Natural	53.3	60.7	●●
Wooden	70.4	74.5	
Logs	48.8	56.6	
Man-made wooden	21.6	17.9	
Fishing gear	2.9	1.3	●
Other plastics	16.4	15.4	
Dead animals	1.8	2.6	
FADs	4.7	2.7	●
Other	1.1	1.0	
SHAPE			
Cylindrical	38.7	46.1	●●
Polygonal	18.7	15.8	
Irregular	22.9	20.7	
DIMENSIONS			
Size ≥4 m	34.3	33.7	
Angle of inclination ≥45°	10.4	20.0	●
COLOR			
Yellow	55.8	15.9	●●
Brown	16.7	46.3	●●
AGE			
Long time in water	29.0	37.0	●
Epibiota present	50.4	45.3	
Epibiota coverage >10%	56.0	56.9	
≥75% underwater	57.1	47.2	●
Depth >2m	14.7	15.4	
FISHING			
Previously fished	7.9	21.7	●
Aggregated shape (FAD-like)	14.9	9.5	●●
PHYSICAL ENVIRONMENT			
Temperature: ≤83°F	70.5	54.5	●●
Cloud cover: none	36.2	39.2	
Beaufort: 1-3	84.9	87.9	
Time: 0900-1500	60.0	47.6	

●●: significant at $\alpha = 0.01$
●: significant at $\alpha = 0.05$

TABLE 2. SPECIES AGGREGATIONS (% counts) AND SEA TURTLES

	SEA TURTLES		
	PRESENT	ABSENT	
TUNA			
Yellowfin	32.9	33.4	
Skipjack	33.6	33.9	
Bigeye	2.9	1.7	
Bluefin	0.3	0.2	
Black skipjack	15.3	15.7	
Bullets	14.5	14.1	
Bonito	0.5	0.9	
OTHER FISH			
Blacktip shark	1.7	1.8	
Whitetip shark	1.8	0.8	●●
Hammerhead shark	0.5	0.4	
Other shark	3.4	2.8	
Unidentified shark	16.3	16.1	
Manta ray	1.2	0.6	●
Stingray	0.5	0.3	
Other billfish	1.31	0.7	●
Unidentified Marlin	5.4	3.5	●●
Sailfish	0.6	0.5	
Swordfish	0.4	0.3	
Other large fish	2.5	2.4	
Dorado/Mahi mahi	25.2	23.4	
Wahoo	6.1	5.9	
Rainbow runners	2.1	2.3	
Yellowtail	2.8	2.7	
Other small fish	4.4	5.6	
Triggerfish	10.0	13.9	●●
Small baitfish	12.7	14.1	
BIRDS			
Boobies	39.9	46.6	
Shearwaters	5.7	5.2	
Terns	8.2	5.8	
Frigate	27.6	11.1	●●
Petrels	1.6	2.3	
Unidentified/Other	13.8	26.9	●
EPIBIOTA	1.6	2.3	
INVERTEBRATES	0.7	0.7	
Unidentified fish	0.4	0.4	
Other fauna	0.1	0.1	
None (no fauna)	0	0.6	

note: ●● sig. at α = 0.01; ● sig. at α = 0.05

CURRENT STATUS OF TRADE AND LEGAL PROTECTION OF SEA TURTLES IN INDONESIA

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The commercial exploitation of sea turtles around the world has led to the decline and extirpation of entire populations. This paper focuses on the exploitation of sea turtles in Indonesia, highlights the lack of information on their status in Indonesian waters, and considers national legislation aimed at their protection. All available evidence indicates that these populations are seriously threatened.

The International Trade: Under the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), there is a ban on international trade in sea turtles and their products. Under CITES, Japan holds reservations on the olive ridley and hawksbill turtle, thus exempting itself from the ban on their trade. In the last twenty years alone, Japan has imported a range of turtle products representing over two million sea turtles. It is the largest importer of sea turtle products in the world, and continues to be the driving force behind such international trade. Raw hawksbill shell, known as bekko in Japan, is the main component of this trade, and Japan still imports approximately 20,000 kg every year, representing about 19,000 adult hawksbill turtles. However, at the recent International Symposium on Hawksbill Management in Nagasaki in November 1990, Japanese bekko importers agreed to controls which will effectively reduce their imports, and place further restrictions on the origin of the shell.

The Indonesian Trade: Until recently Indonesia has dominated the international sea turtle trade. Japan now imports most of its bekko from Cuba. Although Indonesia joined CITES in March 1979, Japanese customs statistics continued to record bekko imports from Indonesia until 1988. It is clear that these statistics do not always reflect the true situation. They do not take account of products laundered through non-parties. For example, Indonesia laundered bekko through Singapore, and subsequently through Brunei, until these countries joined CITES and imports appeared to cease. Continued illegal trade in sea turtle and other wildlife products from Indonesia is also well documented. For example, Greenpeace investigators were informed by exporters, that during 1988 and 1989, over 1.5 tonnes of bekko was exported in violation of CITES, to Hong Kong, Taiwan and Singapore.

Indonesia currently has over eighteen tonnes of bekko stockpiled by traders in Ujung Pandang, Sulawesi. These stockpiles are constantly being added to in the hope that legal trade with Japan will be allowed to continue.

However, it is not only hawksbill turtles that are exploited to satisfy commercial demand in Indonesia. Southern Bali is the centre of the most intensive exploitation of green turtles in the world. Green turtles are killed mainly for their meat. Although the majority of Indonesians are Muslems, who do not eat turtle meat, (they do eat the eggs), Bali is dominated by the Hindu religion, where turtle meat is used in religious ceremonies and feasts. At the height of the trade over 30,000 sea turtles every year were being brought into Bali. The Indonesian government claims that this figure has now dropped to approximately 10-15,000. Recent Greenpeace investigations have revealed that in 1990, it was at least 21,000. Neither of these estimates take account of mortality during shipment, direct sales en route or juvenile turtles.

There are at least six slaughter houses in southern Bali, each of which kill between five and twelve turtles every day. Considerably larger numbers are slaughtered for religious occasions. No attempt is made to kill the turtles before butchering begins, and they are slowly cut up alive. As well as the meat, the skin, eggs, fat and bones are also sold. The green turtle shells are thought to be sent to Jakarta for use as a furniture veneer, and possibly in Chinese medicine.

One of the most extensive forms of turtle exploitation in Indonesia is the collection of eggs for human consumption. An estimated seven to nine million eggs are collected annually from all species of turtle nesting in Indonesia. Since almost every egg layed is collected, the population recruitment has been reduced to zero.

Population status: Dramatic declines of these populations are well documented, both in historical records and by the turtle boats, which are forced to travel further and further afield, as local turtle populations become commercially extinct. Sea turtle biology is poorly understood, and very little is known about the migratory movements of these populations in Indonesian waters. It is thought that some populations feed in Indonesian waters and nest elsewhere, possibly Australia. The lack of information about these populations, coupled with high levels of unregulated exploitation gives cause for grave concern. If current levels of exploitation are allowed to continue, the extermination of Indonesia's nesting sea turtle populations is inevitable.

Ranching: The Indonesian government's efforts towards sea turtle conservation have so far focused mainly on ranching, with the financial backing of the Japanese. This must surely bring into question whether their motivation is genuine conservation or monetary gain. CITES has never accepted ranching as a beneficial management and conservation technique for sea turtles, and protection of the wild populations must remain Indonesia's foremost priority.

National Legislation: The conservation of sea turtles in Indonesia falls under the remit of the Ministry of Forestry, where the budget for marine conservation is low, and legislation is poorly enforced. However, a new wildlife conservation law has recently been passed, which will be effected through a series of specific regulations, yet to be written.

Greenpeace strongly urges that the regulations on sea turtles include the following measures: a) A ban on the capture of any species of sea turtle for commercial trade, with only a limited quota allowed for religious ceremonies. b) Full protection for hawksbill turtles in Indonesian waters. c) Full protection for breeding green turtles on or near nesting beaches. d) Full protection for all turtles larger than 80 cm and smaller than 60 cm. e) A total ban on the sale of turtle meat in all public places. f) A license requirement for all turtle collectors. g) The in situ protection of a minimum of 70 percent of eggs on the nesting beaches (The actual number taken should be based on scientific evidence that this would not be detrimental to the population as a whole). h) A prohibition on the sale of all stuffed turtles. i) Sea turtles should be humanely killed before butchering begins. j) Adequate resources should be made available to fully implement and enforce these regulations.

In 1990, the Governor of Bali signed a decree which incorporates much of the above. However, this has not been implemented.

In conclusion: all available evidence indicates that despite an international ban, the pressure on Indonesia's sea turtle populations has not been reduced. The domestic demand in Japan for hawksbill shell continues to fuel the illegal trade, and stockpiles within Indonesia continue to increase.

The Indonesian government has an international responsibility to stop all exports in sea turtle products, and to protect these migratory species within its waters. The numbers of green turtles being killed in indonesia are not decreasing, and indeed, all evidence indicates that the numbers are significantly higher than the official figures suggest. Greenpeace calls for immediate enforcement of the Governor of Bali's Decree, and the development of strict regulations to protect sea turtles under the new conservation law. These measures are critical for the survival of sea turtles in Indonesia.

LITERATURE CITED

Canin, J. 1989. International Trade in Sea Turtle Products. Greenpeace International Submission to the Ninth Annual Workshop on Sea Turtle Conservation and Biology.

Canin, J. 1991. Personal communication from Nagasaki Symposium.

Davenport, J. 1988. The Turtle Industry of Bali. Brit. Herp. Soc. Bull. 25, 16-24.

FAO Species Catalogue. 1990. Sea Turtles of the World, FIR/S125 Vol.11.

Greenpeace International. 1989. Sea Turtles and Indonesia. Greenpeace International, TRAFFIC Japan (1990) - Aspects of Sea Turtle Trade in Indonesia.

Groombridge, B. and Luxmoore, R. 1989. The Green Turtle and Hawksbill (Reptilia Cheloniidae): World Status, Exploitation and Trade.

Limpus, C. 1991. Personal communication.

TRAFFIC Japan. 1990 Communication from Tom Milliken, Director World Wide Fund for Nature (1989) - Submission to CITES 1989 on Indonesia.

LEATHERBACK TURTLE (*Dermochelys coriacea*) NESTING BIOLOGY, SANDY POINT, ST CROIX : 1981 - 1990.

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INTRODUCTION

Presumably, leatherback sea turtles have been nesting on Sandy Point, St. Croix, USVI throughout all of recorded history. This nesting population was first brought to the attention of biologists in the mid 1970s by a VI environmental enforcement officer named Otto Tranberg. Tags were first put on some of these turtles in 1977 and 1979. In 1981 the Division of Fish and Wildlife, Department of Planning and Natural Resources, initiated a comprehensive study of the nesting biology of leatherbacks on Sandy Point with Section 6 funds from the US Fish and Wildlife Service. The 1981 season suffered from lack of adequate personnel and this resulted in an incomplete data set. Since 1982 the Division of Fish and Wildlife has run the project by contracting two Field Directors and using Earthwatch (of Belmont, MA) volunteers. Critical Habitat was established for the leatherbacks at Sandy Pt. in the water (NMFS) and on the land (USFWS) in the late 1970s. Sandy Point was acquired as a National Wildlife Refuge in 1984 by the USFWS.

METHODS

The study area is a 2.6 km long portion of the Sandy Pt. NWR. This is a classic leatherback nesting beach, having a broad profile and nearby deep water access. To ensure encountering every turtle that nests on this beach, hourly patrols are performed from 2000 to 0500 hours nightly from late March until 10 days after the last nest. All turtles that nest on Sandy Pt. are measured and weighed, if possible. All turtles are tagged on their front and rear flippers. Monel tags are used as plastic tags tear out of the flippers and titanium tags have a matte finish which leads to excessive biofouling and stress on the attachment point. All nests laid are located by a series of numbered stakes placed every 20 m around the inside perimeter of the beach. Triangulation from the nearest two stakes provides precision location to within 10 cm. Erosion is the most serious natural threat to nests on this beach. To obviate this threat, all nests laid in historically erosion prone areas on the beach are relocated at the time of laying to stable parts of the beach. Nest dimensions are duplicated and relocated sites are physically similar to that of the original nest site. Relocation generally is accomplished within one hour with a minimum of handling.

RESULTS

Since 1981, 203 individual leatherback turtles have been tagged on Sandy Pt. with a range of 18 to 48 turtles nesting per year. Annual remigration rates have averaged 28.5 percent with 36 turtles having returned 80 times in subsequent seasons. Remigration intervals have most commonly been two years (60%), followed by three years (25%) and only one one-year and two four-year intervals. Nine turtles have returned with definite tag scars but, in the absence of other identifying marks, are not able to be classified by interval.

As with most other turtle nesting studies, the vast majority of Sandy Pt. leatherbacks apparently only nest one season (80%). Nine percent have nested in two seasons, 6% in three, 3% in four, .5% in five and 1% in six. One of the two six season nesters is turtle G603, originally tagged in 1979. This turtle has returned in 1981, 1983, 1985, 1987 and 1990, for twelve years of observation.

During the course of this project a number of inter-beach and inter-island movements and nesting activity have been documented within seasons. With the start of the Manchenil Beach Project in 1983 and the Culebra Island project in 1984, the documentation of these movements became possible. Since 1984, two turtles have moved from Sandy Pt. to Culebra, five have moved from Sandy Pt. to Manchenil, six have moved from Manchenil to Sandy Pt. and one has moved from Culebra to Sandy Pt. All had nested at least once on the original beach. In 1989, a turtle fitted with a satellite transmitter was documented to nest three times on Sandy Pt., then once on Vieques Island and finally four times on Culebra. In 1988, another turtle nested eight times on Sandy Pt. and then was observed nesting in Anquilla, BWI. In 1981, one of 20 turtles tagged that season was found stranded in Atlantic City, NJ, 85 days after her last nest on Sandy Pt. Death was due to blockage of the ileocoecal valve by a clay-like mass. In 1988, a turtle who had nested two years previously on Sandy Pt. was caught by a shark fisherman in the Triangle Cays, Campeche, Mexico.

Turtles nesting on Sandy Pt. since 1981 have ranged in carapace length from 137 to 177 cm (over the curve). Weights (N = 134) have been obtained since 1985 from 102 turtles and have ranged from 259 to 506 kg. Length vs weight show a positive regression of $y = 5.2076x - 468.84$ with $R^2 = 0.551$.

Since 1981 nesting activity has ranged from an early season nest on February 11 to a last nest on July 23. The peak nesting period occurs in mid to late May. During the past ten years, 69.9 percent of all nesting activities have resulted in egg deposition (range = 54.7 to 79.2 per annum, SD = 8.66). Turtles have laid a mean of 5.01 nests per season (range = 3.9 to 6.14 per annum, SD = .64) with a maximum of 10 nests laid for a single turtle in one season. The mean internesting interval has been 9.61 days (range = 9.4 to 9.8 per annum, SD = .15).

Mean total clutch size has been 116.6 eggs (range = 112.7 to 119.3 per annum, SD = 2.16) with a mean of 80.1 yolked eggs (range = 72.9 to 85.9 per annum, SD = 4.59) and a mean of 36.5 yolkless eggs (range = 31.2 to 41.6 per annum, SD = 3.43). Incubation periods have ranged from 57 to 76 days per annum with a mean of 62.9 days (SD = 1.20). The longer incubation periods occur early in the season when sand temperatures are cooler and shorter incubation periods occur later in the season when sand temperatures are warmer. Since 1981, 1,476 nests have been laid with a range of 82 to 242 laid in any one season. Since 1982, successful hatching has occurred in 62.24 percent of all eggs laid in nests that have survived to term.

Since 1982 48.6 percent of all nests laid on Sandy Pt. have been relocated to prevent loss to erosion. Success rates for relocated vs in situ nests have varied considerably. In three of the years, nest success for relocated nests has been higher than for in situ nests and the opposite for the remaining six years. Overall, in situ nest success has been slightly higher at 65.8 percent than for relocated nests at 59.7 percent. Since 1982, between 55,200 and 56,100 hatchlings have emerged from nests on Sandy Pt. The range is due to uncertainties in analyzing post-hatch nest contents.

Prior to the initiation of nest relocation on Sandy Pt. in 1982 we estimate that up to 50 to 60 percent of all nests laid on this beach were lost annually to erosion. Our relocation efforts have reduced this loss to between 0.7 and 9.8 percent annually. Some loss has still occurred during tropical storms or early season nests which were not observed at the time of laying. Likewise, prior to 1981, poaching of nests was reported to approach 100 percent annually. Our nightly presence on the beach throughout the nesting season has reduced that amount to between 0 and 1.8 percent per year with no known poaching during the last five years.

During the ten years of this project the education value has increased remarkably. In St. Croix, both locals and visitors to the island have demonstrated an increasing awareness and desire to learn about sea turtles in general and leatherbacks in particular. As more people have become exposed to leatherbacks proprietary interest has increased the protection afforded this population. Whereas in 1981 less than 50 people visited the project, in 1989 694 people visited the beach to see and learn about leatherbacks. There was a drop to 297 people in 1990 due to the lingering effects of Hurricane Hugo and people concentrating more on rebuilding their island.

CONCLUSIONS

The Sandy Pt. population of leatherback turtles appears to be the largest nesting aggregation of leatherbacks under US jurisdiction. Given the movements between this and other nearby aggregations, the Sandy Pt. aggregation may represent part of a larger population with subgroups having stronger fidelity to particular beaches.

Continued relocation of nests is essential for the long term recovery of this population of leatherbacks. While hatching success is slightly lower in relocated nests, most likely due to handling, any success is an increase in numbers of hatchlings reaching the sea as these nests would otherwise be lost to erosion. Likewise, although the leatherback has become a symbol of the conservation effort on St. Croix, in the absence of all-night patrols, societal elements responsible for poaching of nests would probably become active again.

Having the ability to monitor every individual to nest on Sandy Pt., this project offers a unique opportunity for the long term acquisition of data on the biology of this species. The project also offers an opportunity for visiting researchers to collect data on a variety of questions not obtainable from other populations of leatherbacks.

ACKNOWLEDGEMENTS

The success of this project is due in large part to Earthwatch of Belmont, Mass. and the 593 Earthwatch volunteers who have spent 47,440 hours patrolling over 57,635 kilometers of beach. US Fish and Wildlife Service Section 6 appropriations have provided most of the funding for the project. Special thanks are due to past Field Directors of the project; Scott and Karen Eckert, Susan Basford and Robert Brandner. Many Division of Fish and Wildlife and Bureau of Environmental Enforcement personnel have given of their time over the years and each one of them is owed a big thanks. Pat and Mac McFee of Cottages By The Sea have been wonderful hosts to the project and to all the volunteers since 1982.

ESTABLISHMENT OF A MARINE TURTLE INFORMATION AND DATA BANK CENTER IN MEXICO

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We report on the current status of the Marine Turtle Information and Data Bank Center ("Banco de Informacion sobre Tortugas Marinas"- BITMAR) which has operated since the end of 1989 (see MTN 51:7). The center manages three separate data base "streams" depending on the type of information being dealt with: numeric, bibliographic or textual. It also publishes Archelon, a quarterly bulletin, serving as a national forum on marine turtles carrying news on current conservation, research and environmental education projects, as well as points of view and short articles.

Data on biological, tagging and environmental parameters are mostly numeric and are currently managed by a dBASE III+ program within a distinct data bank (Banco de Datos sobre Tortugas Marinas, "BDTM"). Information coming from beach observations are entered by users into one of the separate files using standard formats (Figure 1). Beach files include data on: geographic location, turtle tagging and biometry, nesting or incubation and hatching results. Data from pelagic zones all go into a single file covering relevant parameters. A routine automatically sorts the information on tagged turtles from appropriate nesting and pelagic files with which an ancillary Tagging Information Data Bank is updated. Although the bank covers most of the biological data commonly associated with nesting studies, because of the variety of projects being carried out, not all groups will gather information covering the entire set of parameters. There are also additional or optional files which will be used only by a few groups for specific and sometimes short-term purposes producing data which will also be managed by BITMAR. The computer programs simplify the procedures for data input, editing and printing, following identical formats. The current version of this program is being field tested by a selection of work groups in order to evaluate its efficacy and detect run-time bugs. Future versions will enhance user-friendliness and include routines for ancillary calculations, as well as statistical and graphic analysis.

While agreement was reached for BITMAR to make available tagging information once it is processed, search services covering other data stored within the numeric data bank are restricted over a period of time defined by internal statutes adopted by consensus to protect author's copyrights. We are also beginning on the laborious, though essential, effort to locate and incorporate into our data base information contained within documents written on sea turtles in Mexico before BITMAR began functioning.

Our Bibliography Data Bank has been in operation for over 6 months now. It offers users key-word search services and document duplication. At the same time it functions as a regional catchment center, processing sea turtle-related articles for the Aquatic Science and Fisheries Information Service (ASFIS) (Figure 2). We have adopted the formats and the text-oriented data base management program (micro ISIS) used by ASFIS with which we can search for key words among all standard bibliographic categories into which entries are processed. Based largely on the lists of recent literature in the Marine Turtle Newsletter, we have been requesting authors for their publications and their response has been generous. The offprints have been received, processed and catalogued at a rate of about 40 per month. Copies of all current technical reports, student theses and congress proceedings produced on sea turtles in Mexico have also been obtained and processed. In all, we have generated a collection of about 300 documents. In addition, the USFWS donated a set of computer diskette copies of its 7,000+ references to sea turtle literature, updated to 1989, which are being incorporated into our system. An updated catalog of the BITMAR collection will be published at the end of each year.

At the end of 1990 we began a national survey of institutions, personnel and projects related to marine turtles in Mexico. Questionnaires designed to capture descriptive (textual) information on who is doing what, where and how have been sent to all relevant university, government and non-government organizations in the country. The information will produce a readily updated electronic archive from which we will publish an indexed Directory of Resources Committed to the Conservation, Management and Research of Sea Turtles in Mexico at the end of 1991. Together with the above project, we also began a survey of nesting beaches in the country. From information on which species nest, during which months, what development or poaching pressures from neighboring communities exist, whether or not there are conservation camps established on the beach, etc. we plan publishing a Catalog of Sea Turtle Nesting Beaches in Mexico and their Current Conditions also by the end of 1991.

The progress of BITMAR during the last year has been substantial. Although the project has been solely financed by our university and backed by other national academic institutions, we have been successful in obtaining support and participation from the government ministries which have jurisdiction over fisheries, research and conservation information on sea turtles. BITMAR has also been instrumental in the organization and operation of regional and national workshops in which the current status and constraints of projects on sea turtles have been discussed. Many of the developments we report here follow the recommendations voiced during these workshops.

FIGURE 1

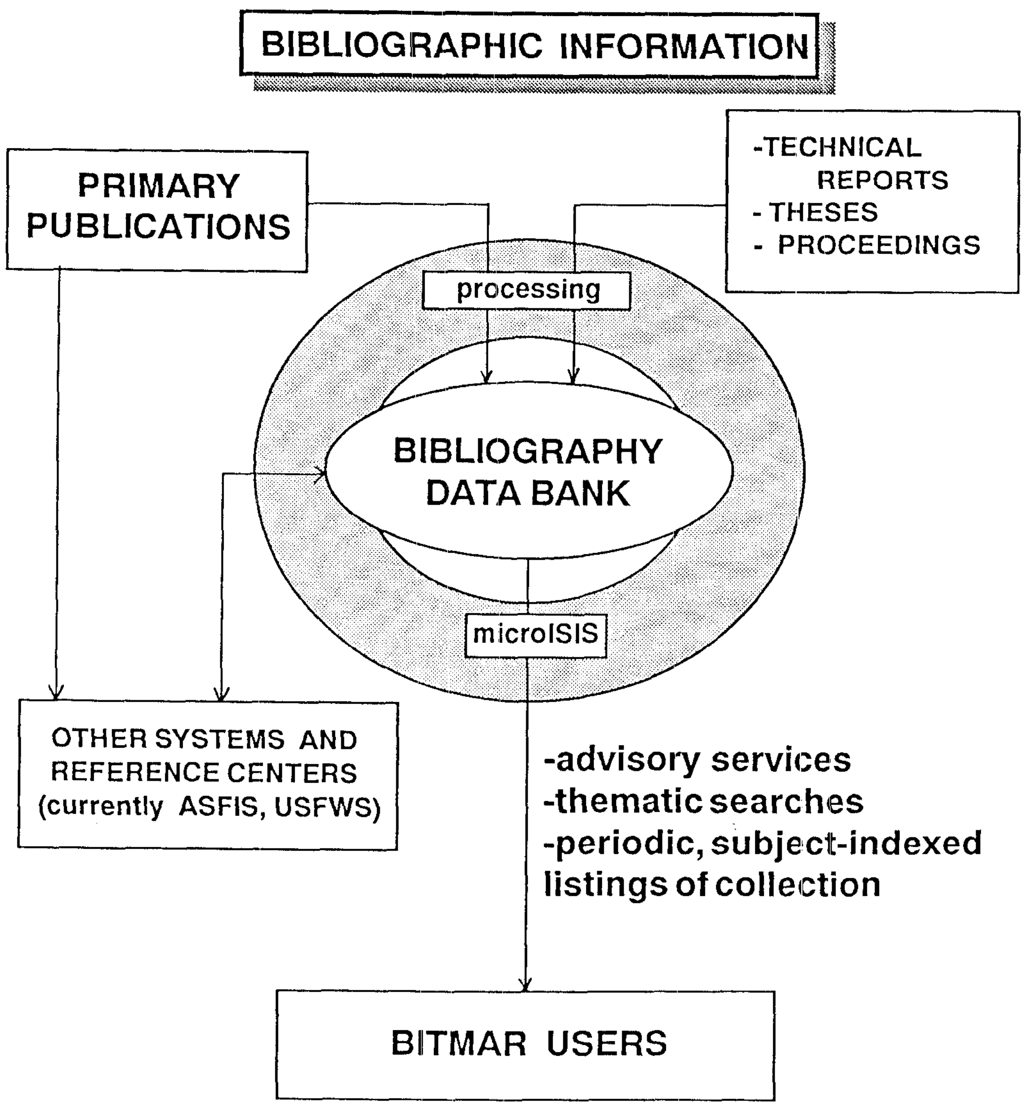
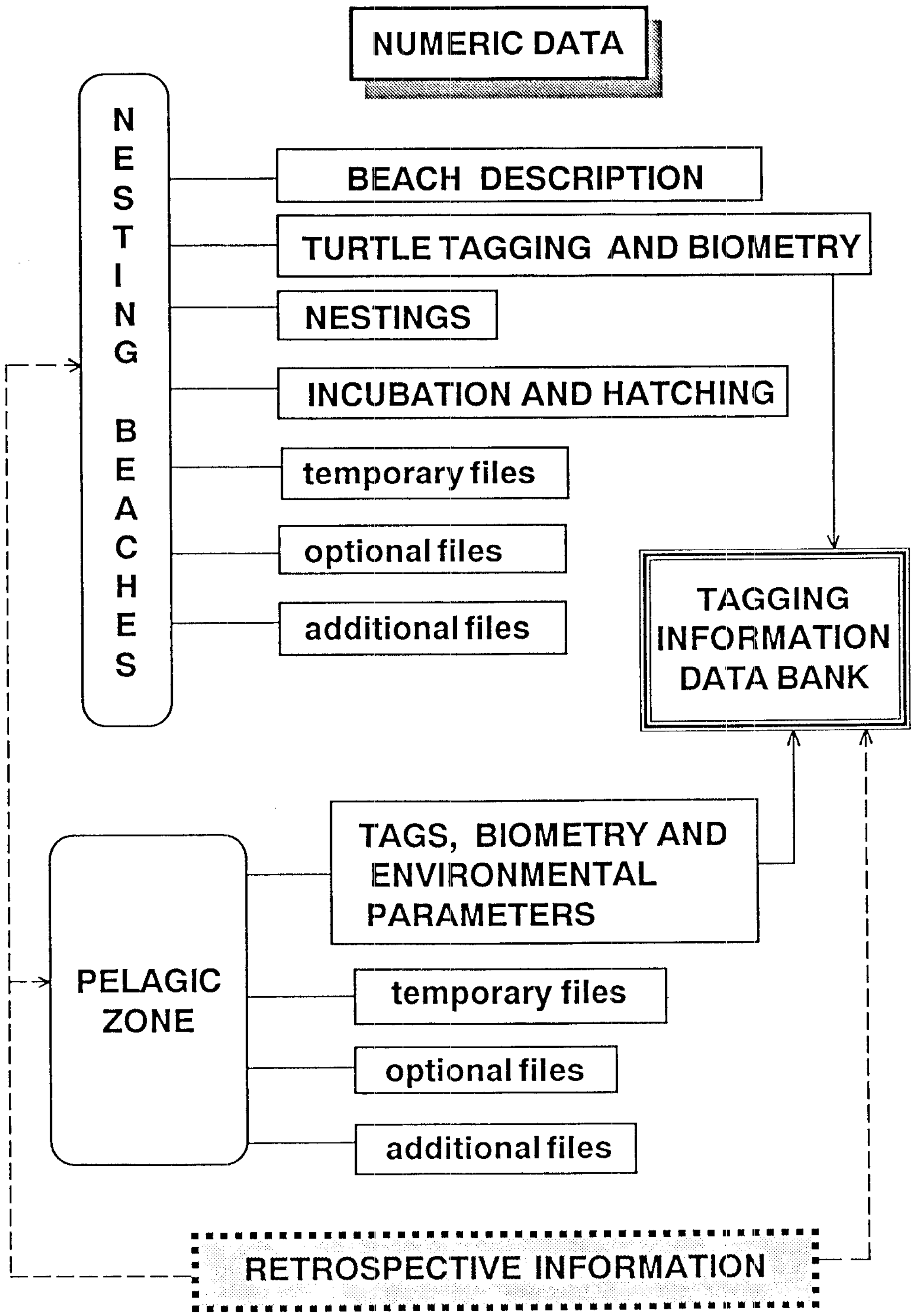

BIBLIOGRAPHIC INFORMATION
PRIMARY PUBLICATIONS
-TECHNICAL REPORTS
- THESES
- PROCEEDINGS
processing
BIBLIOGRAPHY DATA BANK
microISIS
OTHER SYSTEMS AND REFERENCE CENTERS (currently ASFIS, USFWS)
-advisory services
-thematic searches
-periodic, subject-indexed listings of collection
BITMAR USERS

FIGURE 2


NUMERIC DATA
NESTING BEACHES
BEACH DESCRIPTION
TURTLE TAGGING AND BIOMETRY
NESTINGS
INCUBATION AND HATCHING
temporary files
optional files
additional files
TAGGING INFORMATION DATA BANK
PELAGIC ZONE
TAGS, BIOMETRY AND ENVIRONMENTAL PARAMETERS
temporary files
optional files
additional files
RETROSPECTIVE INFORMATION

EFFECTS OF BEACH RENOURISHMENT ON THE SURVIVIAL OF LOGGERHEAD SEA TURTLE NESTS

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I studied the fate of loggerhead sea turtle (Caretta caretta) clutches at four beach sites in Boca Raton, Florida. A beach renourishment project took place in July, 1988. Sand was taken from a nearshore borrow pit. The renourished beach was 2.3 km in length; an adjacent control beach was 0.3 km in length and devoid of renourished sand. In 1990, before nesting began, dune soil was placed on top of the beach sand at the southern portion of the control site. This portion of the control site was designated as "manipulated 1" site. A section of beach to the south of this area was a mixture of dune soil and sand; it was designated as the "manipulated 2".

Significantly more (90%) sea turtle hatchlings emerged from nests (N=70) deposited on the renourished beach than at the other sites(~80% from 155 nests). These results differ from those reported by Raymond (1984) who found equivalent percentages of hatchlings emerged from nests on natural and renourished beaches located in Brevard County, Florida.

I carried out further studies to determine why emergence success was greater on the renourished beach. Specifically, I compared the four sites with regard to their thermal regime, moisture content of the substratum, sand grain size, and sand pore spacing at depths where eggs were typically deposited. These parameters were selected because beach renourishment might change the beach microenvironment of the nest and thus affect the survival of hatchlings (Packard, et. al., 1988; Swingland and Coe, 1979). I also weighed and measured (straight-line carapace length) hatchlings from randomly selected nests (20/nest, 12 nests at each site) to determine if turtles at each site differed in size.

The measurements were used to answer the following questions: (1) Are there differences in the clutch fate of in situ nests at each of the different beach sites? (2) Are there differences in the physical characteristics of the sand at the sites? (3) Are there differences in the size (weight or carapace length) of hatchlings that complete development at each site? (4) If differences in clutch fate are found, can they be correlated with the physical characteristics of the sand?

METHODS

To determine clutch fate, nests were excavated three days after the first emergence of hatchlings. Each egg in the clutch was inspected to determine if the egg had hatched, remained unhatched, if the hatchling had pipped through the shell but failed exit the egg, or if the turtle left the egg but not the nest. Remaining egg shells represented those turtles that had left the nest. The percentage of the clutch that was in each of these five categories was calculated.

Beach sand characteristics were monitored during the 1990 nesting season to establish their correlations with clutch fate. I measured sand temperature (at 1400-1500 hours), moisture content, grain size, and pore spacing at nest depth at each site. Samples were obtained every two weeks over a 10 week period (July - September). The samples were taken from nest depth (45.72 cm). To measure moisture content, a 50 g sample was placed in a 38 C oven for 24 h. Difference between wet and dry weight was used to calculate sample moisture content. Weighted sand samples from each beach site were size-separated through a set of graded sieves. The fraction remaining in each sieve was weighed and used to calculate percentage composition. Grain sizes were log transformed into phi scale values (a standardized measure of grain size). Sand grain size was plotted against percent sand fraction; the median grain size was indicated by where the 50% line crosses the curve.

Sand pore spacing was determined from four core samples, taken from each site at nest depth. Samples were dried at 38 C for 24 h, then weighed. The volume of the core container was determined. Bulk density (g/cm^3) was calculated for each sample, divided by particle density (a constant), then multiplied by 100. This percentage was subtracted from 100% to calculate how much of the volume in the core sample was air and how much was sand (pore spacing).

I collected 20 hatchlings as they emerged from 12 nests at each site. Hatchlings were weighed ($\pm$ 0.01 gram) and measured (straight-line carapace length) with calipers ($\pm$ 0.01 mm).

RESULTS AND DISCUSSION

Hatching success was 91.5% at the renourished, 91.4% at the natural, 89.6% at manipulated 1, and 91.0% at the manipulated 2 site (n.s. by an ANOVA). However, emergence success varied significantly. It was 90% at the renourished, 80.7% at the natural, 80.2% at the manipulated 1, and 81.4% at the manipulated 2 site ($F = 7.588$, 3 d.f.; $p < .001$). Significantly more turtles left the renourished than the other sites (Tukey tests). The proportion of unhatched eggs in clutches on the different beaches did not differ significantly. The proportions of pipped eggs were 0.9% at the renourished, 6.7% at the natural, 5.4% at manipulated 1, and 5.7% at the manipulated 2 beach. ANOVA tests on these data revealed these differences were significant ($F = 13.46$, 3 d.f.; $p < .001$). A Tukey comparison revealed that fewer pipped eggs were found in clutches on the renourished beach. The proportion of dead hatchlings in the egg chamber was 0.6% for the renourished beach, 3.6% for the natural beach, 3.2% for the manipulated 1 beach, and 3.8% for the manipulated 2 beach. ANOVA tests on these data showed these differences were significant ($F= 8.209$, 3 d.f.; $p < .001$). A Tukey comparison of the means revealed that fewer dead hatchlings were found in egg chambers on the renourished than on the other beaches.

Although beach temperatures differed significantly between sites, (ANOVA; $F = 10.805$, 3 d.f.; $p < .001$), patterns of differences were unrelated to differences in hatchling survival. The renourished (31.08^{o}C) and natural beaches (31.26^{o}C) were warmer than the manipulated 1 (30.29^{o}C) and manipulated 2 (30.40^{o}C) beaches. The moisture content of the renourished beach was 5.18%, the natural beach was 3.60%, the manipulated 1 beach was 4.45%, and the manipulated 2 beach was 3.51%. ANOVA tests on the moisture content data revealed these differences were significant ($F = 8.143$, 3 d.f.; $p < .001$). Tukey comparison of means reveal that the sand from the renourished beach contained significantly more moisture than the sand from other sites with the exception of the manipulated 1 site.

The smallest median grain size was found on the manipulated 2 beach, while the largest median grain size was present at the natural beach. Pore spacing was smallest at manipulated 1 (39.99%), intermediate at the natural beach (40.59%), manipulated 2 site (41.92%), and highest at the renourished beach (44.45%). ANOVA tests revealed these differences were significant ($F= 7.252$, 3 d.f.; $p < .001$). Tukey comparison of means showed that at the renourished beach, pore spacing was significantly greater (more air available to the clutch) than at all sites except the manipulated 2 beach.

Both the weight and straight-line carapace length of hatchlings from different beaches differed significantly (ANOVA; $F = 30.96$, 3 d.f., $p < .001$). Average weight was 17.98 g on the natural, 18.04 g on the manipulated 1, 18.50 g on the manipulated 2, and 18.99 g on the renourished beach sites. Tukey comparison of means revealed that the heaviest hatchlings emerged from nests deposited on the renourished beach while the lightest hatchlings emerged from nests on the natural beach. The average carapace length of hatchlings was 43.23 mm on the natural, 43.61 mm on the manipulated, 43.70 mm on the renourished, and 44.31 mm on the manipulated 2 beach sites. ANOVA tests revealed these differences were significant ($F = 25.973$, 3 d.f.; $p < .001$). Tukey comparison of means test showed that the shortest hatchlings emerged from nests deposited on the natural beach, while the longest hatchlings emerged from nests deposited on the manipulated 2 beach.

In summary, emergence success was greatest at the renourished beach site, and uniformly lower at all other sites. Analysis of nest contents revealed that at all other beach sites, more hatchlings died in the nest either during the hatching process, or between the time of hatching and emergence. At the renourished beach, the sands contained more moisture and provided greater pore spacing and presumably, better gas exchange between the turtles and the external environment than at the other beach sites. Temperature differences between sites showed patterns which were less clearly related to emergence success. Hatchlings at the renourished beach and one manipulated beach were significantly heavier than hatchlings from the other sites. The natural beach produced both the lightest and the shortest hatchlings.

Regression analysis indicated strong positive correlations between physical characteristics of the sand and the emergence success of clutches. As pore spacing and moisture content increased, mortality within the egg chamber decreased. Further study is needed to determine which of the correlated variables described here are causal factors.

I conclude that beach renourishment is correlated with the fate of sea turtle clutches, and that beach sand characteristics are an important factor in the development of sea turtle embryos. In this instance, the effect was beneficial. In another study (Raymond, 1984), no statistically significant differences in emergence success were found between the renourished and natural beaches. Obviously, how renourishment correlates with the survival of sea turtle nests probably varies, depending upon the composition of the sands which are employed. It would be preferable to know these effects before decisions are made concerning which substrates are used in renourishment. Until that practice becomes a reality, the effects of renourishment will necessitate study on a case-by-case basis. It would be a mistake to assume, on the basis of Raymond's and my results, that renourishment activities on sea turtle beaches will have no adverse effects on the nests of sea turtles.

LITERATURE CITED

Packard, G.C., M.J. Packard, K. Miller, and T.J. Boardman. 1988. Effects of temperature and moisture during incubation on carcass composition of hatchling snapping turtles (Chelydra serpentina). J. Comp. Physiol. B 158:117-125.

Raymond, P. W. 1984. The effects of beach restoration on marine turtles nesting in south Brevard County, Florida. M.S. thesis, Univ. of Central Florida, Orlando.

Swingland, I.R., and M.J. Coe. 1979. The natural regulation of giant tortoise populations on Aldabra Atoll: recruitment. Philos. Trans. R. Soc. Lond. 286B: 177-188.

SEA TURTLE STRANDINGS AND SHRIMPING EFFORT ON COASTS OF SOUTHWESTERN LOUISIANA AND TEXAS

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Strandings of sea turtles increase during commercial shrimping seasons and decrease with closing of the seasons on the Atlantic coast of the United States (Hillestad et al., 1978; Talbert et al., 1980; Ruckdeschel and Zug, 1982; Booker and Ehrhart, 1989; Schroeder and Maley, 1989). Texas and Louisiana produced almost 74% of the offshore (seaward of barrier islands) commercial catch of penaeid shrimp in the southeastern United States during 1986-1989, yet the relationship between turtle strandings and shrimping in the northwestern Gulf of Mexico has received limited attention (Rabalais and Rabalais, 1980; Amos, 1989; Whistler, 1989; Magnuson et al., 1990). We examined the relationship between sea turtle strandings (at sea or on shore) and shrimping effort during 1986-1989, the years in which year-round systematic surveys of strandings were conducted along the coasts of southwestern Louisiana and Texas.

Monthly turtle strandings (all species) and shrimp fishing effort were grouped into two zones, the upper coast (subareas 17-18) and the lower coast (subareas 19-21)(Figure 1). The upper coast has a wider Continental Shelf than the lower, so the distance from shore of a particular depth contour is greater on the upper than on the lower coast. In the upper coast zone we included only those strandings that occurred west of the Mermentau River, Louisiana, because the coastline east of the Mermentau had not been systematically surveyed for strandings. The number of monthly strandings in a zone was standardized by dividing it by distance of shoreline surveyed within the zone to obtain S, the monthly turtle strandings per 100 km of shoreline.

Monthly fishing effort was standardized by dividing it by the surface area (Patella, 1975) of the geographic unit (zone x depth interval) within which the effort occurred. The standardized effort (E) was expressed as days fished per 100 km^2 of surface area within each geographic unit. The surface area within geographic units was usually greatest nearshore and decreased seaward (Fig. 1).

Standardized strandings and fishing effort were normalized by transformation to natural logarithms (after the addition of 1 to each value, because some values were zero). The data sets for each geographic unit contained 48 pairs of observations (12 months x 4 years). Product-moment correlations between $\ln(S + 1)$ and $\ln[E + 1]$ were determined, first for depth interval 0-5 fathoms, then 5-10 fathoms and so on to 25-30 fathoms (45.7-54.9 m), for each of the two zones. We did not extend the analyses beyond 30 fathoms (54.9 m), because only 7% or less of the shrimping effort and shrimp catch within shrimp statistical subareas 17-21 occurred beyond 30 fathoms during 1986-1989.

On the upper coast, three correlation coefficients, **r**, were significantly different from zero ($P < 0.05$), and also were positive (Fig. 2). They occurred for fishing effort in the 0-5, 5-10 and 10-15 fathom intervals. On the lower coast, **r** was significantly different from zero ($P < 0.05$) and positive for fishing effort in the 5-10 and 10-15 fathom intervals. These correlations indicated that strandings increased as fishing effort increased. They were detected despite the relatively coarse temporal-spatial scale of the observations. There was no significant ($P > 0.05$) heterogeneity among the five significant correlations. Correlation coefficients for the remaining depth intervals within the two zones did not differ significantly ($P > 0.05$) from zero.

The correlations we observed were circumstantial evidence, and did not demonstrate that the strandings were caused by shrimping. However, our results are consistent with the conclusion by Magnuson et al. (1990) that incidental capture in shrimp trawls is a major cause of sea turtle mortality and it occurs for the most part in depths up to 27 m (15 fathoms).

Loggerhead (Caretta caretta) and Kemp's ridley (Lepidochelys kempi) occurred most frequently in the strandings, followed by hawksbill (Eretmochelys imbricata), green (Chelonia mydas) and leatherback (Dermochelys coriacea). Turtle strandings occurred year-round with peaks in April and May, and with a secondary peak in August.

LITERATURE CITED

Amos, A. F. 1989. Recent strandings of sea turtles, cetaceans and birds in the vicinity of Mustang Island, Texas, p. 51. In: Proc. First International Symposium on Kemp's Ridley Sea Turtle Biology, Conservation and Management, C. W. Caillouet, Jr. and A. M. Landry, Jr. eds., Texas A&M University, Sea Grant College Program, TAMU-SG-89-105 (abst. only), 260 p.

Booker, W. C. and L. M. Ehrhart. 1989. Aerial surveys of marine turtle carcasses in National Marine Fisheries Service statistical zones 28 and 29; 11 August 1987 to 31 December 1988, p. 15-17. In: Proc. Ninth Annual Workshop on Sea Turtle Conservation and Biology, S. A. Eckert, K. L. Eckert and T. H. Richardson compilers, NOAA Tech. Memo. NMFS-SEFC-232, 305 p.

Hillestad, H. O., J. I. Richardson and G. K. Williamson. 1978. Incidental capture of sea turtles by shrimp trawlermen in Georgia. Proc. Annual Conf., Southeastern Assoc. Fish and Wildl. Agencies 32:167-178.

Magnuson, J. J., K. A. Bjorndal, W. D. DuPaul, G. L. Graham, D. W. Owens, C. H. Peterson, P. C. H. Pritchard, J. I. Richardson, G. E. Saul and C. W. West. 1990. Decline of the sea turtles: causes and prevention. Committee on Sea Turtle Conservation, Board of Environmental Studies and Toxicology, Board on Biology, Commission on Life Sciences, National Research Council, National Acad. Press, Wash., D. C., 190 p.

Patella, F. 1975. Water surface area within statistical subareas used in reporting Gulf Coast Shrimp Data. Mar. Fish. Rev. 37(12):22-24.

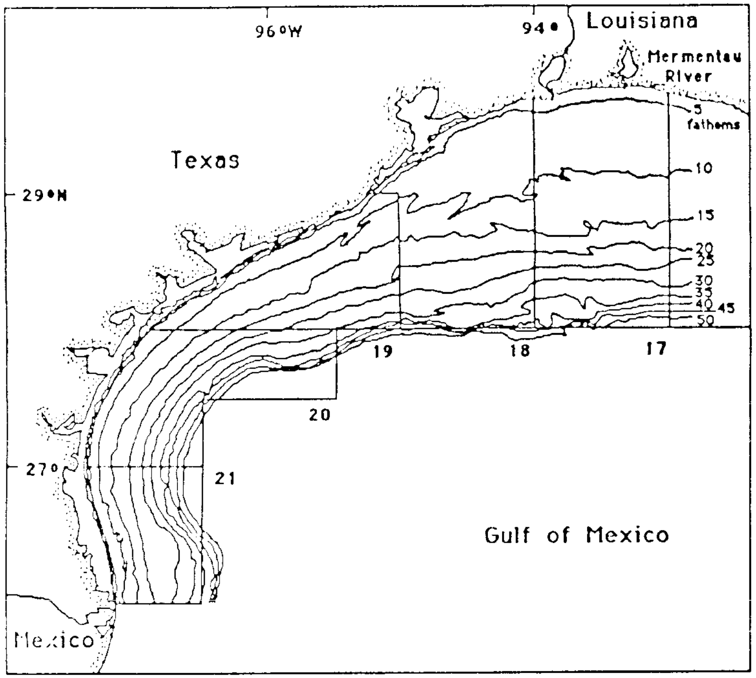
Rabalais, S. C. and N. N. Rabalais. 1980. The occurrence of sea turtles on the south Texas coast. University of Texas, Marine Science Institute, Contrib. Mar. Sci. 23:123-129.

Ruchdeschel, C. and G. R. Zug. 1982. Mortality of sea turtles Caretta caretta in coastal waters of Georgia. Biol. Conserv. 22:5-9.

Schroeder, B. A. and C. A. Maley. 1989. 1988 fall/winter strandings of marine turtles along the northeast Florida and Georgia coasts, p. 159-161. In: Proc. Ninth Annual Workshop on Sea Turtle Conservation and Biology, S. A. Eckert, K. L. Eckert and T. H. Richardson compilers, NOAA Tech. Memo. NMFS-SEFC-232, 305 p.

Talbert, O. R. Jr., S. E. Stancyk, J. M. Dean and J. M. Will. 1980. Nesting activity of the loggerhead turtle *Caretta caretta* in South Carolina I: a rookery in transition. Copeia 1980:709-718.

Whistler, R. G., 1989. Kemp's ridley sea turtle strandings along the Texas coast, 1983-1985, p. 43-50. In: Proc. First International Symposium on Kemp's Ridley Sea Turtle Biology, Conservation and Management, C. W. Caillouet, Jr. and A. M. Landry, Jr. eds., Texas A&M University, Sea Grant College Program, TAMU-SG-89-105, 260 p.



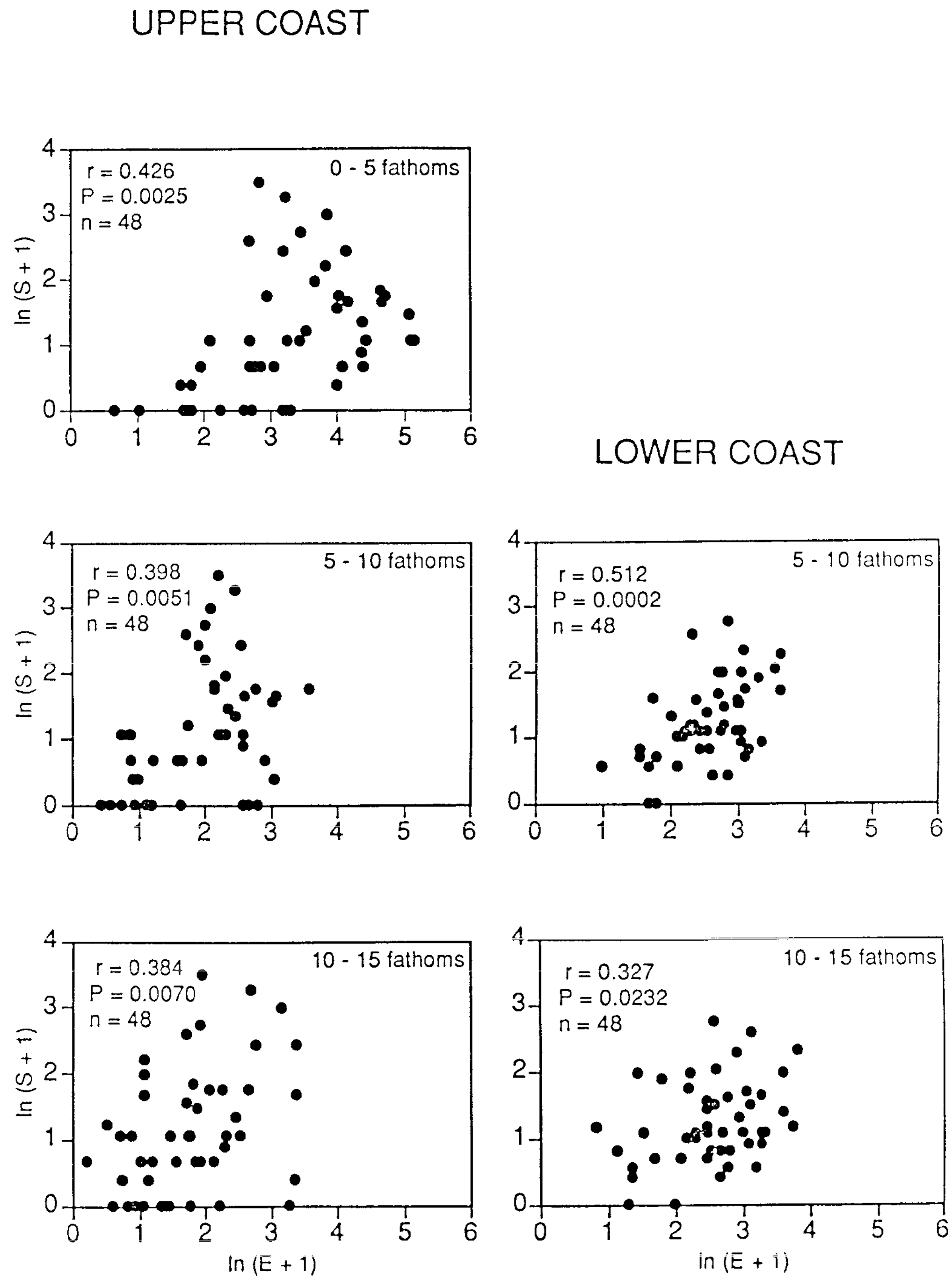


FIGURE CAPTIONS

Figure 1. - Boundaries of shrimp statistical subareas 17-21 and 5-fathom (9.1 m) depth intervals in the northwestern Gulf of Mexico (see Patella, 1975).

Figure 2. - Scatter plots for significant ($P < 0.05$) correlations, r, between transformed monthly sea turtle strandings, $\ln(S + 1)$, and transformed monthly shrimping effort, $\ln(E + 1)$, on the upper coast (shrimp statistical subareas 17-18) and lower coast (subareas 19-21) of the northwestern Gulf of Mexico, 1986-1989.

SURFACE OCEAN FRONTS AND THE PELAGIC HABITAT OF SEA TURTLES: THE QUESTION OF FOOD AVAILABILITY IN NON-FRONTAL ZONES

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Above-background concentrations of near-surface plankton in downwelling areas associated with frontal interfaces may play an important role in the feeding ecology of pelagic sea turtles. To evaluate the "background" abundance, distribution and diversity of near-surface macroplankton potentially available as forage for sea turtles, catches from 644 Gulf of Mexico and North Atlantic collections were analyzed with respect to 26 met-ocean variables. Results indicated that non-frontal zone, near-surface macroplankton was relatively abundant in all areas sampled over the 14 year period 1976-1990, and suggested that sea turtles are not food-limited in surface waters. The association of some sea turtles with major surface watermass/current boundaries may be adaptive primarily as dispersal and migratory pathways. Foraging in downwelling areas may increase feeding efficiency, decrease search and handling times, and accelerate growth rates, but it seems unlikely that survivorship would be significantly increased by this "strategy". However, in light of very limited information it seems prudent to retain a working hypothesis that convergent downwelling areas and forage are interrelated components of the pelagic habitat of sea turtles.

ZAKYNTHOS 1990: STILL TRYING TO LIVE TOGETHER

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Zakynthos, a small island (40 x 600 ha) lying 17 km from the west coast of Peloponnesus, has proved to be the most important nesting area for the marine turtle Caretta caretta in the Mediterranean. The rookery, comprised of 3.5 km of sandy coastline within the Bay of Laganas and divided in six separate beaches, hosts from 850 to 2000 nests/season, depending on the season. Of the six beaches, Sekania (0.35 km long) contributes more than 50% to the total nesting capacity (see Figure 1 from Margaritoulis, 1988).

Sea turtles are protected by law in Greece, which in 1983 also ratified the Bern Convention. Legislation has been in effect since 1983, imposing building restrictions on an area adjacent to the nesting beaches. Maritime measures were introduced in 1988 to regulate speedboat and fishing activities in the Bay.

Zakynthos, once a quiet island catering mostly for a small number of Greek visitors has, in the recent years, turned into a prime tourist resort. In 1990, it experienced a 30% increase when at the same time neighbouring resorts with a long tradition in tourism were well into a recession. From the beginning of May through the end of September, 1,047 chartered flights, mainly from the U.K., Germany and Austria, flew in 142,000 foreign visitors, which is four times the permanent population of the island. The high nesting density of the rookery and the ever growing tourist influx, dictated the need for an intensive campaign to protect both the turtles and the nesting grounds.

In 1987, the Sea Turtle Protection Society of Greece (STPS) which has been carrying out a monitoring/tagging project since 1983, initiated with financial assistance from the EEC, WWF and others a Public Awareness Programme, conducted mainly through information stations on the beaches, slide shows at hotels, daytime beach patrols and night time guarding of beach accesses.

In the years that followed, inadequate enforcement of existing legislation coupled with the incompetence of the Greek authorities to deliver a compensation scheme, engendered the indignation of the affected landowners, who view the tourist industry as an easy and lucrative enterprise.

During the 1990 summer programmes, the despair and fury of these landowners culminated in violence and physical assaults against STPS volunteers. Nevertheless, the STPS and a contingent of over 130 volunteers from Greece, U.K., USA, Italy, Brazil, Germany, etc., successfully completed the programme in close cooperation with the "Zakynthian Ecological Movement" and other concerned individuals from the island. The main Information Station at Laganas became the focal point for over 30,000 tourists. Seven thousand signatures were collected on a petition urging the authorities to save the turtles and ninety slide presentations were organized at hotels.

After four years the Public Awareness Programme succeeded in:

a. Minimizing the number of tourists attempting to visit the beaches at night. This is demonstrated in the westernmost sector of the East Laganas beach which borders with the tourist resort of Laganas. Since 1989, a rise in the nesting activity was recorded and in 1990 the increase reached 18% compared to 1988 (Fig. 2).

b. Sensitizing the majority of the local inhabitants. Thirty Zakynthians participated in the programme.

c. Increasing national and international lobbying and exerting pressure on the authorities to speed up the procedure for the preparation of a Management Plan.

It is obvious that in order to secure full protection it is necessary to acquire a core area and compensate landowners for the land they cannot utilize. To this end, it is imperative to proceed immediately with the acquisition of Sekania, probably the most densely nested beach in the world for the loggerhead turtle (up to 3,000 nests/km).

The completion of a Management Plan is required in order to determine land use in the protected area and set the foundations for a Marine Park.

It is also necessary to maintain a broad buffer zone which will allow for a soft development and funds generated by the Marine Park will be used to offer affected landowners a steady income.

LITERATURE CITED

Margaritoulis, D. (1988). Nesting activity of the loggerhead turtle on Zakynthos island during 1986 and 1987 nesting seasons. Unpublished Report for the Ministry of the Environment, Athens.

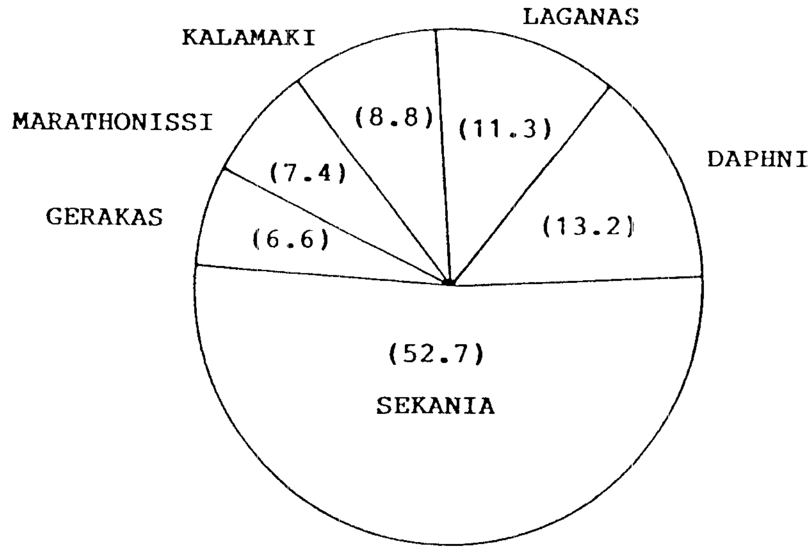

Fig.1. Distribution of nesting on Zakynthos nesting beaches as a percentage of the total number of nests per season. Values represent means over six nesting seasons(1984-1989)

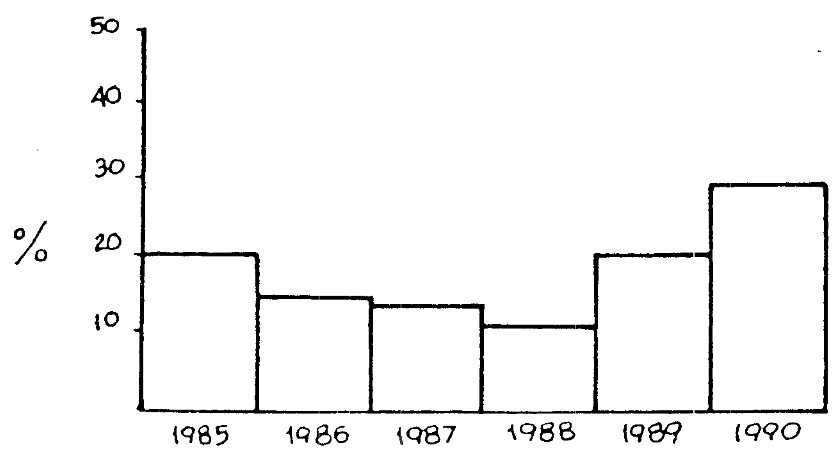

Fig.2. Evolution of nesting activity over six nesting seasons (1985-1990) on sector A of the East Laganas beach.

INTERNATIONAL SEA TURTLE TRADE AND THE PELLY AMENDMENT

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The Pelly Amendment is a new solution to the old problem of international sea turtle trade. In actuality, international sea turtle trade today means basically one thing: Japan's trade in hawksbill shell, known as bekko, and olive ridley skins. There are indications that Japanese dealers may soon cease their exploitation of olive ridley turtles. But the future for the hawksbill is much more bleak. In oceans around the world, Japan's relentless pursuit of these magnificent animals for luxury markets is driving populations of hawksbills toward extinction.

However, in recent months, there have been a number of indications that substantial changes in this trade could soon occur. First, there is a growing awareness within the government of Japan that international criticism over their wildlife trade, and especially the turtle trade, is hurting Japan internationally.

Second, the Japanese shell dealers have finally accepted that their levels of exploitation are causing hawksbill populations to decline. In November 1990 the bekko associations organized the second international symposium on the resource management of the hawksbill. It provided an opportunity for biologists, the dealers and those of us familiar with trade to discuss the biological status of this turtle and the problems of the shell trade.

Third, during a recent visit to Japan to celebrate the 20 year anniversary of the World Wildlife Fund there, Prince Phillip spoke with Prime Minister Toshiki Kaifu about Japan's dropping its 10 CITES reservations (6 whales, 2 sea turtles, and 2 lizards) in time for the next meeting of the parties to the Convention on International Trade in Endangered Species (CITES) to be held in Kyoto, Japan in March 1992.

Lastly, and perhaps most importantly, four major US conservation organizations have invoked a potentially powerful but seldom used tool for conservation known as the Pelly Amendment to force Japan to end its trade in sea turtle products.

Last April the Center for Marine Conservation, the National Wildlife Federation, National Audubon Society, and Environmental Defense Fund petitioned the Departments of Commerce and Interior to certify Japan and Mexico under the Pelly Amendment to the Fisherman's Protective Act of 1967 (22 U.S.C. 1978) for undermining sea turtle conservation.

Certification to the President is made under paragraph (1) and/or (2) which read as follows:

(1) When the Secretary of Commerce determines that nationals of a foreign country, directly or indirectly, are conducting fishing operations in a manner or under circumstances which diminish the effectiveness of an international fishery conservation program, the Secretary of Commerce shall certify such fact to the President.

(2) When the Secretary of Commerce or the Secretary of Interior finds that nationals of a foreign country, directly or indirectly, are engaging in trade or taking which diminishes the effectiveness of any international program for endangered or threatened species, the Secretary making such finding shall certify such fact to the President.

Upon receipt of certification embargoes can be imposed by the president from the offending country for "such duration as the President determines appropriate."

If a country is certified under paragraph (1) for fishing operations, fishery products can be embargoed. If a country is certified under paragraph (2) wildlife products are affected.

Within sixty days following certification, the President shall notify Congress of the actions he has taken.

To date, six countries have been certified on six separate occasions for fishing violations. Japan, the USSR, Chile, Peru, Korea, and Norway have been certified for whaling, and Korea and Taiwan were certified for fishing with drift nets in 1988 (Japan and USSR in 1974; Chile, Peru and Korea in 1978; the USSR in 1985; Norway in 1986 and Japan in 1988; Norway in 1990). In most cases, sanctions have never had to be used because the problems have been resolved by the offending countries.

To date, the wildlife provision has never been used. The Pelly Amendment petition for sea turtle trade is an excellent opportunity to set a precedent for certification under the wildlife provision.

Under the Pelly Amendment, the following products can be banned:

4) The term "fish products" means any aquatic species (including marine mammals and plants) and all products thereof exported from an offending country whether or not taken by fishing vessels from that country, or packed, processed, or otherwise prepared for export in such country or within the jurisdiction thereof,

6) The term "wildlife products" means fish (other than those to which paragraph (4) applies) and wild animals, and parts (including eggs) thereof, taken within an offending country and all products of any such fish and wild animals, or parts thereof, whether or not such products are packed, processed, or otherwise prepared for export in such country or within the jurisdiction thereof.

Mexico: Shortly after our Pelly petition was submitted, Mexico ended the harvest of olive ridleys which was the subject of the petition; the harvest ban has held. For more than twenty years Mexico has sanctioned the killing of 25,000 olive ridleys for their skins under a quota system. But the enforcement of the quota has been an abysmal failure and in some years the slaughter has exceeded 75,000 turtles, the majority of which were breeding age females preparing to nest.

The US government has chosen not to certify Mexico. Our four organizations support this decision.

Japan: Among the evidence that our organizations provided to the government was documentation of Japan's current excessive levels of hawksbill shell (bekko) imports from around the world and the trade in olive ridley skins from Mexico.

While the other nations of the world have banned the trade in sea turtle products, Japan's markets have flourished under a reservation or exception to CITES ban. Until recently Japan imported 30,000 kg of shell annually under a quota system. This year the quota was reduced to 20,000 kg. Although shell weights from various regions appear to vary, 1.06 kg represents the shell of one adult hawksbill.

Our analysis of Japan's trade shows that more than half of the hawksbill shell imported by Japan in 1989 could not have been legally obtained from 11 of the 14 nations cited as countries of origin, and in 1990 10 of 15 nations exporting shell could not have done so legally in the quantities cited.

The problems associated with current bekko imports fall into four major categories.

1) Bekko is imported from CITES countries which do not allow this trade or have not provided proper export documents.

2) Bekko is imported from non-CITES countries which do not allow this trade.

3) Bekko is imported in large quantities from countries where few hawksbills are found.

4) Bekko is imported from countries where hawksbills can be legally exploited but biologically they should not be harvested.

Mounting evidence indicates that hawksbill populations cannot withstand the levels of exploitation to which they are subjected. Japan's annual consumption may be the equivalent of the number of hawksbills that nest each year. Japan must announce now when its reservation on the hawksbill will be dropped.

In the interim, the annual quota on bekko must be dropped significantly to reflect the amount of shell that can be legally obtained. Documents for bekko imports should be made readily available to the CITES Secretariat and Dr. Karen Bjorndal, the Chair of the Marine Turtle Specialist Group.

To date, the Departments of Commerce and Interior have not announced whether they will certify Japan. We believe they will. However, it is important to remember that conservation issues are not resolved in a vacuum. For example, the United States is presently at war and needs $9 billion from Japan. Additionally, if we embargo Japanese fish products, there is the possibility that Japan will reciprocate. The US has a positive balance of trade with Japan for fish exports.

All of us, and our organizations, need to bring enormous pressure on Japan to drop its 10 CITES reservations in time for the next meeting of the CITES parties in March 1992. We have never had a better opportunity to resolve this issue, and we must seize the moment!

There is no doubt that Japanese trade is undermining sea turtle conservation around the world. The hawksbill sea turtle is a regional resource. These animals have intrinsic value and are a part of the natural resources within the regions where they are found. If our government fails to certify Japan under the Pelly Amendment, our organizations are prepared to sue. While we know that we will win this suit, it will be far better if our government willingly certifies Japan for undermining sea turtle conservation.

Postscript: On March 20, 1991 the Departments of Interior and Commerce certified Japan under the wildlife provision of the Pelly Amendment for importing large quantities of raw sea turtle shell and sea turtle skins, thereby diminishing the effectiveness of CITES. Certification occurred despite Japan's final offer to reduce its annual quota to 5,000 kg of hawksbill shell effective August 1, 1991. Sanctions are pending.

TAGGING STUDY OF SEA TURTLES IN SAN DIEGO BAY, 1990-1991

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The effluent channel of the San Diego Gas and Electric Co. power plant in south San Diego Bay, California, is the only area on the west coast of the United States where sea turtles are known to aggregate. In May 1989 we began a study to verify species and numbers present, determine origins and movements, and assess their health status (Dutton and McDonald, 1990).

We continued to see turtles in the effluent channel throughout the year in 1990; however, as in the previous year, fewer turtles were seen during the summer when temperatures of up to 93.2 ^{O} F were recorded in the effluent channel (Figure 1). More turtles were seen in the winter (up to 13 at any one time), when water temperatures ranged from 65.1 - 77.5^{O} F in the effluent channel, and 56.5 - 66.1^{O}F in the rest of the bay (Figure 1). These observations suggest that the turtles dispersed into the bay when temperatures in the effluent channel rose above 85^{O} F in July, and returned to the channel when temperatures cooled again (Figure 1). Sighting reports and recoveries of 2 strandings from other areas of the bay during July and August tend to support this hypothesis.

We captured a total of 12 turtles in the effluent channel from March 1990 -February 1991 (Table 1). These include 6 individuals, 46.7 - 64.4 cm straight carapace length (SCL) and 13.0 - 38.0 kg, which are probably juveniles. Of the six larger turtles, two were mature males measuring 85.5 and 95.5 cm SCL, and weighing 100 and 112 kg respectively (Table 1). (One of the males, X103/104, stranded in July, apparently killed by a boat collision). One turtle was recaptured 8 months after its initial capture; it had grown 3.6 cm SCL and 15.5 kg during that time. In addition to the tagged turtles we have identified 3 individuals that have so far eluded capture. It therefore appears that there are at least 15 turtles that frequent the effluent channel in San Diego Bay. This estimate will likely increase as the study progresses. One large female with a deformed carapace is identical to one Stinson described and photographed in 1979 (Stinson, 1984). The presence of small juveniles suggests that turtles continue to recruit into the bay.

It was difficult to distinguish between Chelonia agasizzi and Chelonia mydas based on plastron color and carapace color and shape (as outlined in Pritchard et al., 1983), and thus determine possible origins of the captured turtles, because many of them had a mixture of characteristics. At least 11 turtles appeared to be C. agasizzi, and probably belong to the Mexican breeding population, although 2 of these were larger than the maximum size reported for C. agasizzi (Table 1; Pritchard et al., 1983; Lopez, 1989). The origins of these turtles will have to be determined from our ongoing genetic studies.

Three of the turtles captured in May 1990 had small fibropapilloma tumors in the eye area (McDonald & Dutton 1991). One of these turtles was recaptured in January 1991, and the tumor was somewhat smaller. The turtles all appeared otherwise healthy. Boat traffic remains the main threat, particularly since the effluent channel is a popular area for water skiers.

LITERATURE CITED

Dutton, P. and D. McDonald. 1990. Status of sea turtles in San Diego Bay, 1989 - 1990 Final Report. Sea World Research Institute Technical Report #90-225. 18 pages.

Lopez, A.F. 1989. Contribucion a la determinacion del estatus taxonomico de la Tortuga negra (Chelonia agasizzi Bocourt, 1808) de Michoacan, Mexico. Thesis, Universidad Michoacan de San Nicolás de Hidalgo. 35 pages.

McDonald, D. and P. Dutton. 1990. Fibropapillomas on sea turtles in San Diego Bay, California. Marine Turtle Newsletter 51:9-10.

Pritchard, C.H., P.R. Bacon, F.H. Berry, A.F. Carr, J. Fletemeyer, R.M. Gallagher, S.R. Hopkins, R.R. Lankford, R. Marquez M., L.H. Ogren, W.G. Pringle, Jr., H.A. Reichart and R. Witham. 1983. K.A. Bjorndal and G.H. Balazs (eds.). 1983. Manual of sea turtle research and conservation techniques, Second Edition. Center for Environmental Education, Washington, D.C. 125 pages.

Stinson, M. L. 1984. Biology of sea turtles in San Diego Bay, California, and in the northeastern Pacific Ocean. Master's Thesis, San Diego State University. 578 pages.

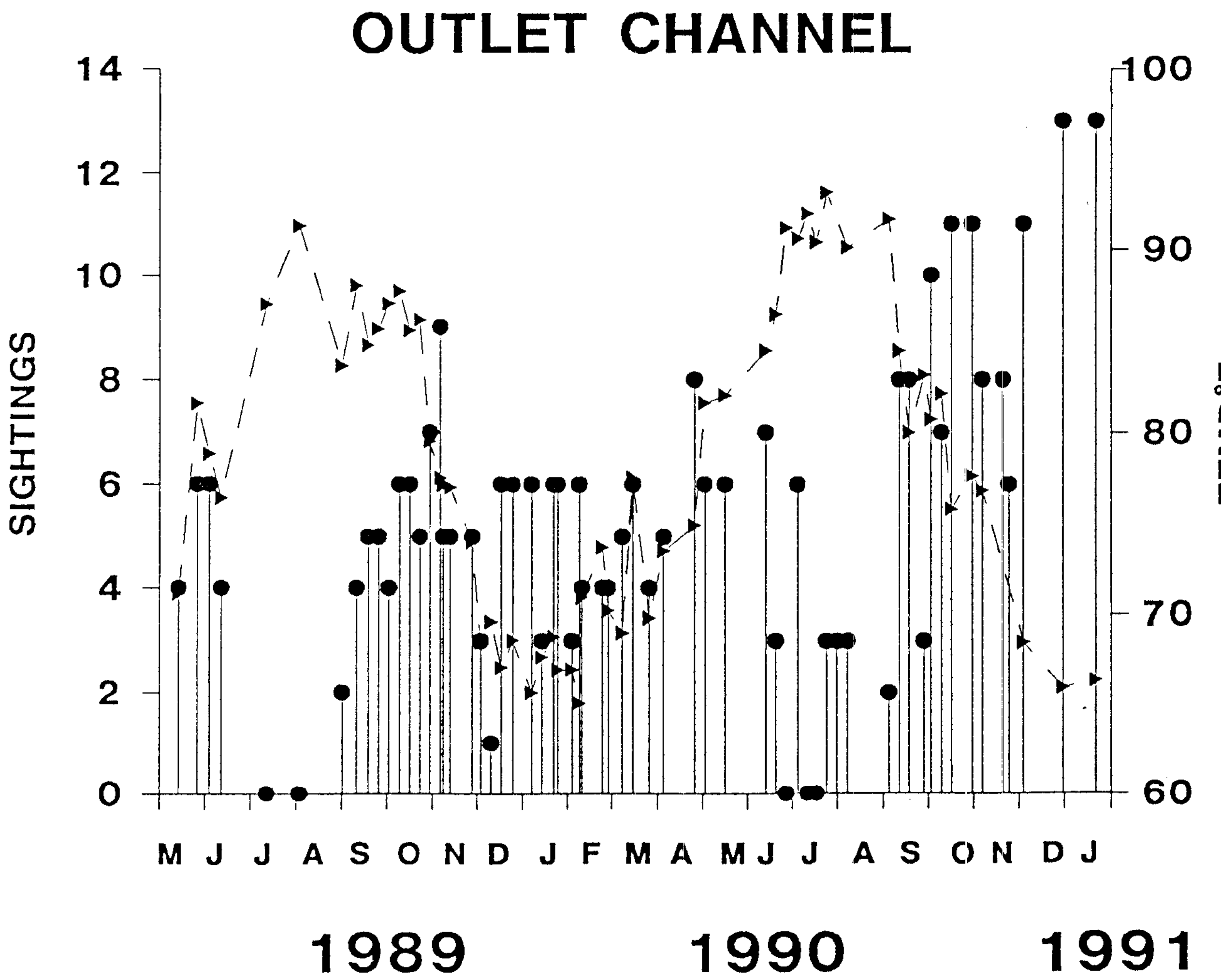

Figure 1. Sea turtle, Chelonia sp., sightings (●) and water temperatures (▲) in the effluent channel adjacent to the SDG&E power plant in San Diego Bay, from May 1989 through February 1991.

Table 1. Sea turtles tagged in south San Diego Bay through February, 1991.

NMFS Tag No.	Date Tagged	Sex	Weight (kg)	Straight Carapace Length (cm)	Carapace Color	Plastron Color	Carapace Indentations	Probable species
X101-102	3/31/90	Juv	29.0	56.7	Black, round	Gray, yellow patches	slight	Black
X103-104	5/12-13/90	Male	100.0	85.5	Dark grey, mottled, oblong	Gray	slight to none	Black?
X105-106	5/12-13/90	Juv	24.0	54.4	Dark brown with creamy streaks	Pale blue-gray	slight	Black
X107-108	5/12-13/90	Fem	99.9	92.0	Dark brown with gray-green streaks	Gray with cream blotches	pronounced	Black
X109-110	5/12-13/90	Fem	88.0	85.0	Brown with green-cream streaks	Gray with cream blotches	pronounced	Black
X111-112	5/26-27/90	Male	112.0	95.5	Black with gray-green mottling	Gray, mottled	pronounced	Black
X113-114	5/26-27/90	Juv	40.5	67.0	Mottled olive and brown	Cream with gray blotches	pronounced	Black
X115-116-117	12/2/90	Fem	172.4*	104.0	Mottled dark brown and olive green-cream	Dark gray	none	?
X118-119	1/14/91	Juv	38.0	64.4	Black/brown	Gray	slight	Black
X120-121	1/14/91	Juv	26.0	59.5	Black, pointed	Gray	slight	Black
X122-123	1/28/91	Juv	13.0	46.7	Dark brown	Light brown/cream	none	Green?
X124-125	1/28/91	Fem	88.0	86.7	Dark brown with cream streaks	Gray on margin, creamy gray in middle	pronounced	Black

* This turtle was last weighed in March, 1979 (Stinson, 1984).

PROTOCOL CONCERNING SPECIALLY PROTECTED AREAS AND WILDLIFE IN THE WIDER CARIBBEAN REGION: AN UPDATE

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The Oceans and Coastal Areas Programme Activities Center within the United Nations Environment Programme has two major components: the Marine Living Resources Programme and the Regional Seas Programme. The Regional Seas Programme was conceived as an action-oriented program focused on mitigating the causes and effects of marine degradation using a cooperative regional approach. When member States activate the Regional Seas Programme, two documents are produced. One is a Convention which serves as a legal framework for the Programme -- in the Caribbean, this is the Convention for the Protection and Development of the Marine Environment of the Wider Caribbean Region. The other is an Action Plan, which is formulated according to the needs of the region as perceived by the Governments concerned. The Action Plan is designed to link environmental assessment and environmental management of marine ecosystems and to promote the parallel development of regional legal agreements and of action-oriented program activities.

In the case of the Caribbean Environment Programme, the Action Plan was drafted jointly by UNEP and the Economic Commission for Latin America, beginning in 1977. In 1981, an Intergovernmental Meeting was convened in Montego Bay, Jamaica and 22 Caribbean nations adopted the Action Plan. In 1983, a Conference of Plenipotentiaries met in Cartagena, Colombia to negotiate a Convention on the Protection and Development of the Marine Environment of the Wider Caribbean Region. Colombia, Costa Rica, Cuba, France, Grenada, Guatemala, Honduras, Jamaica, Mexico, the Netherlands, Nicaragua, Panama, Saint Lucia, the United Kingdom, the United States, and Venezuela adopted the Convention (known as the "Cartagena Convention") and a Protocol concerning cooperation in Combating Oil Spills in the Region. The Meeting recommended that priority be placed on the development of additional protocols for pollution from land-based sources, and specially protected areas and wildlife.

The Cartagena Convention includes 30 articles. Article 10 is of special interest because it addresses the responsibilities of Contracting Parties to "individually or jointly ... protect and preserve rare or fragile ecosystems, as well as the habitat of depleted, threatened or endangered species, in the Convention area". This, of course, has the potential to protect sea turtles and their habitats on a regional scale. The Cartagena Convention came into force in 1986 after having been ratified by the requisite nine Caribbean States. To date, 18 States have ratified -- Antigua and Barbuda, Barbados, Colombia, Cuba, Dominica, France, Grenada, Guatemala, Jamaica, Mexico, the Netherlands, Panama, St. Lucia, St. Vincent and the Grenadines, Trinidad and Tobago, the United Kingdom, the USA, and Venezuela.

There are several features of the new Convention that suggest that it will be more effective than others of its kind. First, a decision was made at the Second Intergovernmental Meeting in 1983 to establish a Regional Coordinating Unit (RCU). The RCU is geographically situated within the Region (in Jamaica) and has the responsibility of coordinating and facilitating all activities associated with the Convention, the Protocols, and the Action Plan of the Caribbean Environment Programme. Second, there are regularly scheduled meetings which are well attended and a mechanism for contributing to the Caribbean Trust

Fund in order to support the objectives of the Convention. Finally, two very useful Protocols or sub-agreements have already been negotiated and adopted, including the Protocol Concerning Specially Protected Areas and Wildlife, or SPAW. Additional protocols on a variety of subjects, such as land-based sources of pollution, are planned.

In January 1990 in Jamaica, 13 of the 15 Contracting Parties to the Cartagena Convention adopted the SPAW Protocol, which explicitly states in its Preamble that: ill-conceived development of the marine and coastal environment of the Wider Caribbean Region poses a grave threat; that protection and maintenance of the environment of the Wider Caribbean Region are essential to sustainable development within the region; that the Wider Caribbean Region constitutes an interconnected group of ecosystems in which an environmental threat in one part represents a potential threat in other parts; and that the establishment and management of protected areas and the protection of threatened and endangered species will enhance the cultural heritage and values of the countries and territories in the Region, and bring increased economic and ecological benefits to them. The geographical scope includes the marine environment, estuarine systems, and related terrestrial areas, including watersheds.

The SPAW Protocol includes provisions for the establishment of protected areas and buffer zones (including planning and management), national measures for the protection of threatened and endangered flora and fauna, environmental impact assessment, exemptions for traditional activities, public awareness and education, and scientific and technical management research. Significantly, Article 3 requires each Party to manage their fauna and flora with the objective of preventing species from becoming threatened or endangered in the first place. This agreement represents an enormous step forward for conservation in the Wider Caribbean region.

The SPAW Protocol will also include three Annexes. Annex I will include species of marine and coastal flora exempt from all forms of destruction or disturbance. Annex II ensures total protection and recovery of listed species of fauna, with minor exceptions. Specifically, Annex II would prohibit the taking, possession or killing (including, to the extent possible, the incidental taking, possession or killing) or commercial trade in such species, their eggs, parts or products; and to the extent possible, the disturbance of such species, particularly during periods of breeding, incubation, estivation or migration, as well as other periods of biological stress. Annex III will be a list of species in need of "protection and recovery", but subject to a regulated harvest. With respect to fauna, Annex III will prohibit all non-selective means of capture, killing, hunting and fishing; implement closed hunting and fishing seasons and other measures for maintaining designated populations; and regulate the taking, possession, transport or sale of living or dead species, their eggs, parts or products.

In order to develop these Annexes, 16 Caribbean States and territories appointed a scientific expert to become part of a group charged with recommending which species would be listed on the three Annexes. This group met last November 1990 in Martinique to achieve this task. As has been the case in the past, UNEP invited WIDECAST to participate in this important meeting. Not surprisingly, there was quite a debate over the proposal that sea turtles be included in Annex II. However, after intensive lobbying by WIDECAST, Greenpeace, and Monitor International, and solid support from a majority of government scientists and representatives, the recommendation that sea turtles be included in Annex II emerged victorious over the "special instructions" of some governments. In the end, and after considerable discussion, the group recommended by consensus that all six species of sea turtles in the Wider Caribbean, Caretta caretta, Chelonia mydas, Eretmochelys imbricata, Dermochelys coriacea, Lepidochelys kempii, and L. olivacea, be included in Annex II. That is, that these species be provided total protection from direct harvest (turtles and eggs) and incidental capture throughout the Wider Caribbean.

This decision has far-reaching implications for the conservation of sea turtles in the region, and is a profound achievement of those States, intergovernmental bodies, and non-governmental organizations who have tirelessly worked to highlight the plight of sea turtles of the region. The Annex recommendations will be presented to the second Conference of Plenipotentiaries for negotiation and adoption in June 1991. WIDECAST will continue to lobby for formal adoption of the Martinique recommendations, and urges that all citizens of the Wider Caribbean encourage their respective governments to support the protection of Caribbean sea turtles under the auspices of the SPAW Protocol to the Cartagena Convention.

A MORPHOLOGIC AND HISTOCHEMICAL STUDY OF THE LUNGS AND AIRWAYS OF LOGGERHEAD SEA TURTLE (Caretta caretta) HATCHLINGS

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A study of the lungs and airways of hatchling loggerhead sea turtles by means of gross observations, light, scanning and transmission electron microscopy has largely confirmed observations of previous investigators. SEM was used to complement gross observations in describing the arrangement of the intrapulmonary airways and their relationship to the respiratory surfaces. Similarities between the observed pattern and that of mammalian airways has suggested nomenclature revision of the turtle system. TEM examination showed the airways and respiratory surfaces to be lined by cells very similar to those seen in mammalian lungs. By means of histochemical staining the epithelium of the airways was found to contain goblet cells secreting acid mucosubstances, both sialo- and sulphomucins, and, widely scattered, small-granule cells, a type of neuroendocrine cell. These cell types were quantified in airways from 30 hatchlings from natural nests and compared to similar data from hatchlings whose eggs had been manipulated, i. e., from artificial nests. Preliminary analysis of these data suggest that there is a normal range of variation in the ratio of the different cell types in the hatchlings from natural nests and that manipulation of the eggs by transferring them to artificial nests results in a change in this ratio outside of the normal range. The largest significant differences appear to be in numbers of serous (neutral pH) secretory cells indicating that perhaps differences in humidity may play a dominant role in the differentiation of the airway epithelium in the developing turtle, both before and immediately after hatchling.

A NON-LETHAL METHOD FOR THE REPETITIVE SAMPLING OF STOMACH CONTENTS FROM SEA TURTLES

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INTRODUCTION

As sea turtle numbers decline throughout the world, there is a growing interest in the preservation of sea turtle species and in the study of sea turtle ecology. The majority of research conducted to date has focused upon the demographic dynamics of various sea turtle populations with little attention paid to the energetic relationships these animals share with their environment. As energetic relationships ultimately influence the demographic characteristics of a population, a species' trophic ecology is significant.

The feeding habits of wild turtles can be determined by a variety of methodologies including the collection and analysis of diet samples from dead or moribund animals. However, the diets of these animals may not reflect the diets of healthy wild individuals and care should therefore be exercised when interpreting these findings. Observations of animals feeding in the wild may also be employed in determining food habits, however the difficulties of approaching and observing animals underwater are obvious. In addition to these limitations, observational techniques will usually only yield qualitative data on feeding habits. Collecting food fragments from the mouths of wild caught turtles may also be employed but the food fragments present may in fact represent only those forage species (e.g. the algae Gelidiella sp.) which are harder to swallow or are impinged upon various buccal structures such as the papillae of the nasal choanae. The examination of feces has proven successful in determining food habits but the difficulty of collecting fecal samples usually proves quite cumbersome and time consuming. The examination of the digestive tract contents from sacrificed, wild-caught healthy animals provides one of the best determinations of diet, however the ecological and moral implications of sacrificing sea turtles are obvious and this technique is limited to a single temporal sample. Stomach flushing or gastric lavage is a technique which has proven to have the greatest benefits for the analysis of sea turtle diets.

Various techniques of stomach flushing have been employed in freshwater turtles by Legler (1977) and in sea turtles by Limpus (pers. comm.) and Balazs (1980) and in various other vertebrate groups as reviewed by Legler (1977). If samples of the diet are to be retrieved from living animals without harm to the animal, only stomach flushing (gastric lavage) proves feasible.

A new system of non-lethal stomach flushing of sea turtles has been developed from modifications of the techniques previously cited. This system allows for the rapid retrieval of large volumes of food from the esophagus and anterior stomach regions of sea turtles ranging in size from approximately 25 cm CCL to animals in excess of 115cm CCL. The technique, as described in detail by Forbes and Limpus (1991), has been successfully utilized on over 600 sea turtles including green (Chelonia mydas), hawksbill (Eretmochelys imbricata), flatback (Natator depressa), olive ridley (Lepidochelys olivacea) and loggerhead turtles (Caretta caretta) without any apparent ill effects. There is no reason to assume that this technique would not be equally successful on the leatherback (Dermochelys coreacea) if they could be lifted and moved as required throughout the procedure.

individuals have been recaptured from the day after the procedure up to three years later and appear to be quite healthy and feeding. Laparoscopic examination of the intestines following the procedure did not detect any swelling or damage to the intestines. Many individuals have been lavaged more than three times without any known detrimental effect. The entire technique can be performed in less than 10 minutes and is rarely unsuccessful. The smallest turtle lavaged by this technique is a 35cm CCL C. mydas and the largest a 118cm CCL C.mydas. This technique has also been employed to force feed turtles by following the procedure described with the elimination of the injection tube and by passing food to the anterior stomach via the retrieval tube.

This system has proven to be a quick, safe, inexpensive, repeatable and reliable method by which sea turtle stomach samples can be obtained in the field without injury to the animal.

ACKNOWLEDGEMENTS

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REFERENCES

Balazs, G., 1980. Field methods for sampling the dietary components of green turtles (Chelonia mydas). Herp. Rev. 11(1): 5-6.

Forbes, G. and C.J. Limpus, 1991. A non-lethal method for retrieving stomach contents from sea turtles. In review; Australian Wildlife Research.

Legler, J., 1977. Stomach flushing: a technique for Chelonian dietary studies. Herpetologica v33: 281-284.

THE MARINE TURTLE SITUATION IN THE YUCATAN PENINSULA: THE NEED FOR A REGIONAL ACTION PLAN

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The Yucatan Peninsula, composed of the states of Campeche, Yucatan and Quintana Roo, has 1,700 km of coast line; the vast majority, coraline sandy beach. In addition, there are offshore islands and cays from Campeche Sound, in the southwest, to the Caribbean Sea, in the southeast. The Peninsula, especially the Caribbean coast, has been an important source of marine turtles - notably Chelonia mydas and Eretmochelys imbricata - for centuries, for both local and international markets.

Biologically, the Yucatan Peninsula is of world importance because of nesting populations of 3 species. Of primary significance is Eretmochelys which may lay more than 1,000 nests annually. The number of Caretta nests is above 1,000, and annual numbers of Chelonia nests may approach two thousand. In addition, at least one individual of Lepidochelys kempi seems to nest regularly in Campeche, and Dermochelys nests sporadically in Quintana Roo. There appear to be important feeding grounds for all of these five species in coastal waters of the Peninsula.

Traditionally all species have been used, and there is an ageless demand for turtle products. Not only is egg poaching heavy on some beaches, as elsewhere in the country, but there is a great demand for meat and a well developed trade in tortoise-shell, involving the local crafting of high quality articles.

Systematic work on marine turtles in the Yucatan began in the late 1970's, and today includes about 20 "campamentos" on the Peninsula. A prodigious number of institutions and individuals are now involved, including; 3 entities of the Federal government (each with a respective delegation in each of the 3 states); 1 secretariat of State government; 2 centers of investigation; 2 universities; 1 municipal museum; 5 NGO's; Boy Scouts; divers' associations; and private companies.

Hence, over the past few years there has been a great increase in conservation activities, with more areas, more turtles, and more nests being protected by more people and more institutions. For example, in 1980 for the first time studies were made in Celestun and El Palmar, both sites in Yucatan State.

On the other hand, logistic, economic and human resources are very restricted. The inter-institutional situation has become complex and there is a need for a coordinated regional action plan to make more efficient use of resources and stimulate greater cooperation between both biologists and administrators.

A critical problem involves the veracity and standardization of data; certain sources (e.g. some government offices) have been found to be questionable or fictitious; field techniques and reporting practices are often specific to certain beaches, making it difficult (if not impossible) to make meaningful comparisons between different sets of data. Management procedures are highly variable and include questionable (or unadvisable) practices (e.g. locating nests by probing with a stick, excavating nests just to count eggs, and transplanting eggs without need).

In 1988 PRONATURA, a local NGO, organized the first regional sea turtle workshop, and over the past 3 years these meetings have been a forum of discussion and collaboration, free from differences. The fourth regional workshop will be held from 11 to 13 March, as usual with the coordination of CINVESTAV, a federal center of investigation. As the workshops have evolved they have acquired ever more qualities; it is now planned to encourage an active forum of discussion and to publish the proceedings soon after the meeting.

This year for the first time, SEDUE - the federal authority now responsible for sea turtles in Mexico - will organize a Regional Reunion immediately after the Regional Workshop; it will also convene relevant federal and state authorities, universities, research centers and NGO's. The plan is to develop regional and national plans for conservation and investigation, increasing efficiency and optimizing resources. This will be done in 3 stages; the Gulf of Mexico and Caribbean, the southern Pacific and the northern Pacific. Because of the advanced organizational structure in Yucatan, and the earlier nesting seasons there, it was decided to lead off with the first of these national reunions in Yucatan.

In both cases, the Regional Workshop and the Regional Reunion, an urgent need to develop effective coordination and planning has been recognized. For years nesting seasons have begun without knowledge of what resources and personnel will be available to execute the programs. Training and direction are also critically needed. However, without continuity and adequate planning, training people with no job security or permanency is futile as they soon move on and replacements have to be hired - after delays - and trained from scratch.

Apart from these operational problems, five geographic sites have been identified as high priority for the Yucatan Peninsula; the name of each site is followed by reasons why it is of high priority ("+") and then by future activities needed to conserve the turtles there ("*"); the order of presentation is simply geographical (data presented are summarized from reports to be presented at the IVth Regional Workshop).

1) Isla Carmen to Huanito (100 km), Campeche;

+ major importance for Eretmochelys nesting (>>321/yr);
+ important nesting area for Chelonia (>>207/yr);
+ intense egg poaching occurs along a national coastal highway;
+ program has been operating for >10 years.
* continue monitoring;
* increase coverage and protection of beaches;
* reduce loss/perturbation/manipulation to nests;
* include about 120 km of beach in some form of protected area.

2) Rio Lagartos to Boca Chipepté (60 km), Yucatan;

+ major importance for Eretmochelys nesting (>261/yr);
+ important nesting area for Chelonia (>248/yr);
+ the program has been operating for >5 years;
+ the area is part of the system of national protected areas.
* continue beach monitoring and population study;
* control feral dogs;
* reduce perturbation/manipulation to nests and beach.

3) Isla Holbox (36 km), Quintana Roo;

+ major importance for Eretmochelys (>>87/yr) nesting;
+ important feeding area for 3 or 4 species;

+ preliminary projects have been carried out for several years.
* enhance environmental education on Holbox and nearby towns;
* plan the field season to encompass the full nesting season;
* investigate feeding areas;
* include the Island and lagoon in some form of protected area.

4) Isla Cozumel (18 km), Quintana Roo;

+ major importance for Caretta (162/yr) and Chelonia (545/yr) nesting;
+ the area is part of the system of national protected areas.
* continue monitoring and protecting beaches;
* use the inter-institution model for other areas.

5) Xcacel & Aventuras DIF (4km), Quintana Roo;

+ major importance for Caretta (259/yr) nesting;
+ dense nesting area for Chelonia (62/yr);
+ relatively unperturbed, but under threat of development;
+ the program has been operating for several years.
* include the beaches in some form of protected area (e.g. municipal reserve);
* continue beach monitoring and population study.

In addition, five general activities have been identified as high priority for the Yucatan Peninsula; these are listed alphabetically.

1) Develop environmental education:

* train teachers;
* develop, produce and distribute didactic materials;
* put up sign boards in protected areas and nesting beaches.

2) Evaluate the problem of incidental capture:

* include shrimp trawls, shark nets, and seine nets.

3) Expand and support beach patrols:

* in areas of known major importance;
* in areas of probable importance that are poorly known.

4) Investigate coastal areas, lagoons, and reefs thought to be important as feeding or maturation areas:

* e.g. Arrecife Alacranes, Celestun, Coloradas and Isla Holbox.

5) Evaluate and strengthen the tagging program:

* synthesize the existing information;
* redefine objectives in the light of this information;

* continue tagging as long term work in selected areas;
* start new tagging programs in areas where it is warranted.

In summary, two general goals have been identified:

I) Reduce perturbation:

* increase the continuity, efficiency, impact and coverage of beach protection;
* use the minimum manipulation possible with nesting females, eggs, and beach patrols;
* create and implement protected areas.

II) Increase basic information necessary for conservation:

* consolidate and synthesize information for existing studies;
* publish and distribute these results;
* stimulate and support priority studies and activities with adequate planning and support.

OFFSHORE OIL AND GAS STRUCTURES AS SEA TURTLE HABITAT

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A summary of observational data compiled by National Marine Fisheries Service personnel from 1986-1990 is presented. Sea turtle monitoring is required whenever explosives are utilized to remove these offshore structures. The frequency of turtle sightings by depth, area, and time of day is discussed. Several locations were found which represent high use areas by loggerhead turtles. Trends in utilization of platforms as habitat are discussed.

ECOLOGICAL GEOGRAPHY OF WESTERN ATLANTIC LOGGERHEADS AND GREEN TURTLES: EVIDENCE FROM REMOTE TAG RECOVERIES

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Since the UCF Marine Turtle Research group began tagging sea turtles in Brevard County, Florida in 1973, fifty adult female loggerheads have been recovered at distances greater than 150 km. Three routes of travel are now evident from the recoveries. About 25 % of the recoveries come from turtles crossing the Florida Current to northern Bahama Islands. Another 25% were recovered in Cuba mainly along the northern coast. Another group of almost 25% apparently never cross the Florida Current and generally hug the west coast of Florida. Crossing the Florida Current evidently influences at least some of the post-nesting loggerheads by temporarily carrying southbound post-nesters northward with the current as they attempt to cross it. Four loggerheads that were recovered north of Brevard County along the Atlantic coast less than seven months after nesting provide evidence of this. Little is known of the ecological geography of the Florida green turtle. To our knowledge no adult green turtle nesting on Florida's beaches has ever been recovered on a foraging ground. However, two juvenile green turtles captured in Mosquito Lagoon, Florida during cold-stunning episodes have been recovered, one in Cuban waters and the other off Bluefields, Nicaragua.

DRIFT AND DISPERSAL PATTERNS OF SEA TURTLE POST-HATCHLINGS IN THE EASTERN TROPICAL PACIFIC: A SIMULATION STUDY

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The pelagic ecology and distribution of sea turtles in the eastern tropical Pacific, and in particular that of post-hatchlings and juveniles, is practically unknown, even though these animals spend most of the adult and all of the neonate-juvenile stages of their life cycle in this area. Habitat selection theory predicts that reproductive female sea turtles should select nesting beaches on the basis of characteristics affecting the success of nesting, hatching, and the subsequent survival of their progeny. In evolutionary terms, this "quality assessment" should include not only the physiographic characteristics of the beach (type of sand, temperature, tide patterns) that enhance hatching success, but also the marine circulation patterns that determine the transport and dispersal of hatchlings entering the sea. The choice of location and the time of hatching should be based on maximizing offspring survival, which probably means placing the hatchlings in the "right" current systems which ensure that they reach suitable nursery grounds. Suitability of an area can be defined by feeding conditions, protection from predators, or a combination of factors affecting survival.

To identify areas where concentrations of post-hatchlings and juveniles may occur, and to test the hypothesis that selection of nesting beaches is based on increasing offspring survival, a simulation of drift and transport of young sea turtles was carried out. The basic assumption is that for at least some time after the initial swim frenzy period, neonate sea turtles behave as drifting objects and are carried by surface currents. It is possible that active movements may be important for even small sea turtles, but we assumed that the energy costs of swimming against or across currents are so high that most successful life cycle strategies will avoid them. Another concept emphasized by the model is spatial heterogeneity ("patchiness") of the oceanic environment; reaching areas with the right conditions is so crucial for survival that the process cannot be left to chance alone. In a more homogeneous environment, random movements could be a successful strategy.

A wind-driven physical model of the equatorial physical model of the equatorial Pacific was used to generate monthly vectors of circulation from 1980 to 1986. In a second stage, the transport of young turtles away from the nesting beaches was modelled in a La grangean manner, using weighted averages of these circulation vectors. To add a stochastic element to the trajectories, a dispersion parameter periodically generates some random variability in the location of the drifting body. This parameter has been kept low, because we lack information on the degree of hatchling dispersion in the ocean.

In a first approach, data for the period 1980-1986 only were used; this gave an idea of the inter-annual variability as well as of the impact of the very strong El Nino of 1982-1983. Geographically, the model is limited to the area between latitude 20^{o} N and 20^{o} S, which creates some difficulties in modelling those populations nesting close to the edges of this area.

Inter- and intra-annual changes were examined at several nesting beaches used by four turtle species along the west coast of the American continent. Initial results show that the drift patterns for any given beach are quite similar across years, but that dramatic changes occurred in the 1982-1983 El Nino. In typical years, drifting neonates from continental sources are retained in the rich coastal environment and transported north- or southward along the coast, sometimes reversing direction in different periods; in other cases they are retained in eddies or in areas with little circulation. If the source is an island, the most common patterns show reversals of direction that eventually bring the animals back to the starting point. A comparison of these trajectories with the areas of primary productivity in the region shows that the areas of retention and transport coincide closely with the most productive areas.

During the 1982-1983 El Nino drift patterns changed significantly, and many of the trajectories would have carried the hatchlings offshore. The effects of these changes on hatchling survival are unknown, because we do not know the effects of an El Nino on the spatial patterns of productivity, abundance and distribution of predators, etc.

Intra-annual variation is also large: in cases where the direction of currents differs with the season, hatching is limited to a period in which a current flows in a certain direction. With this approach, the possibility of spurious correlations cannot be eliminated: for example, hatchlings emerging early in the hatching season may be transported to different areas than those hatching during the peak or late in the season.

These results should be considered as preliminary. A more detailed study, focusing on individual species and taking into account their biological differences, is required. Further exploration of intra-annual variability, extended to the periods outside the hatching season, are also needed, as are comparisons between different El Nino periods. However, these findings support the hypothesis that habitat selection for the early life of sea turtles may play an important role in the selection of breeding areas, and offer insights into reproductive strategies and sex-related differences in survival rates for all sea turtle species. They also have implications for the management of sea turtles, indicating some requirements that must be satisfied if new nesting ares are to be developed.

SATELLITE TRACKING OF A LOGGERHEAD TURTLE (Caretta caretta) IN THE MEDITERRANEAN

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We report on the first attempt to track a loggerhead turtle in the Mediterranean by satellite. The PTT (Mariner Radar Ltd., model 15S) weighed 650 g in air and 300 g in water. It was approximately 16 cm long, 11 cm wide and 6.5 cm high, and was hydraulically tested to withstand pressure up to a depth of 1000 m. An immersion sensor was incorporated into the housing to turn off the PTT when the turtle submerged, thereby preserving battery power. To determine the location of the PTT, we used the Data Collection and Location System provided by Service Argos. At 38^{o} N (the approximate latitude in this study), an average of 10 overpasses occur per day (Argos, 1989). A
95% confidence area may be defined within which the true position of the PTT occurs on 95% of occasions. If it assumed that such 95% confidence areas are circular, then they will have a radius of 300 m for location class (LC) 3,700 m for LC 2, and 2000 m for LC 1. Class 0 locations have undefined accuracy (Argos, 1989).

We examined the accuracy of locations by switching on the PTT for 9 days in a fixed position immediately behind Potamakia beach on the island of Cephalonia, Greece. During this time 51 locations for the PTT were obtained. Seven (13.7%) were LC 2, nineteen (37.2%) were LC 1, and twenty-five (49.0%) were LC 0. This high percentage of class 0 locations, and the low number of locations (5.7 per day compared with the expected number of 10 per day), may have been because the mountainous terrain of the island restricted the time that the satellites were in line of sight of the PTT on each overpass, hence limiting the number of uplinks. Such problems in mountainous terrain have been reported before with the Argos system (Harris et al., 1990).

To investigate the accuracy (i.e. the deviation of locations from the true position) for LC 0, we assumed that the mean of the class 2 locations (38.067^{o} N, 20.758^{o} E) represented the true position of the PTT. For LC 0, locations were within 172 km of the true position on 95 % of occasions (n = 25, mean deviation = 47.8 km, SE = 12.9 km).

On 18 June 1990 between 05:00 and 05:30, the PTT was attached to a female loggerhead turtle after she had nested on Potamakia beach. We used 800 g of a fibre-glass based car body filler (David's Isopon P.40) to form a foundation (approximately 4 cm thick) on the carapace into which the PTT was embedded. The attachment procedure took approximately 25 minutes to complete. After the PTT was attached to the turtle, a total of 25 locations was obtained. One was LC 2, four were LC 1, and twenty were LC 0. The last uplink was obtained on 15 August, 58 days after attachment. The turtle was not seen again after the transmitter had been attached.

Class 0 locations after attachment, ranged from 19.4 to 174.7 km from the beach location (mean deviation = 57.2 km, n = 20, SE = 7.5 km). Nineteen of these twenty class 0 locations were within 172 km of the beach location, the same number as that expected if the turtle had not moved from the beach. This suggests that the turtle was only making small (< 172 km) movements that the class 0 locations were unable to resolve. The previous mark-recapture study in the Mediterranean using numbered livestock tags attached to the flippers, has shown that loggerheads nesting in Greece may move long distances (up to at least 1500 km) after the end of the nesting season (Margaritoulis, 1988). Class 0 locations may be effective in describing such movements.

The class 1 and 2 locations obtained after attachment were between 8.1 and 27.4 km from the beach location (Figure 1). The 95 % confidence areas for three of these locations were partly on land on the south coast of Cephalonia. Two of these locations (locations 4 and 5, Figure 1) were obtained at night, the time when loggerheads usually nest (Dodd, 1988). Loggerheads on Cephalonia are known to nest several times during a season, and on more than one beach on the island (Hays & Sutherland, in press). Therefore, we assumed that the turtle nested again on the nights that locations 2, 4 and 5 were obtained, corresponding to inter-nesting intervals of 14, 15 and 14 days respectively. These all lie within the reported range of inter-nesting intervals for loggerheads on Cephalonia (range of 13 to 25 days, Hays & Speakman, in press).

For the 12 days preceding these suspected nesting dates, we plotted the daily number of uplinks as a percentage of the maximum recorded in that inter-nesting interval (Figure 2). As the turtle approached suspected nesting dates, the percentage of uplinks increased significantly, suggesting that the turtle was spending longer at the surface. The surfacing behaviour of loggerheads during the inter-nesting period has not been recorded before (Dodd, 1988), and hence data from more individuals are needed to show if the change we recorded is typical for this species.

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REFERENCES

Argos. 1989. Guide to the Argos system. CLS/Service Argos.

Dodd, C. K., 1988. Synopsis of the biological data on the loggerhead sea turtle Caretta caretta (Linnaeus 1758). U. S. Department of the Interior Fish and Wildlife Service, Biological Report, **88** (14), 110 pp.

Harris, S. G., Fancy, S. G., Douglas, D. C., Garner, G. W., Amstrup, S. C., McCabe, T. R. & Pank, L. F., 1990. Tracking Wildlife by satellite: current systems and performance. U.S. Department of the Interior Fish and Wildlife Service, Fish and Wildlife Technical Report, 30, 52 pp.

Hays, G. C. & Speakman, J. R., in press. Reproductive investment and optimum clutch size of sea turtles (Caretta caretta L.). Journal of Animal Ecology, 63.

Hays, G. C. & Sutherland, J. M., in press. Remigration and beach fidelity of loggerhead turtles nesting on the island of Cephalonia, Greece. Journal of Herpetology.

Margaritoulis, D., 1988. Post-nesting movements of loggerhead sea turtles tagged in Greece. Rapports et Proces-verbaux des Reunions. Commission Internationale pour l'Explorartion Scientifique de la Mer Mediterranee, 31: 284.

Stoneburner, D.L. 1982. Satellite telemetry of loggerhead turtle movements in the Georgia Bight. Copeia, 1982 (2), 400-408.

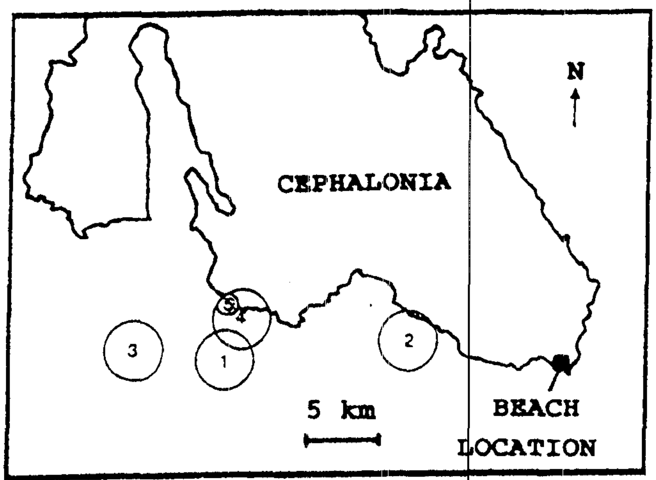

Figure 1. The position of the class 1 and 2 locations after the PTT was attached to the turtle. ■ = beach location. Circles represent the 95 % confidence area for each location. Dates and times of the locations were: location 1 = 1 July, 07:15; location 2 = 2 July, 13:32; location 3 = 15 July, 12:54; location 4 = 17 July, 02:47; location 5 = 1 August, 03:08.

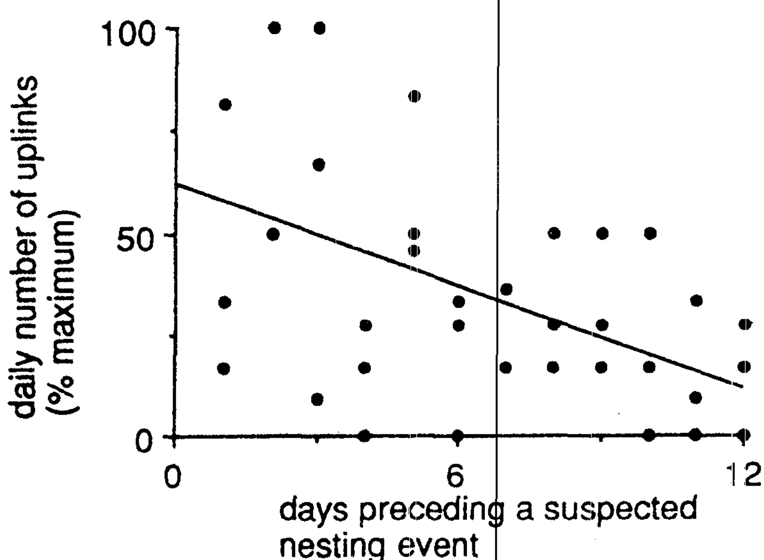

Figure 2. The daily number of uplinks during the 12 days preceding a suspected nesting event. Days were defined as 21.00 local time to 21.00 the next day. Number of uplinks was calculated as the % of the maximum number recorded in that 12 day period. F = 11.4, d.f. = 1, 34; $r^2 = 0.25$, $p < 0.01$.

ANALYSIS OF A FIBROPAPILLOMA OUTBREAK IN CAPTIVITY

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In mid-September 1986 two facilities in the Florida Keys received hatchling green sea turtles (Chelonia mydas) from Hutchinson Island, Florida. One facility was a pen (approximately 4 by 2 by 1.5 meters deep) built under the dock at Lignum Vitae Key State Botanical Site specifically for headstart turtles. These were the only turtles housed at this site, and the pen design ensured constant flushing with very clean seawater. The second facility was Theater-of-the-Sea, a tourist attraction on Windley Key, approximately 7 km northeast of Lignum Vitae Key. Theater-of-the-Sea cooperates in the sea turtle stranding network, housing sick and injured turtles. The facility has an array of pools excavated in the fossil coral bedrock of the island. Sea water flows into the facility through an excavated trench from a nearby marina and through a culvert under a road. A pair of pumps lift 12 million gallons per day one to two meters into a higher trench. From there it flows by gravity throughout their pool system. The pool system includes a series of eight small pools used for displaying sea life, then a much larger pool housing several dolphins. The upstream display pool contains two female California sea lions. The second display pool, immediately downstream of the sea lion pool, houses a variety of fish, including several sharks, and at one time housed a large green sea turtle. This turtle developed fibropapillomas after at least several years in captivity, apparently without ever coming into direct contact with other green sea turtles. The third, fourth, fifth, and sixth housed fish and a few rehabilitating and permanently captive sea turtles. The fourth contained a fenced "hospital" enclosure in the mid-1980s that was used for rehabilitating injured and ill turtles, including turtles with fibropapilloma. The seventh houses rays, and the eighth, nurse sharks. The large dolphin pool is at the downstream end of the system. No surface outlet exists, and water returns to the surrounding ocean through the highly porous fossil coral. Water quality in the system is surprisingly high, but some nutrification may be occurring in the source marina.

The Lignum Vitae Key facility received 35 hatchling green sea turtles on 17 September 1986, and at about the same time, Theater of-the-Sea received 24. All 35 turtles at Lignum Vitae prospered, and in the course of a year, outgrew their pen. At Theater-of-the-Sea, the turtles were placed in a floating pen in the hospital enclosure in pool four. Survival was poor, but none developed visible papillomas. On 11 August 1987 the 35 turtles from Lignum Vitae were transferred to Theater-of-the-Sea for the second year of their life. After a brief period in the floating pen in the hospital enclosure, all the headstart turtles were transferred to a pen opening into the second pool, just downstream of the sea lions. A total of 30 of the turtles, including 24 from the Lignum Vitae batch, survived the second year of captivity. In June 1988, approximately ten months after the transfer from Lignum Vitae, small fibropapillomas were noticed on some of the turtles. By July all 30 surviving turtles had developed fibropapillomas. Blood samples were taken from all 30 turtles in July 1988 for sex determination. Four turtles were transferred to the House of Refuge for examination of the papillomas, and on 15 September 1988 were released into the Indian River Lagoon. The remaining 26 were released on 6 August 1988 at Sombrero beach, Marathon.

At the time of release, papillomas were growing around the eyes, on the flippers, and elsewhere on the skin. They were particularly prevalent on the perforations in the flippers caused by tagging. At the time of release most papillomas were less than 2 cm in diameter.

This incident provides some insight into the epidemiology and etiology of fibropapilloma in green sea turtles. If the turtles were all from the same clutch, embryonic transmission from the mother is a possibility to keep in mind. The most likely explanation for the outbreak, however, is that the as yet unidentified infectious agent was introduced to Theater-of-the-Sea by one or more infected turtles brought into the facility for treatment and rehabilitation. It is our understanding that infected turtles may have been in direct contact with the Theater-of-the-Sea headstart turtles in the first year, and briefly with the Lignum Vitae turtles in August 1987. Subsequently, all the headstart turtles were maintained in isolation, upstream from the "hospital." This location, however, is contiguous to the pool formerly occupied by the large green sea turtle that contacted fibropapilloma in relative isolation.

The infectious agent could possibly have been transmitted by serial contact with employees of the facility during feeding or other care, but no direct evidence for such transmission is available. The agent also could have persisted in the bottom of pool two, previously occupied by an infected turtle. The agent could have been dispersed through the water, or by direct contact through the pen walls during August 1987. If so, the infection would have remained latent for about nine months. The turtles initially housed at Theater-of-the-Sea could have become infected prior to August 1987, and subsequently infected the Lignum Vitae turtles, in turn. If this happened, the latency periods for the two groups must have been very different (or the turtles were infectious long before showing symptoms). Such different latency periods are unlikely unless turtles are not competent to develop fibropapillomas until a certain developmental stage (reached in this case at age 21 months).

Alternatively, marine leeches (Ozybranchus sp.) present in the facility could have acted as vectors. These leeches commonly are found on green sea turtles with fibropapilloma, and often attach directly to the papillomas. It is our personal opinion that transmission by leeches is the most likely mode of infection. We think transmission by leeches best explains the infection of the large turtle in pool two, although we cannot rule out the possibility of unrecorded direct contact. We are also unsure that these leeches are capable of travelling upstream from pool to pool, although such travel by creeping along the pool walls seems plausible. During a recent visit, the water flow between pools two and three was timed at one-third to one-half meter per second.

We believe that this incident demonstrates a need to develop protocols for the handling and housing of green sea turtles with fibropapilloma. We would suggest the following:

1) Until transmission is better understood infected turtles should be maintained at some level of quarantine from apparently uninfected turtles. At a minimum, turtles with fibropapilloma should be physically segregated from noninfected turtles, and facilities used to hold infected turtles should be disinfected, if possible, before re-use.

2) We also recommend controlling leech populations in holding facilities, and removing leeches from turtles recovered from the wild.

3) Housing infected turtles in separate sea-water systems from uninfected ones would be preferred, where possible. Where possible, treating papilloma turtles in separate facilities from other turtles is advisable.

4) Until the mode of transmission is better understood, the release of turtles with a history of papilloma into the wild may be unwise. Green turtles at the Cayman Islands turtle farm have survived fibropapilloma infections and presumably have become non-infectious. The same likely would be true of rehabilitated turtles, once tumor growth ceased, but this issue needs to be tested.

5) In any case, we strongly recommend that turtles with young, growing papillomas not be released in the future, and in particular, not be transported to be released away from the region where the infection occurred.

SEX RATIO OF GREEN TURTLE HATCHLINGS IN TORTUGUERO, COSTA RICA.

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Tortuguero beach on the Caribbean coast of Costa Rica is one of the major nesting sites in the western Atlantic for green turtles (Chelonia mydas). Sex of green turtles is dependant on the incubation temperatures of the natural nest during the middle third of incubation, and thermally different zones yielded different sex ratios on Tortuguero beach in the 1980 season (Spotila et al., 1987). However, their sample period was rather limited. The purpose of this study is to estimate the natural sex ratio of green turtle hatchlings in Tortuguero by combining three parameters: sex ratio, nesting frequency and egg survivorship for different portions of the entire season. This abstract provides information from two seasons of a three year project.

METHODS

The study area included the central two miles of the beach in Parque National Tortuguero where nesting density is generally high and undisturbed natural environment still remains. The beach was divided into two zones: the vegetation/border zone (which includes dense vegetation and two meters from the vegetation border) and the open sand zone (below the vegetation/border zone).

I conducted a nesting census within the study area every 2-7 days from July through November in 1986 and from the middle of June through November in 1988. The number and position of all nests were recorded.

To investigate egg survivorship, a representative sample of nests was marked and followed throughout incubation. Emergence success was determined by counting egg shells following incubation.

To investigate sex ratio, a total of 55 representative sample nests (12 in 1986 and 43 in 1988) were successfully collected for direct sexing. During nesting, a thermocouple probe was placed in the approximate center of the clutch. To monitor sand temperature near the clutch, another probe was buried in the sand 1 m from each nest at an equivalent depth of the clutch center. In addition, to investigate seasonal thermal profiles, sand temperatures at depths of 60 cm and at 80 cm (only in 1988) in each zone were monitored along two (1986) to four (1988) transect lines . Data for the sites in different zones were pooled. The temperature readings were taken once a day in every two to three days with a Bairly BAT12 thermocouple meter.

Just before hatching, a subsample of 20 eggs were randomly selected from each clutch and sacrificed. The gonads were fixed in 10% neutral buffered formalin, and sex was determined from histological examination of the tissues (Spotila et al., 1983).

RESULTS

Undetermined gonads, which possessed both cortical and medullary components, were found as 0.7% of total samples.

Both mean nest temperatures and mean sand temperatures during the middle third of development showed a positive sigmoidal correlation with percentage of females. Because of metabolic heat generation of the eggs, mean nest temperature during the middle third of the incubation period was about 0.7^{o} C higher than the mean sand temperatures during the same period. The pivotal temperature of the sand, which produces an equal sex ratio, was estimated to be between 28.5 and 29.0^{o} C.

In 1988, the sex ratios of samples varied from 0 to 100 % female in both zones. From the end of August through September, which is the early middle period of the incubation season , the sand temperatures, at least in the open sand zone, rose above the pivotal temperature. Most sample clutches in the open sand zone, which were temperature sensitive during that period, produced female biased sex ratios, while the clutches in the vegetation/border zone showed only slightly female biased sex ratios during the same period. Heavy rain occurred in 5 October (221 mm/d) and Hurricane Joan passed on 22 October decreased sand temperatures. Most of the clutches affected by this cooling showed male biased sex ratio in both zones.

The heavy rain and hurricane also reduced egg survivorship. As a result of these events and depredation of nests by coatis and ghost crabs, the clutches deposited in the later half of August had very low survival rates in both zones. Combining temporal nest distribution with sex ratio and egg survivorship data on a bimonthly basis, overall sex ratio was calculated to be around 40% female in the 1988 season.

In 1986, numerous rainy days and sporadic heavy rains kept sand temperatures lower than the pivotal temperature for most of the entire season. Eight of twelve samples produced only males. Because there was no distinct seasonal difference in the sex ratios over the season in both zones, all data of sexed samples were pooled and overall sex ratio was calculated to be around 10% female in the 1986 season.

ACKNOWLEDGEMENTS

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LITERATURE CITED

Spotila J. R., E. A. Standora, S.J. Morreale, G. J. Ruiz and C. Puccia. 1983. Methodology for the study of temperature related phenomena affecting sea turtle eggs. U.S.F.W.S. Endangered Species Report 11.

Spotila J. R., E. A. Standora, S.J. Morreale, and G. J. Ruiz. 1987. Temperature dependent sex determination in the green turtle (Chelonia mydas): effects on the sex ratio on a natural nesting beach. Herpetol. 43(1), 74-81.

THE MIGRATORY SPECIES (BONN) CONVENTION AND MARINE TURTLE CONSERVATION

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The Convention on the Conservation of Migratory Species of Wild Animals (commonly referred to as the Migratory Species or Bonn Convention) aims to improve the conservation status of migratory species through national action and international co-operative agreements. The Convention applies not only to marine species, but also to terrestrial and avian species, over the whole of their normal migratory range.

The Bonn Convention came into force in 1983, and now has a membership of 35 Parties, from an increasingly wide geographic distribution. There are now 15 European Parties, twelve from Africa, five from western Asia and three from South and Central America. Another eleven states have signed the Convention, but have not yet ratified it.

A small Secretariat under the auspices of the United Nations Environment Programme provides general administrative support to the Convention. A Scientific Council consisting of about 30 experts appointed by the Conference of the Parties and by individual member states advises on scientific matters. A six-member Standing Committee provides guidance on matters related to the implementation of the Convention between formal meetings of the Parties, which are held every three years.

The Convention incorporates two appendices which list migratory species that would benefit from concerted conservation measures. Endangered species, listed in Appendix I, are accorded full protection. This includes all sea turtles, with the exception of the Australian flatback. As an indication of the Convention's relevance, nineteen CMS Parties are Range States for three or more sea turtle species.

Range States of Appendix I species are to endeavor to conserve their habitat, to counteract factors impeding their migration, and to control other factors which might endanger them. Moreover, Range States are obliged to prohibit the taking of animals of these species, with few exceptions. The definition of "taking" includes such activities as hunting, fishing, capturing, harassing and deliberate killing. It is worth pointing out, as well, that the Convention applies the term "Range State" to flag ships engaged in taking migratory species on the high seas, outside national jurisdictional limits. Together, these provisions have quite far-reaching implications for protection of sea turtles, and make the Bonn Convention a particularly appropriate conservation tool.

These points must be emphasized because, all too often, people look mistakenly to other international instruments for protection measures that they cannot provide. By way of example, in a recent article referring to Mexico's 1990 ban on the killing of sea turtles, a conservation group claimed that in order to make the ban permanent, Mexico must join CITES, the Convention on International Trade in Endangered Species. What many people fail to realize is that CITES has no jurisdiction over <u>domestic</u> harvesting or the sale of wildlife harvested within a country. CITES' contribution -- and it is a very valuable one -- is to regulate, and in some cases, prohibit <u>international</u> trade in wildlife. Clearly, Mexico's accession to CITES is vital for the conservation of many species. But if the aim is to prohibit the taking of endangered wildlife at its source, the most appropriate, complementary course of action would be for Mexico (and other countries) to accede to the Migratory Species Convention.

The Convention's potential benefit to migratory species goes well beyond the protection afforded by an Appendix I listing. Appendix II lists migratory species which have a conservation status that requires, or would benefit from, international co-operative agreements. Where appropriate, a species may be listed in both appendices, as is the case with the marine turtles mentioned above.

The Convention provides for two forms of legal instruments for Appendix II species. First, there are AGREEMENTs (the capitalization is intentional) intended to benefit migratory species -- especially those with an unfavourable conservation status -- over their entire range. These AGREEMENTs should be open to accession by all Range States of the species concerned, including those that are not Parties to the Convention.

The text of the Convention spells out very clearly what each AGREEMENT should include. As a minimum, it should incorporate provisions for species research and periodic status assessments; coordinated management plans and exchange of information among Range States; maintenance of suitable habitat; and regulation of factors that are directly harmful to the species concerned or which impede their migration. Thus, the potential scope of these AGREEMENTs is comprehensive.

A second type of agreement (spelled in lower case) is encouraged for populations of species which periodically cross national jurisdictional boundaries, but which are not necessarily migratory under the definition provided by the Convention. Unlike the instruments mentioned above, the text of the Convention does not stipulate guidelines for the content of such agreements.

Three AGREEMENTs covering European bats, white storks, and western Palearctic waterfowl are presently being negotiated, as is a fourth agreement on North and Baltic Sea small cetaceans. Progress towards concluding these accords has been slow, but one or two may be ready for signature by the next meeting of the Conference of the Parties, scheduled for September 1991. Part of the difficulty lies in the fact that each AGREEMENT represents a treaty in itself encompassing many Range States, and a number of legal hurdles need to be overcome. There is reason to be optimistic, however, that once the first one has been concluded, others will follow more easily.

Although marine turtles are truly global in their distribution, there are a number of reasons for which a global instrument is not necessarily the most appropriate vehicle for their conservation. Indeed, the number of Range States concerned is so vast and their conservation needs so diverse, that the effectiveness of a broadly based accord is doubtful. An alternative that offers more promise is a regional approach embracing perhaps as few as a dozen Range States. The emphasis must be on workable, pragmatic arrangements that can address real problems, without being burdened by heavy bureaucracy.

It is pleasing to note that there have been a number of positive developments for turtle conservation in the western hemisphere in recent months. In November 1990, the Ad Hoc Group of Experts for the Development of Annexes to the Protocol on Specially Protected Areas and Wildlife recommended that all six species of marine turtle inhabiting the Wider Caribbean be included in Annex II of the Protocol. With provisions similar to those found under Appendix I of the Bonn Convention, the SPAW Protocol provides the legal means for protection of sea turtles in the region, and its full implementation should be encouraged. It should be pointed out, however, that the comprehensive protection measures envisaged for species covered by AGREEMENTs under the Bonn Convention are even more far-reaching.

We understand, as well, that attempts are being made to resurrect an accord among eight countries on the eastern Pacific, for the six turtle species that inhabit the region. This is the kind of initiative that is needed, and one that could easily fall within the framework of the Bonn Convention.

Clearly, there is an urgent need to develop similar institutional arrangements in other parts of the world with significant sea turtle populations. Parts of southeast Asia and the Mediterranean Sea are prime examples. While the Migratory Species Convention is still relatively young and its scope of activity still being defined, it can make a unique contribution to the conservation of species of concern to this group. For this reason, the CMS Secretariat welcomes the opportunity to liaise with other delegates at this meeting, and to benefit from their input and expert advice.

CRITICAL HABITAT DESIGNATION: IS IT WORTH THE EFFORT?

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In the past year, at least one petition to designate critical habitat for the endangered Kemp's ridley sea turtle has been filed with the National Marine Fisheries Service (NMFS) (Rudloe 1990). There is, however, much uncertainty about the effect of designating critical habitat under the Endangered Species Act (ESA), 16 U.S.C. 1531, et seq. In addition, due to the manner in which critical habitat designations have been implemented by NMFS and the U.S. Fish and Wildlife Service (FWS), questions have arisen as to whether it is worth the effort required to petition to designate critical habitat. To attempt to answer these questions, this paper explains what critical habitat is, what Congress intended it to be, and how, in practice, it has been implemented.

The ESA was enacted to conserve threatened and endangered species and the ecosystems on which they depend. 16 U.S.C.1531(b). To help accomplish the ecosystem conservation purpose, the ESA requires FWS and NMFS, acting on behalf of the Secretaries of the Interior and Commerce respectively, to designate critical habitat "to the maximum extent prudent and determinable" simultaneously with the listing of a species as threatened or endangered. 16 U.S.C. 1533(a)(3). If the agencies determine that critical habitat is not presently determinable, the time for designating critical habitat may be extended by up to one year. 16 U.S.C. 1533(b)(6)(C)(ii). In designating critical habitat, economic and other impacts of such designation must be considered. 16 U.S.C. 1535(b)(2).

"Critical habitat" is defined by the ESA as those areas within the geographic area occupied by a listed species which are essential to the conservation of the species and which may require special management or protection. 16 U.S.C. 1532(5)(A)(i). In addition, critical habitat may include areas outside the geographic area presently occupied by a listed species if such areas are essential for the conservation of the species. 16 U.S.C. 1532(5)(A)(ii). As used in the ESA, "conservation" includes both near-term survival and long-term recovery of a species. 16 U.S.C. 1532(3). Thus, in the case of endangered sea turtles, critical habitat could include both nesting beaches which are currently used and those which, while not currently used, need to be protected to ensure the recovery of the species.

The ESA and its implementing regulations prohibit both public and private parties from "taking" threatened and endangered species. 16 U.S.C. 1538(a); 50 C.F.R. 17.21, 17.31. The ESA defines "taking" as including killing, injuring, harassing or harming listed species. 16 U.S.C. 1532((18). Implementing regulations further define "harm" as including "significant habitat modification or degradation" that actually kills or injures listed species by disrupting essential breeding, feeding, or sheltering. 50 C.F.R. 17.3.

The ESA also requires federal agencies to ensure that any activities which they authorize, fund, or carry out are not likely to jeopardize the continued existence of a listed species or result in the adverse modification or destruction of designated critical habitat. 16 U.S.C. 1536(a)(2). While the requirement applies directly to federal agencies, it reaches private activity that is authorized or funded by federal agencies as well. Regulations promulgated jointly by FWS and NMFS define "jeopardize the continued existence" of a listed species as acting in a manner that directly or indirectly reduces appreciably the likelihood of both the survival and recovery of the species. 50 C.F.R. 402.02.

Similarly, the joint regulations define "destruction or adverse modification" of critical habitat as any direct or indirect habitat alteration that appreciably diminishes the value of critical habitat for both the survival and recovery of a species. 50 C.F.R. 402.02.

Implementation of the ESA's critical habitat provisions has been less than vigorous. Only 22% of listed species have had critical habitat designated (Salzman 1990). Moreover, while Congress intended that only in rare instances would the agencies conclude that designation of critical habitat was not "prudent," between 1980 and 1988 FWS declined to designate critical habitat as not prudent in 317 of 320 cases (Salzman 1990).

With increasing frequency, FWS has concluded that designating critical habitat offers "no net benefit" to species conservation and, therefore, is not prudent (FWS 1990). FWS supports this view by asserting that the jeopardy and critical habitat standards are essentially the same. While there appears to be some agreement with that interpretation (Bean 1983), it does not square with the clear implication that Congress intended to create two independent requirements by establishing separate jeopardy and critical habitat standards in the ESA (Yagerman 1990).

In practice, the collapsing of the jeopardy and critical habitat standards into a single requirement could undermine the recovery of listed species. For example, suppose that a formerly-used sea turtle nesting beach is not designated as critical habitat on the grounds that it would produce no net benefit to the species. If that beach were slated for development, the development would not jeopardize the species since it is no longer found on that beach. On the other hand, the development could impair the recovery of the species by eliminating the beach's availability for recolonization. Absent designation as critical habitat, however, no mechanism to halt the development is available.

In sum, the critical habitat provisions of the ESA offer the promise of significant habitat protection for threatened and endangered species. In particular, the critical habitat provisions are potentially important *for the conservation of habitat not presently occupied by a listed species but essential to its recovery.* As presently implemented by FWS and NMFS, however, the promise of the critical habitat provisions is unfulfilled. Thus, while conservationists should continue to petition for critical habitat designations, clarification of the reach of those provisions may be necessary from Congress and the courts.

REFERENCES

Bean, Michael J. 1983. The Evolution of National Wildlife Law, p. 339 n.95

Rudloe, Dr. Anne. 1990. Petition to Designate Critical Habitat for the Kemp's Ridley Sea Turtle, Lepidochelys kempi.

Salzman, James. 1990. "Evolution and Application of Critical Habitat Under the Endangered Species Act," 14 Harvard Environmental Law Review 311, 332-333.

U.S. Fish and Wildlife Service. 1990. "Final Rule Listing Cahaba Shiner as Endangered," 55 Federal Register 42961, 42965 (Octover 25, 1990).

Yagerman, Katherine S. 1990. "Protecting Critical Habitat Under the Federal Endangered Species Act," 20 Environmental Law 811, 841-845.

THE ENDANGERED SPECIES ACT: PROSPECTS FOR REAUTHORIZATION IN 1992

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In 1992, Congress will take up reauthorization of the Endangered Species Act (ESA), 16 U.S.C. 1531, et seq., the crown jewel of this nation's environmental statutes. Already a contentious debate over the future of the ESA has been joined.

Charging that environmentalists are manipulating the ESA to prevent Americans from using public resources and lands, such diverse groups as miners, shrimpers, millworkers, and loggers are organizing an offensive against reauthorization (Kaley 1990). Secretary of the Interior Lujan, charged with implementing the ESA, has publicly complained that the ESA is being used "as a sword punishing our citizens" rather than as "a shield protecting threatened wildlife" as he believes Congress intended. (Lujan 1990). On the other hand, as Senate Majority Leader George Mitchell has pointed out, threatened and endangered species sound an alarm that their ecosystems are in trouble. In his view, it is irresponsible to respond to this warning by disabling the alarm (Mitchell 1990).

At stake in the emerging debate is the survival of the ESA itself, which represents the United States' commitment to itself, the world, and future generations that it will seek to halt the race to extinction. The ESA is a tough law, befitting the difficult problems it was enacted to solve. The ESA prohibits private parties and public agencies from taking threatened and endangered wildlife, with taking broadly defined to include killing, injuring, harassing, or harming listed species. 16 U.S.C. 1532(19), 1538(a). The ESA also imposes affirmative obligations on federal agencies to conserve listed species and to ensure that any activities which they authorize, fund, or carry out are not likely to jeopardize the continued existence of a species or result in the destruction or adverse modification of designated critical habitat. 16 U.S.C. 1536(a).

In the famous snail darter case, the U.S. Supreme Court clearly established the far-reaching impact of the ESA. There, the Court ruled that the gates of the Tellico Dam, a multimillion dollar public works project which was 99% complete, could not be closed because to do so would have extinguished a 2-inch long endangered fish species, the snail darter. Tennessee Valley Authority v. Hill, 437 U.S. 153 (1978).

This seemingly unyielding nature of the ESA has raised the ire of some. Opponents of the ESA claim that it is stifling economic growth. In fact, between 1979 and 1985, only 15 of more than 48,000 (0.03%) projects reviewed under the ESA were cancelled (Feierabend, et al. 1987).

Other claims by opponents of the ESA are similarly problematic. Opponents claim that the ESA is being misused by environmentalists to lock up lands from development, rather than to protect individual species (Young 1990). Congress, however, unequivocally declared in 1973 that the purpose of the ESA was to "..provide a means whereby the ecosystems upon which endangered species and threatened species depend may be conserved." 16 U.S.C. 1531(b).

Some, including Interior Secretary Lujan, have questioned the wisdom of protecting subspecies and populations under the ESA (Abramson 1990). This complaint ignores the contributions of subspecies to overall genetic diversity. In addition, populations and subspecies in trouble, no less than species, may indicate that an entire ecosystem is endangered. Furthermore, if we fail to conserve populations and subspecies, it may be too late to conserve species by the time the peril is realized.

Opponents of the ESA want to inject economic considerations into purely scientific determinations of whether a species should be listed as threatened or endangered and what steps are necessary to bring about recovery of listed species. This suggestion ignores the fact that economic and other considerations are already taken into account at various stages under the ESA, including the designation of critical habitat, the development of reasonable and prudent alternatives to a proposed action, and the decision by the Endangered Species Committee (the so-called God Committee) whether to exempt a project entirely from the ESA. 16 U.S.C. 1533(b)(2), 1536(b)(3)(A), 1536(h).

Already an effort has been made to short circuit the careful process under the ESA for balancing conservation needs and economic concerns. In October 1990, Senator Robert Packwood of Oregon introduced an amendment that would have prematurely convened the God Committee to consider exempting Pacific Northwest logging from requirements to conserve the threatened northern spotted owl. After lengthy debate, the Senate defeated the Packwood Amendment by a resounding 62 to 34 vote (U.S. Senate 1990).

While the temperature of the reauthorization debate will continue to rise, in all likelihood the ESA will be reauthorized, although perhaps not in 1992, an election year when Congress will also be grappling with reauthorization of the Clean Water Act. The ESA battleground, however, will be what amendments are made. Opponents will focus on such issues as eliminating protection for subspecies, injecting economic considerations at all stages, and exempting specific activities from the ESA. Conservationists, by contrast, will seek strengthening amendments, including greater ecosystem conservation, enhanced protection for plants and invertebrates, and more effective implementation and enforcement of the ESA.

Scientists will play a critical role in the ESA reauthorization struggle. In addition to becoming politically active on the issue, scientists must provide Congress and the public with credible data and analysis regarding the impacts of endangered species conservation measures on both species recovery and resource utilization. To a large extent, the fight over ESA reauthorization will center on information and misinformation. Consequently, scientists specializing in endangered species conservation and biology are uniquely situated to help political leaders separate myth from reality.

REFERENCES

Abramson, Rudy. 1990. "Wildlife Act: Shield or Sword?," Los Angeles Times, p. 1 (December 14, 1990).

Feierabend, J. Scott, C. H. Meyer, and D. M. Debinski. 1987). "Statement of the National Wildlife Federation before the Subcommittee on Environmental Protection of the Senate Committee on Environment and Public Works on Reauthorization of the Endangered Species Act," p. 15 (April 7, 1987)

Kaley, Rita. 1990. Executive Officer, Oregon Lands Coalition, Letter to Concerned Shrimpers of America (June 22, 1990)

Lujan, Manuel. 1990. Secretary of the Interior, Remarks to Republican Governors Association (December 10, 1990)

Mitchell, George. 1990. Senate Majority Leader, 136 Congressional Record S16798 (October 23, 1990)

U.S. Senate. 1990. 136 Congressional Record S16804 (October 23, 1990).

EVALUATION OF COMMERCIAL USE OF TURTLE EXCLUDER DEVICES (TEDs) IN THE GULF OF MEXICO AND SOUTH ATLANTIC

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The primary objective of the study was to determine the impact of TEDs on shrimp catch rates aboard commercial shrimp vessels operating in the U. S. Gulf of Mexico and along the Atlantic coast of the United States. Other objectives included assessing the effects of TEDs on the general performance of shrimp trawls and estimating impacts of TEDs on finfish bycatch. Field work for the project began in March 1988 and concluded in August 1990. Results from the first year of the study were reported at the Tenth Annual Workshop on Sea Turtle Biology and Conservation. Results obtained from field work conducted during the August 1989 through August 1990 period were reported at this year's meeting.

During the second year of the study two TEDs underwent extensive testing: the Georgia TED equipped with an accelerator funnel and the Supershooter TED also equipped with an accelerator funnel. Discussion topics included seasons and geographic areas where data were collected, shrimp and fish CPUE (catch per unit effort) of TED-equipped versus standard nets, and turtle capture rates.

NESTING SUCCESS OF THE LOGGERHEAD TURTLE (*Caretta caretta*) ON CAPTIVA ISLAND, FLORIDA - A NOURISHED BEACH

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All nesting beaches, particularly those on barrier islands, such as Captiva Island, Florida, continuously experience predictable cycles of erosion and accretion. Scientists in recent years have noted an increase in coastal erosion, possibly in response to increasing levels of CO^2 in the atmosphere trapping heat and causing atmospheric warming which stimulates melting ice caps. The necessity to stabilize the beaches against erosion has become a major control management effort.

Some erosion control methods, such as the construction of sea walls, groins, and revetments deflect wave energy downward, causing sand to shift offshore, thereby enhancing erosion, thus reducing available sea turtle nesting habitat. Beach nourishment, the placement of fill or borrow material to a sand deficient area has become a popular approach to shoreline stabilization. After an initial adjustment period, relative stabilization usually occurs, leaving the new beach with a slope and sediment texture more commensurate with local wave currents. Captiva lost only 6.3% of its fill in the first six months after completion in 1981, and at eighteen months, 88.6% of the fill remained.

There seems to be some harmony in the factors that create a stable nourished beach and a beach suitable to sea turtle nesting. The factors that militate for a stable nourished beach, such as sand compatibility, proper shear resistance, and proper contouring also tend to produce a beach compatible with turtle nesting. Rip rap covered with spoil material and Australian pines (*Casuarina equisetifolia*) can seriously interfere with successful sea turtle nesting and should be addressed by permitting and regulatory agencies. High sand cone index values on Captiva did not seem to deter nest excavation.

Before and after nourishment statistics for incidents of false crawls, viable nests and hatch rates are reported. These statistics support the conclusion that sea turtle nesting was enhanced on Captiva Island by beach nourishment in 1981 and renourishment in 1988.

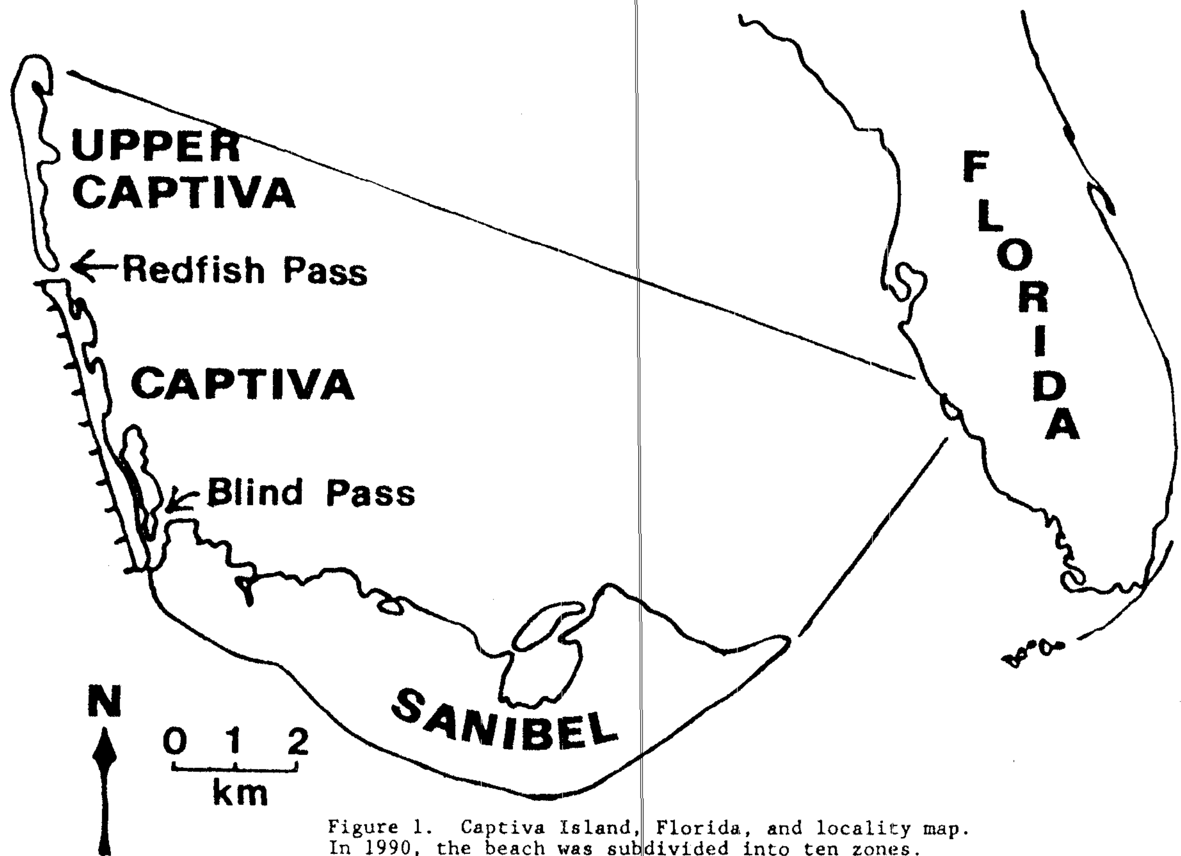

Figure 1. Captiva Island, Florida, and locality map. In 1990, the beach was subdivided into ten zones. See Figure 4.

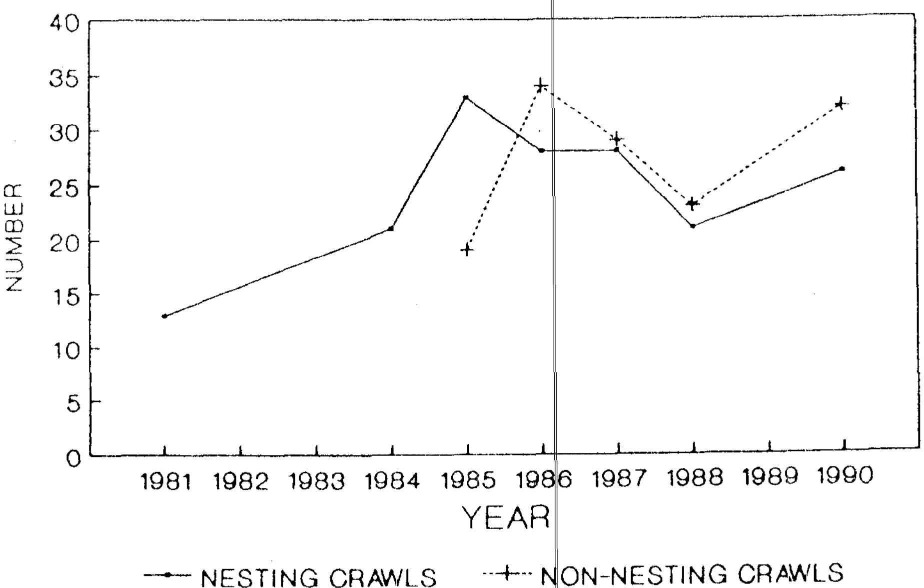

Figure 2. Nesting and non-nesting loggerhead turtle crawls 1981, 1984-1988, and 1990 on the South Seas Plantation beach, Captiva Island, Florida. Incomplete data for 1989.

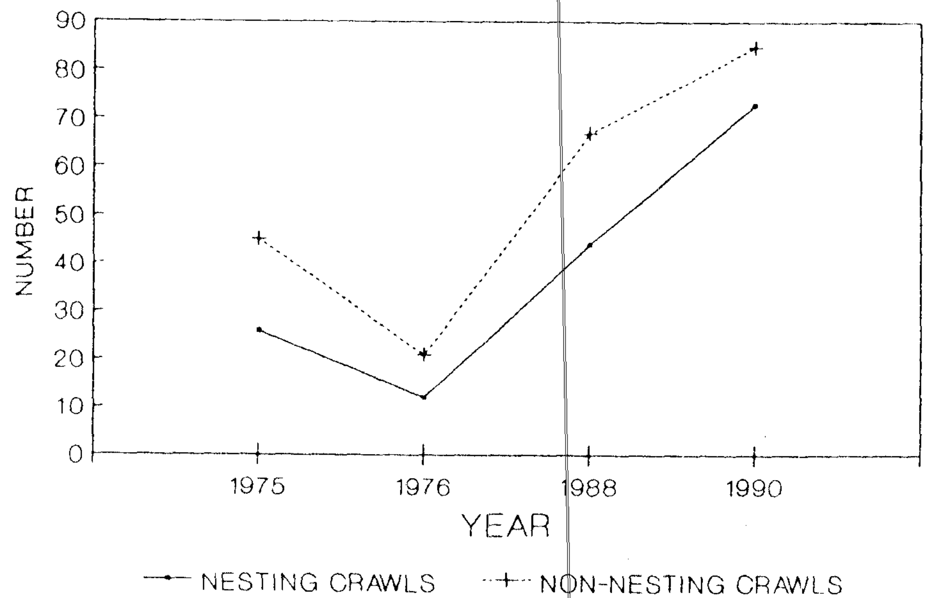

Figure 3. Nesting and non-nesting loggerhead turtle crawls on Captiva Island, Florida. Before and after beach nourishment in 1988.

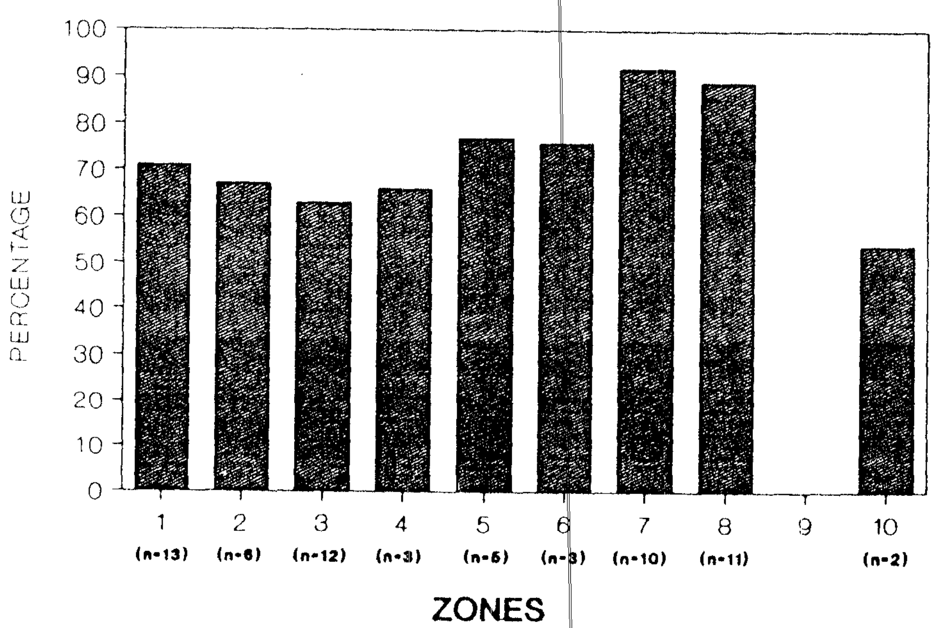

Figure 4. Clutch hatching success, in percentages, of unmanipulated loggerhead turtle eggs on Captiva Island, Florida. 1990.

THE MAGNETIC COMPASS OF HATCHLING LOGGERHEAD SEA TURTLES: EVIDENCE FOR DETECTION OF MAGNETIC INCLINATION

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In previous experiments, Lohmann demonstrated that loggerhead hatchling sea turtles reversed their orientation when exposed to a reversed geomagnetic field. However in these experiments, both the inclination and the polarity of the field were reversed making it impossible to determine whether hatchlings detected inclination and/or polarity. Experiments reported here were designed to distinguish between these alternatives by manipulating inclination and polarity separately. The results indicated that hatchlings respond to inclination, but not polarity, of the earth's geomagnetic field. Similar tests carried out with birds have yielded identical results, suggesting sensitivity to inclination may be a fundamental property of magnetic compasses in most organisms. In sea turtles, the absence of sensitivity to polarity may allow for accurate orientation after magnetic reversals, which occur frequently (mean of 25,000 years) relative to the history of sea turtles. Since inclination changes with latitude, an ability to detect this feature of the earth's magnetic field has important implications. Specifically, sea turtles might use inclination to determine their north-south position on the earth's surface. Such capacities may be one component of a "map sense" used by sea turtles to navigate between widely separated nursery, foraging and nesting sites.

POPULATION STRUCTURE OF GREEN TURTLES (Chelonia mydas) ON FORAGING GROUNDS IN BERMUDA

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Since 1968, green turtles on foraging grounds around Bermuda have been the subject of a tag-and-recapture study conducted by HCF, in cooperation with the Bermuda government. Approximately 700 turtles have been captured during the course of the project, many of them numerous times. In the present study, the sex and maturity status of 56 animals (mean notch-to-notch straight carapace length = 55.6 cm; range 30.5 - 75.5 cm) were determined by directly viewing the gonads via laparoscopy. Blood samples were taken from all animals for testosterone analysis. Calibration of the testosterone titer data using turtles of known sex (via laparoscopy) will enable future sex determination for turtles of this population to be based solely on blood samples. For this initial, limited sample, the sex ratio was not significantly different from 1:1. All individuals were judged to be immature, based on the degree of development of the gonads. This observation, in combination with size data for the entire marked Bermuda population and with size and maturity data for green turtles at another study site in the western Atlantic, suggests that Bermuda serves exclusively as a dev

INTERCEPTION OF TORTUGUERO-BOUND GREEN TURTLES AT BOCAS DEL TORO PROVINCE, PANAMA

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Green turtles (Chelonia mydas) bound for the nesting beach at Tortuguero, Costa Rica, from southern feeding grounds were intercepted at Bocas del Toro Province, Panama. Data were collected from turtles that were caught in our nets, tagged and released, and from the subsistence fishery. Size and weight of migratory turtles were recorded, and blood samples were collected for genetic and hormone analyses. Reproductive condition was determined using laparoscopy. The relatively large number of mated pairs observed at this location, which is approximately 240 km from Tortuguero, suggests that a substantial amount of mating occurs away from the nesting beach. The hypothesis that Bocas del Toro is a point on the migratory route of Tortuguero green turtles is supported by 1) the recapture in the province of over 70 Tortuguero-tagged turtles, 2) the temporal coincidence of the local subsistence fishery and the nesting season at Tortuguero, and 3) recoveries at Tortuguero of adult turtles tagged by us in Bocas del Toro.

HABITAT USE AND FEEDING ACTIVITY OF JUVENILE KEMP'S RIDLEYS IN INSHORE WATERS OF THE NORTHEASTERN U.S.

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New York waters provide important developmental habitat for juvenile Kemp's ridleys (Lepidochelys kempi) (Morreale and Standora, 1990). Each year many of these turtles that reside in inshore areas during the summer and early fall exhibit high growth rates. An analysis of fecal samples from Kemp's ridleys in 1989 indicated that 90% of the turtles had consumed crabs (Burke, 1990). These facts raise two important questions about the foraging behavior of this critically endangered species: 1) What food resources are available to the turtles in the New York waters? 2) What factors control which resources the turtles consume?

Eight sampling sites, where turtles had consistently been observed in previous years, were chosen throughout the eastern waters of Long Island, New York. Benthic trawl surveys were conducted once a month, from July through October 1990, to quantify the availability of food resources at each site. Each site survey consisted of four separate tows, each approximately 100 m long, using a 3 x 5 m crab trawl. Abundance of each species of benthic biota was calculated as the average number of the four tows at each site. Comparisons of benthic species composition and relative abundance were made among sites and among the sampling periods to determine spatial and temporal patterns in distributions of food resource availability.

During the same period as the habitat survey, fecal sample analysis studies were conducted to assess the food resources consumed by the Kemp's ridleys within the sampling area. Fifteen turtles were collected in pound nets by local commercial fishermen. Upon capture, each turtle was placed in an individual 2100 l tank of sea water from which all fecal material was collected over a two day period. Each fecal sample was sorted into component parts (> 2 mm in size) and identified to species where possible. Species abundance was defined as the minimum number of individuals that were identifiable in each turtle's feces. For example, the presence of three spider crab claws (Libinia emarginata) was interpreted to mean a minimum of two separate crabs had been consumed. In all, 16 fecal samples were analyzed, including three samples from turtles that were recaptured during a complimentary telemetry tracking study.

Benthic communities consisted of a broad diversity of biotic groups, including 8 crab species, 12 mollusks, 15 fish, and more than 10 different algae. Among the fecal samples, however, there was a much lower diversity of species. As was observed in the 1989 fecal study (Burke, 1990), crabs were by far the most important component in the feces of the Kemp's ridleys. They were present in 15 of the 16 samples and constituted the greatest proportion of each of these samples. Thus, a more detailed comparison was made between the relative abundance of crabs in the habitat and the species composition observed in the fecal samples.

Four species of crabs that occurred at the sampling sites were large enough to be reliably sampled with the trawl (5 cm stretch mesh). Among these were two species of swimming crabs, the lady crab (Ovalipes ocellatus) and the blue crab (Callinectes sapidus), and two species of walking crabs, the spider crab and the rock crab (Cancer irroratus). While slight differences in relative species abundance were observed temporally, most of the differences were attributed to spatial distribution (Fig. 1). The lady crab was the most abundant species, occurring at all eight sampling sites and predominating at most of these. The spider crab was second in abundance, but was localized in the four eastern-most sites. The other two crab species were only present at three or fewer sites and always in very low densities.

Relative abundance of crab species in the fecal samples differed considerably from their availability at the eight sites (Fig. 2). Spider crabs represented more than 53% of the fecal components (more than twice their overall relative abundance). Lady crabs were the second-most abundant fecal component despite a nearly threefold habitat availability. The relatively sparse blue crabs did not occur in any feces, but the similarly rare rock crabs represented 17% of the diet.

This research represents one of the few sea turtle studies in which dietary composition was directly compared with resource availability. Our preliminary findings suggest that relative abundance of available crab species is not the primary factor governing prey selection by the Kemp's ridley turtles in New York waters. The species composition in the feces was very different than was observed overall among the sampling sites. While it is possible that the turtles are choosing the few sites in which spider and rock crabs are more abundant, this was an unlikely scenario. During this study, turtles were captured at different sites throughout the sampling area. Moreover, our simultaneous telemetry studies showed that turtles move easily among all the sites. In addition, four of the study animals whose movements were constantly monitored spent little or no time in the spider crab rich areas.

We believe that the disproportionate number of crab species represented in the diet can be better explained by behavioral interactions between the prey species and the turtles. Both spider crabs and rock crabs are slow-moving walking crabs which depend mainly on cryptic coloration to avoid predation. The very abundant lady crab and the blue crab are swimming crabs, capable of quickly fleeing and rapidly burrowing. Since all of the Kemp's ridleys in New York waters are small juveniles, they are probably foraging in inshore waters for the first time in their lives. We propose that these young turtles' inexperience at benthic foraging is reflected in a diet which is comprised mainly of slow-moving, more easily captured prey items.

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LITERATURE CITED

Burke, V. J. 1990. Seasonal ecology of Kemp's ridley (Lepidochelys kempi) and loggerhead (Caretta caretta) sea turtles in the waters of Long Island, New York. Buffalo, New York: State Univ. College; 1990. 91 p. Master's Thesis.

Morreale, S. J. and E. A. Standora. 1990. Occurrence, movement, and behavior of the Kemp's ridley and other sea turtles in New York waters. Ann. Rep. to New York State Return A Gift To Wildlife Program. April 1989-March 1990; 48 pp.

FIG. 1. CRAB SPECIES COMPOSITION AT 8 SAMPLING SITES

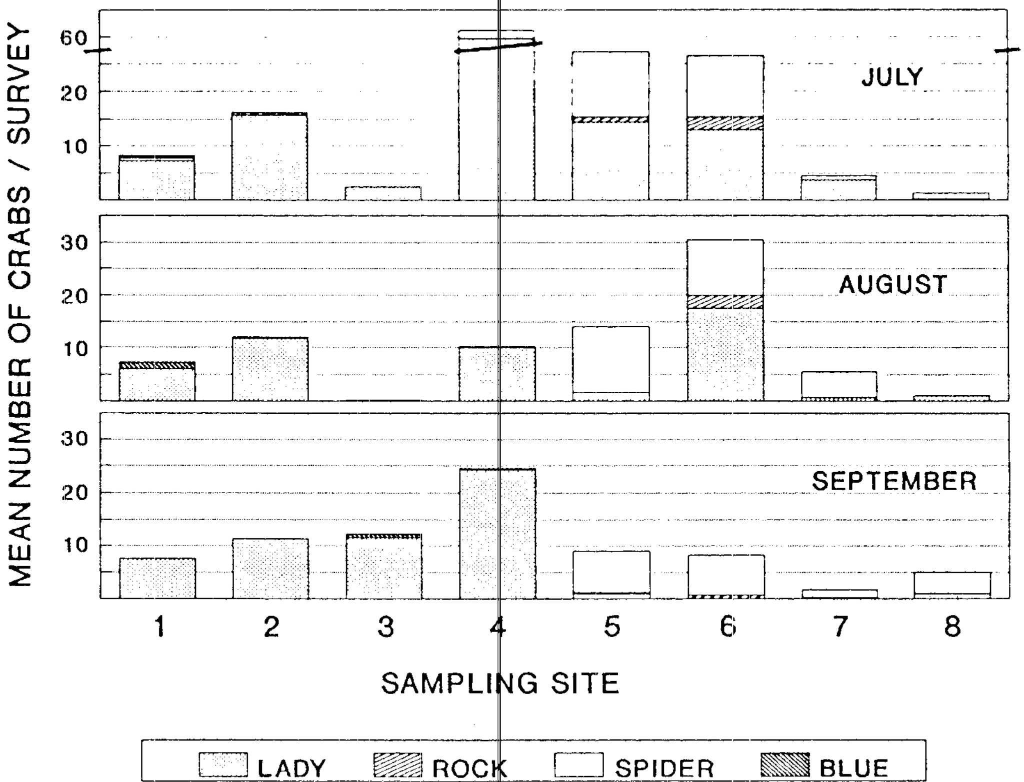
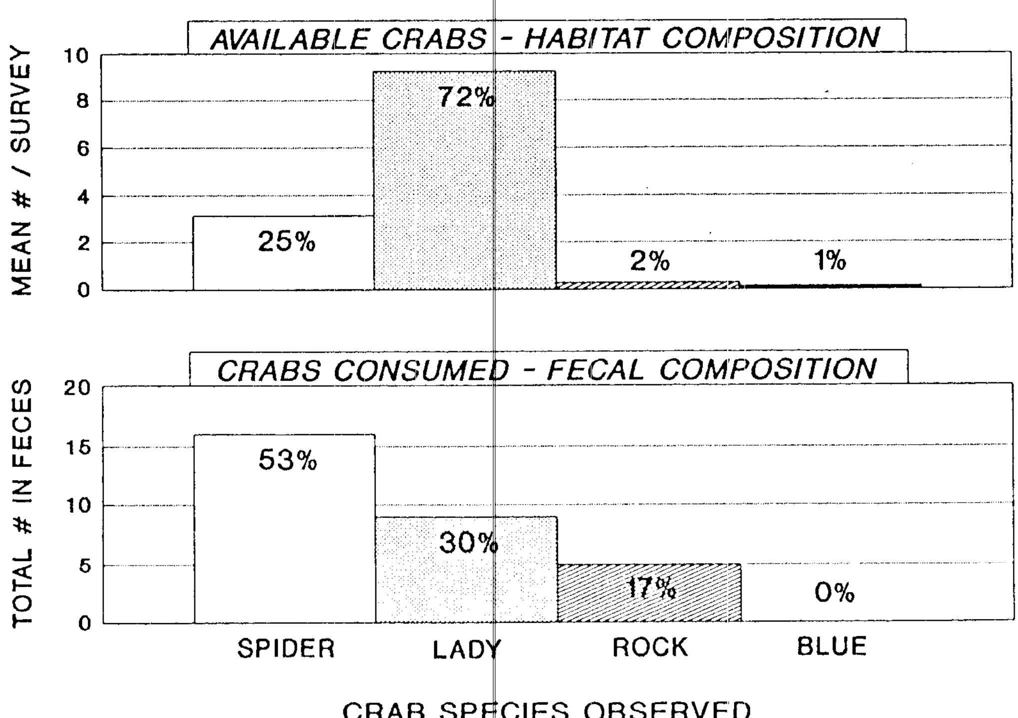


FIG. 2. CRABS AT ALL SITES VS 16 FECAL SAMPLES



PREDICTION OF TRAWL FISHERY IMPACTS ON SEA TURTLES: A MODEL

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All otter trawls fished on the bottom can capture sea turtles incidentally. Such nets are widely used to harvest finfish as well as shrimp, and the size of the mesh, effective diameter of the net opening, and towing speed may vary depending on which species are targeted by the fisheries. Large incidental mortalities can be inflicted on sea turtle populations when heavy trawling activities coincide in time and space with concentrations of sea turtles. Such conditions occurred in early December 1990 just south of Cape Hatteras NC, where large numbers of trawlers concentrated their activities on summer flounder (Paralichthys dentatus). This area is a major migratory corridor for juvenile loggerhead and Kemp's ridley sea turtles (Musick et al., 1987). At least 54 turtles (mostly loggerheads) washed up dead on nearby beaches.

In the present paper, we present and test a model that incorporates estimates of sea turtle densities from aerial and remote sensing data, and technical data from an otter trawl fishery to predict the incidental catch and mortality rates of sea turtles.

METHODS

Aerial Survey: Following protocol established in our turtle research programs over the last several years (Keinath et al., 1987; Musick et al., 1987; Byles, 1988) an aerial survey was flown on December 11, 1990 in a de Havilland Beaver aircraft to determine sea turtle distribution and abundance from Nags Head to Core Bank NC ($35^{o}52$'S to $34^{o}57$'S). Number of observed turtles were converted to densities (per km^2) by dividing the number of turtles observed between 50-300 m of the flight path by 500 m = 0.5 km by the total distance flown (km) on each survey line.

The density of turtles on the surface in a given area may be calculated with the following equation:

$$D_a = N_a / (L_a)(W_a) \qquad \text{Equation 1}$$

where

D_a = density of turtles on surface
N_a = number of turtles observed along a flight line
L_a = length of the flight path
W_a = width of flight path for which effective visual observations can be made.

Diving Parameters: Diving parameters can be studied by attaching radios to free-ranging turtles and then tracking them by boat or by satellite. By recording the times of radio signal transmission and cessation a temporal series of surfacing and diving events can be recorded. These in turn can be analyzed to yield the average amount of time spent on the surface and submerged. The ratio of surface to total time can be applied to surface turtle density data for aerial surveys to yield estimates of submerged turtle density (Keinath et al., 1987; Musick et al., 1987; Byles, 1988). Only submerged turtles close to the bottom are vulnerable to benthic otter trawls like shrimp or flounder trawls.

The following equation was used to estimate density of submerged sea turtles:

$$D_s = \left(\frac{1}{P} D_a\right) - D_a \qquad \text{Equation 2}$$

where

D_s = density of turtles submerged;

$1/P$ = reciprocal of proportion of time spent on the surface;
D_a = density of turtles observed by aerial survey.

Trawl Fishery Parameters: Once the density of submerged turtles has been estimated, the impact of the fishery can be calculated if the total area swept by the trawl (or trawls) can be calculated.

The area covered by a single trawl tow (A_t) can be calculated:

$$A_t = L_t \; W_t \qquad \text{Equation 3}$$

where

L_t = distance towed; and
W_t = effective sweep of net.

L_t is usually calculated:

$$L_t = V \; T \qquad \text{Equation 4}$$

where

V = average speed of vessel while towing;
T = average duration of tow.

Given A_t and D_s the number of turtles captured (N_c) may be estimated most simply:

$$N_c = A_t \; D_s \qquad \text{Equation 5}$$

However, even when on the bottom, some turtles may be able to actively avoid a trawl. The proportion of vulnerable turtles that are actually captured is a measure of catchability. A catchability coefficient can be estimated by comparing N_c estimated from aerial surveys to actual observed N_c from trawl data. The catchability coefficient (C) can be expressed:

$$C = \frac{N_c\,(\text{est.})}{N_c\,(\text{obs.})} \qquad \text{Equation 6}$$

Once C has been calculated, it can be applied to subsequent survey data to yield more accurate revised estimates of $N_C(rev)$:

$$N_C(rev) = A_t\, D_S\, C \qquad \text{Equation 7}$$

In order to compare the accuracy of aerial estimates of N_C, and to estimate a catchability coefficient, data on observed N_C were collected from a commercial flounder trawler under contract to the NC Division of Marine Fisheries. This vessel, typical of others in the fishery from Morehead City, NC, towed paired flounder trawls each with a 70' head rope (trawl width). The effective sweep of such trawls is usually about two-thirds or

$$2/3\ (2 \times 70) = 93' = 28.6\ \text{m}$$

RESULTS AND DISCUSSION

Aerial Survey: Aerial survey data of Cape Hatteras showed that highest concentrations of sea turtles were in the area where mortalities had occurred. Even the highest densities of turtles observed (0.306) did not suggest an unusual concentration of turtles in this area. Rather the values were about average for the fall migration. Musick et al. (1987) reported densities up to 0.350 for the NC coast in late fall.

Diving Parameters: Diving patterns may change with season and area and therefore P may also vary. Our satellite tracking experiments in fall of 1989 showed that one turtle spent 9.4% of the time on the surface (28 observations) the other spent 5.1% on the surface (15 observations), yielding a mean of 7.25%. Byles and Dodd (1989) tracked an adult female loggerhead off Florida in the fall of 1988 and found the animal spent 6.1% of the time on the surface in coastal waters. Thus, the average surfacing percentage we observed was slightly greater than those found for resident juvenile loggerheads in Chesapeake Bay in summer, (Byles, 1988) and for a larger adult in the fall. Thus, our estimate of surface percentage of 7.25% seems reasonable for juvenile loggerheads in the coastal zone off NC in the fall. Stranding records suggest that >95% of loggerheads that participate in this fall migration from Chesapeake Bay past Cape Hatteras are juveniles (Lutcavage and Musick, 1985; Bellmund et al., 1987; Musick, 1988).

Trawl Fishery Parameters: Trawl fishing parameters for the NC inshore area were used to calculate D_S for the inshore area and the estimated number of turtles captured was calculated from Equation 5. The mean number of turtles actually captured was 2.3 and the estimated mean was 3.56. Solving equation 6 yields a catchability coefficient (C) of 0.65. This suggests that about 35% of the turtles that were vulnerable avoided the trawl as it approached. (Escapement after capture is unlikely). This catchability coefficient (C) may be applied to other studies where similar nets and sea turtles of similar size are involved and bottom temperatures are within the turtle's normal activity range (ca. $\geq 16^{\circ}$C). The total impact on sea turtles of the trawl fishery in the inshore area south of Cape Hatteras can be calculated for the 12 days it was in operation. About 14 vessels were active in this fishery. Those vessels usually fished for 4 or 5 days out of the week and made 5 or 6 tows a day, each about 3 h in duration (Jeff Ross, personal communication). The effective net sweep for each boat was about the same (i.e., ca. 28.6 m). The total fishing effort (E) (number of tows) for the 12 day period in question can be calculated thusly:

$$14\ (\text{boats}) \times 12\ (\text{days}) \times 4.5/7\ (\text{days spent fishing}) \times 5.5\ (\text{tows})$$
$$E = 594\ \text{tows}$$

Given an average tow speed of 2.50 knots (=4.63 km hr^{-1}) and an average tow duration of 3.0 hrs (Jeff Ross, personal communication). A_t can be calculated per tow from equations 3 and 4:

$$A_t = 0.40\,km^2$$

Then $$A_t = E(0.40)$$

$$A_t = 237.6\ km^2$$

The number of turtles taken incidently by this fishery can be estimated by solving for the revised N_c(rev) (Equation 7):

$$N_c(rev) = 237.6 \times 3.56 \times 0.65$$
$$= 550 \text{ (rounding off)}$$

If the estimated turtle bycatch was 550 then a crude estimate of turtle mortality may be calculated as 2/3 N_c(rev) because tow duration averages three hours and sea turtle mortality increases substantially after the first hour (National Research Council, 1990). Therefore, total estimated mortality over the 12 days was about 366 turtles, substantially higher than the 54 that were discovered stranded at Cape Hatteras National Seashore.

CONCLUSIONS

The impacts on sea turtles of trawl fisheries in addition to shrimp fisheries should be more closely scrutinized. High sea turtle mortalities associated with one such fishery (the NC fall flounder fishery) is documented herein. Protective regulations can be more precisely implemented by utilizing information on sea turtle abundance gathered from aerial surveys. This approach may be particularly useful during dynamic periods of seasonal migration when sea turtles may temporarily aggregate in local migration corridors, and the fisheries also may be moving geographically following concentrations of fish. Aerial surveys may provide information not only about sea turtle abundance but also about the nature of the fisheries themselves (i.e., the number, size and geographic distribution of fishing vessels).

LITERATURE CITED

Bellmund, S. A., J. A. Musick, R. C. Klinger, R. A. Byles, J. A. Keinath and D. E. Barnard. 1987. Ecology of sea turtles in Virginia. VIMS Spec. Sci. Rept. No 119. 48pp.

Byles, R. A. 1988. The behavior and ecology of sea turtles, Caretta caretta and Lepidochelys kempi, in the Chesapeake Bay. Ph.D. Dissertation, Virginia Inst. of Mar. Sci., School of Marine Science, College of William and Mary.

Byles, R. A. and C. K. Dodd. 1989. Satellite biotelemetry of a loggerhead sea turtle (Caretta caretta) from the east coast of Florida, p. 215-217. In: Proceedings of the 9th annual workshop on sea turtle conservation and biology. S. Eckert, K. Eckert and T. Richardson (compilers). NOAA Tech. Mem. NMFS-SEFC-232.

Keinath, J. A., R. A. Byles and J. A. Musick. 1987. Aspects of the biology of Virginia's sea turtles: 1979-1986. Va. Journal Sci 38(4):329-336.

Lutcavage, M. and J. A. Musick. 1985. Aspects of the biology of sea turtles in Virginia. Copeia 1985(2):449-456.

Musick, J. A., J. A. Keinath and D. E. Barnard. 1987. Distribution and abundance of sea turtles in the proposed EMPRESS II operating sites. Final Report to the Dept. of Navy, Theater of Nuclear Warfare Program. Naval Sea Systems Command, Washington, DC: 36 pp.

Musick, J. A. l988. The sea turtles of Virginia, second revised edition. Virginia Sea Grant Program, Virginia Institute of Marine Science, Gloucester Point, VA 20 pp.

National Research Council. 1990. Decline of the sea turtles, causes and prevention. Nat. Acad. Press, Wash., DC. 259 pp.

NIGHT ORIENTATION IN SEA TURTLES

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The variables that affect light in the ocean are numerous. The visible spectrum is a continuum from 375 nm (violet) to 750 nm (red). The division between blue and green is at about 500 nm and between yellow and orange is at about 600 nm. The intensities or various wavelengths that reach the sea are affected by the incoming intensity of the sun light, water depth, bottom depth and material, angle of incidence, particles content and water clarity, density of water, and other variables. The light reflected by clear sea water is dominated by blue (about 440-475 nm) but may be more green or yellow in different locations depending on the color of the particles in the water column (Jerlov 1976). In shallow water, the color will also reflect the color of the sea bottom substrate (Duntley 1963). The predominant color may shift from blue to yellow (about 550-590 nm)-for shorelines and beaches. The intensity of ocean water can be 5 to 10 orders of magnitude less at night than during the day depending on the phase of the moon and cloud cover (Preisendorfer 1976). Spectra of night light at the ocean surface shifts to a more dominant blue with a fading of the remaining violet and red wavelengths not previously absorbed by particles in the atmosphere and water (Preisendorfer 1976).

Turtles have both photopic (daylight) and scotopic (night) vision as well as color and intensity discrimination abilities (Armington 1954). However, sea turtle eyes are more suited for the nocturnal marine environment with a predominance of cones (Granda and Haden 1970). Although light vision is apparently essential for orientation on land, sea turtles are very myopic (near-sighted) when their eyes are out of water and do not depend on clear resolution of images (Ehrenfeld and Koch 1967, Ehrenfeld and Carr 1967). Granda and O'Shea (1972) found that in the night vision of green turtles the major wavelength sensed was 520 nm with secondary sensitivity at 580 to 600 nm. In dimmer light, 460 nm wavelength sensitivity was evoked. In addition, their peak sensitivity appears to correspond to the ocean radiation which transmits maximally at 470-475 nm for clear sea water (Jerlov 1968).

Sea turtle hatchlings emerge at night from their subsurface nest in the beach, orient seaward, and crawl across the sand into the water. Many systems may be involved but sea finding orientation systems are dominated by phototaxis (visual response to light: Daniel and Smith 1947, Mrosovsky and Carr 1967, Kingsmill and Mrosovsky 1982). Hatchling sea-finding orientation is in response to both light intensity (Ehrenfeld and Carr 1967, Mrosovsky and Shettleworth 1968, Ehrenfeld 1968, Verheijen and Wildschut 1973) and light wavelengths (Hooker 1911, Parker 1922, Mrosovsky and Carr 1967). Hooker (1911), Parker (1922), and Mrosovsky and Carr (1967) stated that sea turtle hatchlings were attracted to blue light (the shorter wavelengths of blue and green) over red. Mrosovsky (1978) showed hatchlings orienting in preference to continuous illumination rather than flashing of brief changes in illumination.

Other studies report that light intensity may be the primary cue to orienting rather than wavelength (Ehrenfeld and Carr 1967, Mrosovsky and Shettleworth 1968, Ehrenfeld 1968, Verheijen and Wildschut 1973). Color filter experiments have shown that the blue light (shorter wavelength) results in higher illumination intensity over longer wavelengths of the red-orange range (Ehrenfeld and Carr 1967, Ehrenfeld, 1968). Since blue wavelengths have a higher energy level than other wavelengths, they would likely be at a higher intensity during testing. Hatchlings compare the light entering each eye which enables them to maintain an orientation toward the light from an open horizon and away from the darker dune and landward vegetation. Hatchlings use this bilateral vision to orient away from longer wavelengths (yellow-red) and towards shorter wavelengths (blue). This shift in directional response to wavelength occurs somewhere in the green wavelengths (455-495 nm)(Dickerson and Nelson 1989). That is, if two light sources are emitting predominantly blue light, then the turtles will crawl towards which ever light has the highest intensity of blue. If two light sources are emitting predominantly long yellow/red wavelengths than hatchlings will move away from the highest intensity of the two. When multiple wavelengths are present in ambient light and commercial lighting, the hatchlings respond to the wavelength of highest intensity. Similar results also have been reported by Witherington (1989).

Little is known as to the effect of sky conditions and the moon on seaward orientation; however, Bacon (1973) showed adult leatherbacks make "orientation circles" more frequently on cloudy moonlit nights. In addition, observations by other researchers, myself included, suggest that hatchlings do not orient to the water as rapidly when the horizon over the water is darker than over the land. On extremely dark nights, additional cues for orientation may be involved such as bioluminescent light which emits peak wavelengths that seem to match the peak sensitivities of sea turtles.

The seaward orientation can be disrupted when landward artificial lights are visible from a nest (Mann 1978). In addition to the disorienting of hatchlings beach lighting has been implicated in the inhibition of nesting by adult females. Generally, fewer nests are found on brightly lighted stretches of beaches (Raymond 1984). On one occasion, I observed an adult female having difficulty finding the water due to a commercial light shining on the beach. I blocked the light from the turtles view and she immediately found her way back to the water.

To prevent the disorienting of hatchlings and adults by beachfront lighting a number of potential solutions have been proposed (Raymond 1984). These solutions include shading of lights and "lights-out" ordinances which require lights to be turned off during the turtle nesting season. Recent research suggests that lights which exclude the blue wavelengths (such as low pressure sodium) could be used, even at high intensities, on the beach and not attract hatchlings (Nelson and Dickerson 1989). However, careful location of lighting is important since hatchlings will move away from longer wavelength lights. High pressure sodium vapor, halogen, incandescent, florescent, and mercury vapor lamps emit blue and all are potential sources of the hatchling disorientation.

LITERATURE CITED:

Armington, J.C. 1954. Spectral sensitivity of the turtle Pseudemys. Journal of Comparative Physiology and Psychology 47:1-6.

Bacon, P.R. 1973. The orientation circles in the beach ascent crawl of the leatherback turtle, Dermochelys coriacea, in Trinidad. Herpetologica 29: 343-348.

Daniel, R.S. and Smith, K.U. 1947. The migration of newly hatched loggerhead turtles toward the sea," Science 106:398-399.

Dickerson, D.D., and Nelson, D.A. 1989. Recent results on hatchling orientation responses to light wavelengths and intensities. In: Eckert, S.A., Eckert, K.L., and Richardson, T.H.(Compilers), Ninth Annual Workshop on Sea Turtle Conservation and Biology, USDOC, NOAA, NMFS, Southeast Fisheries Center, Miami, FL.

Duntley, S. Q. 1963. Light in the sea. Journal of the Optical Society of America 54:214.

Ehrenfeld, D.W. 1968. The role of vision in the sea-finding orientation of the green turtle (Chelonia mydas). 2. orientation mechanism and range of spectral Sensitivity. Anim. Behav. 16:281-287.

Ehrenfeld, D.W. and Carr, A. 1967. The role of vision in the sea-finding orientation of the green turtle (Chelonia mydas). Anim. Behav. 15:25-36.

Ehrenfeld, D.W. and Koch, A.L. 1967. Visual accommodation in the green turtle. Science 155:827-828.

Granda, A.M. and Haden, K.W. 1970. Retinal oil globule counts and distributions in two species of turtles: Pseudemys scripta elegans (Wied) and Chelonia mydas mydas (Linnaeus). Visual Research 10:79-84.

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

Hooker, D. 1911. Certain reactions to color in the young loggerhead turtle. Papers of Tortugus Laboratory 3: 69-76.

Jerlov, N.G. 1976. Marine optics. Elsevier Scientific Publishing Company, New York.

Kingsmill, S.F. and Mrosovsky, N. 1982. Sea-finding behaviour of loggerhead hatchlings: The time course of transient circling following unilateral and asynchronous bilateral blindfolding. Brain, Behavior, Evolution 20:29-42.

Mann, T.M. 1978. Impact of developed coastline on nesting and hatchling sea turtles in southeastern Florida. pp. 53-55 In: Proceedings of the Florida and international conference on sea turtles, Florida Marine Research Publication 33.

Mrosovsky, N. 1978. Effects of flashing lights of sea-finding behavior of green turtles. Behavior Biology 22:85-91.

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

Mrosovsky, N. and Shettleworth, S.J. 1968. Wavelength preferences and brightness cues in the water finding behavior of sea turtles. Behaviour 32: 211-257.

Nelson, D.A., and Dickerson, D.D. 1989. Management implications of recent hatchling orientation research. In: Eckert, S.A., Eckert, K.L., and Richardson, T.H.(Compilers), Ninth Annual Workshop on Sea Turtle Conservation and Biology, USDOC, NOAA, NMFS, Southeast Fisheries Center, Miami, FL.

Parker, G.H. 1922. The crawling of young loggerhead turtles toward the sea. Journal of Experimental Zoology 36:323-331.

Preisendorfer, R.W. 1976. Hydrologic optics volume I: Introduction. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, Honolulu, Hawaii.

Raymond, P.W. 1984. Sea turtle hatchling disorientation and artificial beachfront light. A report for The Center for Environmental Education Sea Turtle Rescue Fund.

Verheijen, F.J. and Wildschut, J.T. 1973. The photic orientation of hatchling sea turtles during water finding behaviour. Netherland Journal of Sea Research 7:53-67.

Witherington, B.E. 1989. Beach lighting and the seaward orientation of hatchling sea turtles. In: Eckert, S.A., Eckert, K.L., and Richardson, T. H.(Compilers), Ninth Annual Workshop on Sea Turtle Conservation and Biology, USDOC, NOAA, NMFS, Southeast Fisheries Center, Miami, FL.

THE STATUS OF REVISIONS TO THE TED REGULATIONS AND IMPLEMENTATION OF PUBLIC LAW 101-162 (THE SEA TURTLE CONSERVATION/SHRIMP EMBARGO BILL)

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TED REGULATIONS:

The National Marine Fisheries Service (NMFS) will soon be proposing regulatory amendments to increase protection of sea turtles. These regulatory amendments will modify and clarify regulations promulgated in 1987 that reduce the level of incidental take and mortality of sea turtles in the southeast United States shrimp trawl fishery.

The regulatory modifications are based in large part on a 1990 report prepared by the National Academy of Sciences titled "Decline of the Sea Turtles: Causes and Prevention." Some of the major findings of this report were:

Shrimp trawling is the largest human caused source of sea turtle mortality.

The NMFS estimate of more than 11,000 sea turtle deaths annually from shrimp trawling could have been underestimated by a factor of four.

TEDs should be required on most trawlers, at most places, most of the time.

The 90 minute tow time limitation in the current regulations is too long. Tow times, if used, should be reduced to 60 minutes in cold months and 40 minutes in warm months.

Three separate regulatory amendments are being proposed to address the Academy's findings.

The first amendment, commonly called the enforcement regulations, will enhance enforcement and compliance with the 1987 regulations. This rule will establish standards for the installation of TEDs, specify standards for hard TEDs, modify the definition of the Morrison soft TED, prohibit certain modifications to TEDs and add prohibitions to increase compliance.

A second amendment, commonly called the conservation regulations, will modify the times and areas where TEDs are required, eliminate some trawls from TED use but expand the TED requirement to other types of trawls and make technical corrections to the 1987 regulations.

The third regulatory action will be an advance notice of proposed rulemaking and request for comments on other fisheries where sea turtle conservation measures are needed.

PUBLIC LAW 101-162:

Public Law 101-162 was signed into law November 21, 1989, as part of the Department's of Commerce, Justice and State Appropriations Bill. Section 609 of this law requires certain actions by the State and Commerce Departments regarding sea turtle conservation. The State Department is designated the lead for implementing the law and the Commerce Department is required to provide technical assistance to the State Department.

The State Department must initiate/expand bilateral or multilateral agreements with other nations for the conservation of five species of sea turtles (loggerhead, leatherback, hawksbill, green and Kemp's ridley).

The President must also certify to the Congress by May 1, 1991, and annually thereafter that, a nation, whose commercial shrimp trawl fishery adversely affects the five sea turtle species aforementioned has adopted a regulatory program governing the incidental take of sea turtles in shrimp trawls comparable to the U.S. and the average rate of the incidental take is comparable to that in the United States. If the certification is not made, shrimp, captured with technology that adversely affects sea turtles, will be banned from importation to the United States. The State Department, is also required to submit a report to the Congress with a list of countries which conduct commercial shrimp fishing in the range of the five turtle species, and those that may adversely affect those turtles. The report must also contain a discussion of implementation progress and measures taken by countries to conserve sea turtles.

The State Department has adopted a clarifying position for implementing the legislation and has issued guidelines for implementation. They have determined that initially they would concentrate on 14 Caribbean basin countries (Mexico, Panama, Brazil, Venezuela, Honduras, Guatemala, Colombia, Guyana, Costa Rica, French Guiana, Trinidad & Tobago, Suriname, Belize and Nicaragua). The import ban applies only to trawl caught shrimp from the Atlantic ocean (Caribbean Sea). The guidelines allow a country three years to fully implement a program, but this must be delineated by May 1, 1991.

A State and Commerce Department delegation met with government representatives from the 14 affected countries in the summer and fall of 1990 to explain the new legislation and the United States sea turtle protection program. The reaction received was mixed. Some of the countries indicated they would adopt regulations that would require the use of TEDs by trawlers shrimping in their waters, others said they would undertake studies to determine the level of incidental take, and a few did not indicate their intention. All the countries expressed concern with meeting the May 1, 1991, deadline and they all requested TED technical training.

In response to these requests, the NMFS submitted a proposal to the State Department's Agency for International Development (AID) to transfer the technology of the TED. The proposal was partially funded and an initial TED training seminar was conducted in Panama City, Panama, in February 1991. Eleven of the thirteen invited countries participated. Separate TED technology training activities have occurred in Mexico under an AID grant and individual proposals have been requested by and submitted to AID Colombia and Honduras.

LITERATURE CITED:

Federal Register, 1990. Turtles in Shrimp trawl Fishery Operations Protection; Guidelines. Federal Register, Vol 56. No. 7. pp 1051-1052.

Federal Register, 1987. Sea Turtle Conservation; Shrimp trawling Requirements; Final Rule. Federal Register, Vol 52. No. 124. pp 24244-24262

THE CUBAN SEA TURTLE FISHERY: DESCRIPTION AND NEEDS FOR MANAGEMENT

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THE CUBAN SEA TURTLE FISHERY

A fishery for sea turtles has existed in Cuba since before the Cuban revolution (1959). Hawksbills (Eretmochelys imbricata), green turtles Chelonia mydas) and loggerheads (Caretta caretta) are caught for both local consumption and international trade. Cuba is one of the largest producers of raw Bekko in the world and, with Panama and Haiti, the largest producer in the Caribbean. Imports of bekko from Cuba to Japan ranged from 2650 kg to 8100 kg per year between 1970 and 1987 (Milliken and Tokunaga 1987) representing approximately 2500 to 7600 hawksbill turtles a year. Catch statistics reported by FAO indicate catches of 100 - 1200 metric tonnes/year of sea turtles (all species 1965 - 1987) (Groombridge and Luxmore 1989, FAO 1989). Dermochelys is reported as a minor portion of the catch (ibid) and Lepidochelys olivacea is reported as a vagrant by Varona (1974). Despite the large volume of harvest and trade the structure of the fishery remains poorly known outside Cuba. Details of the population status of sea turtles in Cuban waters are not available. The senior author (JAO) has been working with Cuban authorities on conservation issues since 1988. In this report we present a preliminary description of the fishery and give recommendations for developing a management plan that will allow the long term conservation of Cuban sea turtle populations. A critical question for this program is to what degree is the turtle fishery in Cuba based on sea turtles that range to other countries in the region.

STRUCTURE OF FISHERY MANAGEMENT IN CUBA

Control of fisheries in Cuba, including the sea turtle fishery, is in the jurisdiction of the Ministry of Fisheries Industry (M.I.P.) (Baisre 1989). Sea turtles constitute a fisheries resource "theme" that is part of the program of four departments of M.I.P..

Centro Investigationes Pesqueras is responsible for fisheries studies and makes recommendations for regulations and fishing quotas based on their data for resource protection and sustainable use.

Direccion de Regulaciones Pesqueras is responsible for policy and implementation and enforcement of regulations.

Direccion Ramal de Impresas Extractivas is the administrative center for control of government fishing centers and harvest plans.

Departamento de Cria Experimental controls farming and ranching operations including a sea turtle head starting facility at Isla de la Juventud.

Fisheries regulations controlling sea turtle harvest have been promulgated since 1976. These include a ban on fishing during the nesting season. For 1988-90 this ban has been adjusted to reflect the seasonality of turtle nesting on the north and south coasts and prohibits taking turtles between May 1 and July 31 (north and southwest) and between September 1 - November 30 (south). Fisheries regulation M.I.P. no. 108 (1983) sets a minimum size of 50 cm carapace length and prohibits capture of nesting females or the collection of eggs. All fisheries in Cuba are in the hands of cooperative fisheries centers run by M.I.P. (MIP 1989).

DESCRIPTION OF THE FISHERY

The turtle fishing fleet is estimated to average about 60 vessels, ranging from 50 to 90 depending on season, and assignment of boats to other fisheries. Most vessels in this group are 10 m or less. Fourteen major ports handle most sea turtle landings in four major fisheries areas of the Cuban shelf. Sea turtles of all species are caught alive using nets allowing release of undersized animals. All species are utilized for meat in local markets and the shell of the hawksbill (bekko) is exported.

Catch statistics: In the period 1976 - 1980 an average of 860 metric tonnes of sea turtles were landed consisting of green turtles (37%), loggerheads (36%) and hawksbills (27%). A small number of leatherbacks are also taken. This catch averages less than 1% of the total Cuban fisheries yield. However because of the high value of hawksbill shell, turtles contribute a disproportionate amount to foreign currency fisheries earnings. Between 1980 and 1982 catch dropped to 839 t/yr but in recent years the general trend has been to increase total catch up to over 900 t/yr. This represents very approximately a minimum of 2000 Green turtles, 2500 loggerheads and 3750 hawksbills a year. There has also been a marked change in the ratio of species. In a sample of 11,480 turtles taken between January 1985 and December 1986 the species composition was 39% (green turtles), 37% (hawksbills) and 24% (loggerheads). In the last two years Hawksbill is reported to have become the most frequent catch. The impact of this harvest on sea turtle populations, in Cuban waters and elsewhere, is not known.

BIOLOGY OF SEA TURTLES IN CUBA

Despite this active fishery, data on the turtles caught are not easily found. The fishery could provide data on size distributions, sex ratios and distribution of the three species.

Preliminary data collected by MIP in 1984 -1987 (Moncada and Nodarse, 1983; Moncada et al., in press; Nodarse et al., in press) indicate that over 70% of the turtles caught of all species are females. Nesting seasons were deduced from the incidence of ovigerous females in the catch and indicate reproductive activity for all species between April and August except for hawksbills nesting in fisheries zone A (the southeast coast) in September through November. Preliminary data are also available on the size of turtles in the catch. Since 1988, JAO, has been collecting turtle tags from the Cuban fishery. 88 turtle tags have been recovered. The tag returns indicate that loggerheads caught in Cuba come from the nesting beaches in Florida. Green turtles caught in Cuba were tagged at Tortuguero, Costa Rica, Florida, Bahamas and Virgin islands. Data on 13 tags are still incomplete. No tags have been recovered from hawksbills in Cuba. This may be because few locations tag Hawksbills in the Caribbean or because hawksbills are less migratory than other species. Clarifying this important point is an immediate priority. No systematic surveys for nesting sea turtles have been conducted. However anecdotal evidence suggest that several species nest on Cuban beaches, particularly along the southern coast and offshore islands. A draft list of localities where sea turtle nesting is reported is available but the relative numbers of nesting turtles is not yet known. Important areas are thought to be the Archipelago Jardines de la Riena for Hawksbills, the Archipelago Canarreos and Isla Juventud for green turtles and the Arch. Los Colorados of the north west coast for loggerheads. Dermochelys are believed to nest only sporadically.

RECOMMENDATIONS FOR MANAGEMENT

The active fishery in Cuba has the potential to provide the biological data necessary for long term management and protection of sea turtles in this area. The existing management structure provides a strong base on which to develop. Management needs are for information, trained personnel and integration with regional initiatives for sea turtle conservation. A program to collect information, train technicians and develop sustainable management policies is recommended.

-- Biological studies to elucidate the distribution and dispersion of sea turtles in and beyond Cuban waters are a priority. A preliminary program has been initiated with the cooperation of M.I.P.. A small number of turtle tags have been provided and are applied to turtles caught and released in the fishery. Efficient return of tags recovered in the fishery from other tagging programs is advised.

-- A survey and analysis of sea turtles nesting in Cuba is necessary.

-- Training junior personnel to conduct sea turtle studies based on the fishery and on nesting beaches is recommended.

-- Careful expert review and evaluation of the existing management policy and judicious fine tuning of quotas, size limits and closed seasons, based on new data as it is generated, is recommended.

Particular questions that need to be addressed are the degree to which sea turtles of all species migrate in and out of Cuban waters, the magnitude of nesting and recruitment from within Cuban waters and the detailed biology of distribution, growth and movements on the Cuban feeding grounds. A detailed proposal for funding a management program is being prepared for inclusion in the global action plan for hawksbill sea turtles.

LITERATURE CITED

Baisre, J.A. 1989. Teoria y practica de la administración de pesquerias. Ministerio de la Industria Pesquera, La Habana. 101 pp.

FAO 1965-1989. Yearbook of Fisheries Statistics 1965-1989. FAO/UNDP Rome.

Groombridge,B. and R.Luxmoore. 1989. The green turtle and hawksbill (Reptilia: Chelonidae): world status, exploitation and trade. CITES Secretariat, Lausanne. 601 p.

Milliken T & H. Tokanaga. 1987. The Japanese Sea Turtle Trade 1970-1986, A special report prepared by TRAFFIC Japan. 171pp.

MIP. 1989. Calendario de Medidas para la Protección de los Recursos Pesqueros Marinos y de la Agricultura. Ministerio de la Industria Pesquera, La Habana.

Moncada G.,F. y G.Nodarse A. 1983. Informe Nacional sobre la actividad desarrollada por Cuba en el estudio y conservación de las tortugas marinas. Ministerio de la Industria Pesquera. 6 pp.

Moncada Gavilán,F., R.Cardona Cuervo, y G.Nodarse Andreu. (In press). Comportamiento reproductivo de los quelonios marinos en el Archipielago Cubano.

Nodarse Andreu,G., S.Elizalde y F.Moncada. (In press). Algunas características de la arribada de los quelonios marinos en la Isla de la Juventud.

Varona,L. 1974. Nuevo reporte de Lepidochelys olivacea (Testudinata: Cheloniidae) de Cuba. Poeyana 137:1-4.

RESPIRATORY PHYSIOLOGY OF LAYING, ACTIVE AND RESTING LEATHERBACK TURTLES ON THE BEACH IN COSTA RICA

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Body mass (M ± 5 kg), respiratory frequency (f, breaths/min), tidal volume (T. V. ± .001 l), ventilation V_e ± 1 ml/kg), oxygen consumption (V_{O2} ± .001 Watts/kg), carbon dioxide production (V_{CO2} ± 1 ml/kg), body and ambient temperatures (T_a and T_b ± .1^{o} C) were measured for at least 5 different female leatherback turtles, Dermochelys coriacea. Measurements were made on the beach in Costa Rica while turtles rested restrained in a net, while they layed eggs, or while they were actively covering their nest. M ranged from 250 - 450 kg (mean = 370); at rest, f ranged from 1.02 - 3.30 (mean = 1.98); T.V. ranged from 4.2 - 6.5 (mean = 5.14); V_e ranged from 16.1 - 33.8 (mean = 27.5); V_{O2} ranged from .186 - .544 (mean = .387); T_a ranged from 21 - 23.8 (mean = 21.9); and T_b ranged from 30.2 - 32.4 (mean = 31.3). While actively covering the nest and throwing sand, f ranged from 4.17 - 6.4 (mean = 4.8); T.V. ranged from 6.4 - 10.3 (mean = 7.5); V_e ranged from 65.1 - 160.9 (mean = 99.2); V_{O2} ranged from .878 - 1.818 (mean = 1.510). While laying f ranged from 3.8 - 4.0 (mean = 3.9), T.V. ranged from 1.3 - 4.5 (mean = 2.8), V_e ranged from 22.4 - 54.9 (mean = 34.6), V_{O2} ranged from .146 - .592 (mean = .326). Mean Respiratory Quotient was O.7 for all conditions tested (rest, covering and laying).

SEA TURTLE ASSOCIATIONS WITH FLOTSAM IN THE EASTERN TROPICAL PACIFIC OCEAN

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I recorded observations of sea turtles associated with flotsam during over 70 months of at-sea time as a marine bird and mammal observer in the eastern tropical Pacific (ETP) since 1975. Turtles were considered associated if they occurred within 100 m of a floating object. A total of 236 individual turtles of 4 species were recorded associated with flotsam. Flotsam included a wide array of objects including biogenic material (e.g., trees, bamboo, coconuts, kelp patties, dead sea lions), as well as anthropogenic debris (e.g., abandoned fishing gear, milled wood, plastic trash bags, bottles); virtually anything that floated on the ocean. Associated turtles included 23 olive ridley, 2 green, 2 hawksbill, 3 loggerhead, and 206 unidentified turtles; no leatherbacks were observed with flotsam. The number of associated turtles numbered from 1 to 5, with single turtles being by far the most common. Turtles probably associate with flotsam on the open ocean for protection (mainly from sharks), but possibly also to prey on fish and other organisms that aggregate around floating objects. Two drawbacks with this associating behavior are 1) drifting fishing nets in the ETP usually have turtles caught in them, and 2) tuna purse seine fishermen often catch and occasionally incidentally kill turtles when they fish for tuna associated with logs. Both factors probably represent relatively minor threats to sea turtles in the ETP.

ARRIBADAS: SOCIAL EVENTS OR SIMPLY AGGREGATIONS? PRELIMINARY RESULTS FROM SATELLITE TELEMETRY

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Arribada is a term used to describe a reproductive behavior unique to sea turtles of the genus Lepidochelys; where a group or aggregation of female turtles emerge from the sea synchronously to lay their eggs on the same beach (Pritchard 1969). Based on observations conducted during arribadas, Pritchard (1969) and Cornelius and Robinson (1986) suggested that the arribadas might consist of several small groups or cohorts of females that arrive at the nesting beach at the same time. Cornelius and Robinson (1986) also suggested that these cohorts might remain cohesive after the arribada when the turtles disperse from the nesting beach. If such a group cohesiveness does occur, this then implies that a form of social interaction may be involved in the nesting aggregations of Lepidochelys.

Satellite telemetry was used to monitor the movements of a "cohort" of female olive ridley sea turtles (Lepidochelys olivacea) to determine if the group remained cohesive during the internesting period and after the nesting season. Six post-nesting female ridleys were captured during the September 1990 arribada at Playa Nancite, Costa Rica. Female ridleys were taken from the same section of beach on 19 September during a 3 hour time period and all were in the same phase in their reproductive cycle. Reproductive status of the turtles was determined with an Aloka 500 ultrasound scanner with 5 Mhz convex linear probe. The six "cohort" females had ovarian follicles > 2 cm diameter which indicated each turtle was going to lay another clutch of eggs. After the September arribada, the "cohort" females dispersed away from Playa Nancite in the Gulf of Papagayo independently of one another. Five of the six females dispersed from the Gulf of Papagayo into the Pacific Ocean and the last remained in the Gulf. In October, four of the six females returned to the Gulf of Papagayo just offshore Playa Nancite. No arribada occurred during October and none of the September "cohort" females were found nesting at Playa Nancite. All of the September "cohort" females re-aggregated near Playa Nancite in November. An arribada began during the early morning of 24 November 1990 and that evening, 5 of the 6 September "cohort" females were recaptured on the beach. Recaptured females were found nesting within 20 meters of the places where they were found nesting during September. They nested within a 3 hour time period as occurred in September when they were first captured. Ultrasound images revealed depleted ovaries (i.e. a lack of large follicles) with a generous number of atretic (reabsorbing) follicles present. Immediately following the November arribada, September "cohort" females dispersed from Playa Nancite, again independently of one another. The September "cohort" did not remain cohesive during the internesting period nor did they remain cohesive after the November arribada. Our preliminary conclusion based on these data is that an arribada is not a social event, but rather is an aggregation of turtles reacting in similar fashion to as yet unknown common stimuli.

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LITERATURE CITED

Cornelius, S.E. and Robinson, D.C. 1986. Post-nesting movements of female olive ridley turtles tagged in Costa Rica. Vida Silvestre Neotropical 1(1):12-23.

Pritchard, P.C.H. 1969. Studies of the systematics and reproductive cycles of the genus Lepidochelys. Ph.D. dissertation. University of Florida. 226 pp.

STATUS OF THE ARCHIE CARR NATIONAL WILDLIFE REFUGE

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The Regional Director for the U.S. Fish and Wildlife Service's Southeast Region approved the final plan for Archie Carr NWR in August 1990. The proposed refuge is located along Florida's east-central coast and includes four segments 3.2, 0.5, 2.5, and 2.8 miles long each along the 20 mile stretch of coast between Melbourne Beach and Wabasso Beach. Small undeveloped tracts between the segments within Brevard County are also proposed for purchase and total an additional mile. Total estimated costs for the refuge are 80-90 million dollars. The State of Florida through its Conservation and Recreation Lands Program (CARL) approved a revised project design for Wabasso Beach and Brevard Turtle Beach projects in August 1990. They are now known as Archie Carr Sea Turtle Project and include most of the undeveloped property within Archie Carr NWR boundaries.

Sea turtle nesting activity between Melbourne Beach and Wabasso Beach during the period 1987-90 is summarized in Table 1. Approximately 25% of the loggerhead (Caretta caretta) and 30-35% of the green turtle (Chelonia mydas) nesting in the U.S occurs along this 20 mile long stretch of beach. Other federally listed species would be protected by the refuge and include the southeastern beach mouse (Peromyscus polionotus niveiventris), Florida scrub jay (Aphelocoma c. coerulescens), and eastern indigo snake (Drymarchon corais couperi).

In July 1990 the State of Florida purchased a 2.6 million dollar 14 acre parcel from The Nature Conservancy for inclusion in the refuge. The State of Florida has ranked Archie Carr NWR high on its list for funding under the CARL program and plans to spend 10 million dollars for acquisition in 1991 and a similar amount each year in subsequent years. The U.S. Fish and Wildlife Service received two million dollars from Congress to begin land purchases for Archie Carr NWR in fiscal year 1991. Table 2 summarizes the acquisition status for each segment of the refuge. As of February 1991 approximately 204 acres of the 860 acre proposed refuge were in public ownership.

Table 1. Number of sea turtle nests deposited along the 20 mile stretch of beach between Melbourne Beach and Wabasso Beach, Florida during the period 1988-90.

	1988	1989	1990
Caretta caretta	10,550	11,500	16,404
Chelonia mydas	105	208	588
Dermochelys coriacea	0	4	0
Eretmochelys imbricata	0	1	0

Table 2. Acquisition status of Archie Carr National Wildlife Refuge (February, 1991).

Segment		Length (miles)	Acreage	Acres in Public Ownership
Brevard County	1	3.2	217	103 (47%)
Brevard County	2	0.5	54	28 (52%)
Brevard County	3	2.5	191	2.4 (1%)
Brevard County	(Misc.)	1.0	218	0
Indian River County		2.8	179	71 (40%)
Total		10.0	859	204.4 (24%)

ESTIMATES OF HATCHLING SEX RATIOS FOR Caretta caretta: A FIVE YEAR STUDY FROM CAPE CANAVERAL, FLORIDA, 1986-1990

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Loggerhead sea turtle (Caretta caretta) hatchlings were collected over three seasons (1986-1988) from the nesting beach at Cape Canaveral, Florida to determine natural sex ratios. In addition, measurements of beach temperatures at the depth of turtle nests were taken from 1986-1990. The present results show that the female-biased sex ratio reported previously for the 1986 nesting season at this site (Mrosovsky and Provancha 1989) was not an isolated atypical event. We estimate that in 1986 92.6-96.7%, in 1987 94.7-99.9% and in 1988 87.0-89.0% of the hatchlings produced on this beach were females. Over the five nesting seasons, sand temperatures were predominantly above the pivotal level for loggerhead turtles. The 1989 and 1990 temperatures suggest sex ratios that were also very highly skewed toward females. Strongly female-biased sex ratios in this population of loggerhead turtles pose theoretical and practical challenges.

LITERATURE CITED

Mrosovsky, N., and Provancha, J. 1989. Sex ratio of loggerhead sea turtles hatching on a Florida beach. Can. J. Zool. 67:2533-2539.

TRACKING OF SEVEN SEA TURTLES BY SATELLITE TELEMETRY

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During the past 18 months, movements of seven sea turtles have been monitored by satellite telemetry for various time periods in order to 1) help explain the movement and dive patterns of sea turtles, 2) develop a biological model to make these patterns more predictable and 3) explain the interactions between sea turtles and offshore oil and gas structures.

The turtles include 4 loggerheads in the Gulf of Mexico and 3 Kemp's ridleys in Atlantic U.S. coastal waters. Topics of discussion include home range, submergence time by day, night and species, and movement of a Kemp's ridley in relation to water temperature. All data are preliminary. Data from additional turtles must be collected to provide sufficient sample size for a modeling effort.

OCEAN FINDING BY HATCHLING SEA TURTLES: INTERPLAY OF SILHOUETTE, SLOPE AND BRIGHTNESS AS GUIDEPOSTS IN ORIENTATION

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Green and loggerhead sea turtle hatchlings emerge at night from underground nests located on oceanic beaches. They then immediately crawl down the beach to the ocean. Several cues might serve as guideposts for orientation, and have been postulated as important. These include: photic (light intensity) contrasts between the view toward land and out to sea; detecting silhouettes of dunes and vegetation toward land; and beach incline (slope). In typical experiments, one cue is presented in the absence of the others. We used a large circular arena, half of which was dimly illuminated (matching light levels out to sea on moonless nights) while the other half was dark. In some experiments only this single (photic) cue was present; in others, photic cues were paired with either silhouettes or with slope. Paired cue tests revealed if turtles had cue "priorities", or if two cues together improved orientation ("interactions"). In priority tests, each stimulus of the pair indicated the sea was on the opposite side of the arena.

When tested with a single (photic) cue, groups of hatchlings showed significant orientation toward the brighter screen. In paired cue tests, all hatchlings showed the strongest orientation away from silhouettes. Only green turtles responded to slope; they detected inclines of as little as 2^{o}. Orientation responses to inclines which typically occur on local beaches were, however, weaker than those to silhouettes.

High silhouettes (both species) and steep inclines (green turtles) elicited orientation toward either a dim or a dark horizon. Thus both silhouette and incline took priority over brightness as an orientation cue. However, responses to low silhouettes (both species), or down shallow inclines (green turtles) were improved (i.e., groups of turtles show less scatter from the mean orientation angle) if they directed turtles toward a bright horizon. Thus, interactions occur between low silhouettes or shallow inclines when paired with photic cues.

Three points emerge. First, hatchlings may use two (or more) cues to find the ocean, arranged in a hierarchy of preference. Secondly, the most important cue for green turtles and loggerheads is silhouette. Under natural conditions, hatchlings probably reach the ocean by orienting away from dunes and/or vegetation on land. Thirdly, loggerhead and green turtles differ in the kinds of cues they use though why remains to be determined.

SUBADULT KEMP'S RIDLEY SEA TURTLES IN THE SOUTHEASTERN U. S.: RESULTS OF LONG-TERM TAGGING STUDIES

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The demographic characteristics of the Kemp's ridley sea turtle have changed significantly over the past twenty years as a consequence of the continued decline of adult turtles and the intensive effort to protect their eggs. The number of subadult Kemp's ridleys found in the coastal waters of the Gulf of Mexico and Atlantic Ocean has reportedly increased in recent years (Ross et al., 1989: Ogren, 1989). Despite these claims, the wide distribution and cryptic habits of subadult turtles makes quantification relatively difficult. Most of the information concerning this developmental stage comes from reports of incidental capture in commercial fisheries and stranding records. The following account will present some observational data and tagging results of long-term studies conducted by the NMFS Panama City, Florida laboratory.

Since 1986, a total of 344 Kemp's ridleys have been collected by fishery-dependent methods, such as trawls and strike gill nets, or by large-mesh tangle nets. This represents the largest collection of subadult Kemp's ridleys living under natural conditions. The majority of effort occurred on the northwest and central-east coasts of Florida with limited seasonal (summer) effort in South Carolina. All captured turtles were double tagged on the front flippers; the location of capture, date, tag code, straight-line carapace length and width, weight, and condition of the turtle was recorded.

In an earlier study, Henwood and Ogren (1987) provided information on length frequency, seasonal occurrence, and long distance migration of Kemp's ridleys on the Atlantic coast. Presently, 95 additional Kemp's ridleys have been captured and tagged on the east coast, primarily offshore of Cape Canaveral. The importance of this area as a winter foraging ground is supported by the high capture rates occurring from October to March and multiple recaptures within a season. A turtle originally tagged in February was recaptured in Georgia waters during July, reaffirming the seasonal north-south migration reported by Henwood and Ogren. Despite the intensive tagging efforts, both past and present, there is still no indication whether these subadult ridleys recruit to the Gulf of Mexico breeding population.

On the west coast of Florida, fishery independent capture efforts have resulted in the tagging of 127 Kemp's ridleys near the Cedar Keys. In addition, 119 ridleys were taken in the Apalachicola Bay-Panacea area Rudloe (Rudloe, et. al., in press; Ogren, 1989). The occurrence of Kemp's ridleys in the northeastern Gulf nearshore coastal waters is highly seasonal with no turtles captured during the coldest winter months. Long-term recaptures inthe Cedar Keys provide evidence that these turtles return to this particular habitat over successive years. Additionally, recaptures at the location of initial capture, both within a netting season and between seasons, indicate that the ridleys in this area may have a restricted home range. Future tracking studies will provide more information on the movements of Kemp's ridleys within these feeding grounds.

With the exception of a single individual on the east coast, all turtles can be classified as immature. On the Atlantic coast, the majority of Kemp's ridleys are in the early subadult phase. A similar distribution has been reported for the Apalachicola-Panacea region. In contrast, ridleys captured at the Cedar Keys are in the late subadult phase. The two aforementioned areas may represent a developmental habitat for ridleys that recently entered the coastal-benthic stage, while the latter area may be a long-term foraging habitat. The recapture data supports this statement. However, these length frequency distributions should be viewed with some degree of caution as gear bias is possible. In the case of the fishery independent study, the use of large mesh webbing allows smaller turtles to pass through the nets and avoid capture.

Recaptures of turtles have also shown the suitability of flipper tags for the study of subadult turtles. The #681 inconel tag (National Band and Tag Co.) has proven to be more resistant to corrosion than the monel tags used in earlier studies. However, the absence of copper in the inconel alloy appears to have made this tag susceptible to fouling by encrusting organisms. Barnacle growth on inconel tags was observed for every Kemp's ridley recaptured in the Cedar Keys. In addition, coral growth was reported from the study in Cape Canaveral. Six turtles, 5 Kemp's ridleys and 1 green turtle, captured in the Cedar Keys had notches in their front flippers indicating tag loss. Two of these ridleys were identified as recaptures from photographs taken when first captured.

It has been postulated that the sharp edges of the metal tags increase the likelihood of tag loss whereas the smooth posts of plastic tags allow for longer retention (Bjorndal and Bolten, unpubl.). Higher drag resulting from barnacle growth plus the sharp cutting effect of the barnacles would further increase the chance of inconel tag loss. Consequently, we began tagging turtles at Cedar Key with plastic Jumbo-Roto tags (Dalton Supplies Ltd.). Recent recaptures have revealed that plastic tags are also becoming encrusted with barnacles and tag loss has been documented. Because of this high rate of tag loss, PIT (Passive Integrated Transponder) tags will be applied in the future.

These research activities will be carried on by NMFS and the University of Florida and will be expanded to include documentation of movements by telemetric methods, establishment of baseline blood chemistry, and increase in netting efforts to determine the southern extent of Kemp's ridley distribution along the Florida coast.

LITERATURE CITED

Henwood, T.A. and L.H. Ogren. 1987. Distributions and migrations of immature Kemp's ridley turtles (Lepidochelys kempi) and green turtles (Chelonia mydas) off Florida, Georgia and South Carolina. Northeast Gulf Sci. 9(2): 153-159.

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

Ross, J.P., S. Beavers, D. Mondell and M. Airth-Kindree. 1989. The Status of the Kemp's Ridley. Center for Marine Conservation, Washington, D.C. 51 p.

Rudloe, A., J. Rudloe and L.H. Ogren. In press. Occurrence of subadult Kemp's ridley turtles, Lepidochelys kempi, in coastal waters of northwest Florida. Northeast Gult Sci.

SEX CHANGES IN CAPTIVE LOGGERHEAD TURTLES

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The first documented instance of natural sex change in 13-year old subadult loggerhead turtles, held in captivity since birth, is reported. Based on straight line carapace (CL)/tail length (TL) ratios near six for females and 2.5 for males, four of six subadult loggerhead turtles exhibiting female characteristics began to change and assume, when they were between nine and 13 years old, male characteristics and behaviors. Comments explore the causes or controls affecting sex change.

ACTIVITY OF ANOXIC, FRESHWATER TURTLES: A MODEL FOR MARINE TURTLES?

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INTRODUCTION

Each year, especially during the summer months, an estimated 5,500 to 55,000 sea turtles die following entrapment in trawl nets along the southeastern U. S. (National Research Council, 1990). Shoop et al. (1990) proposed that many of the turtles do not drown in the nets, but become comatose and eventually die from subsequent treatment. Here, we used the freshwater eastern painted turtle, Chrysemys picta, to formulate a model reflecting various changes that a turtle undergoes during forced submergence (anoxic conditions).

We chose two parameters to construct the model: swimming activity, because it was easily observable and quantifiable over the entire submergence period, and plasma lactate concentration as a physiological estimator of anoxic condition since it is the primary end-product of anaerobic respiration (Jackson, 1988). The painted turtle is well suited for anoxic studies. Masacchia (1959) showed that freshwater turtles could withstand months submerged at temperatures of 3° C, and days at 20° C. Painted turtles are also able to tolerate the extreme drop in blood pH levels that accompany metabolic and respiratory acidosis resulting from long-term submergence (Jackson and Heisler, 1982).

The objectives of this study were: (1) to define plasma lactate concentrations in different states of anoxia at 20° C; (2) to quantify the behavioral activity associated with different states of anoxia; and (3) to develop a predictive model using swimming activity and/or lactate levels to judge a turtle's condition.

MATERIALS AND METHODS

Eastern painted turtles were used in all experiments. Fifty, wild-caught turtles from Rhode Island were kept in large, flow-through tanks prior to use in experiments. Following a 3 week acclimation and fasting period, each turtle was selected for a 4-, 8-, 12-, 20-, 28-, 36-, and 44- hr submergence time interval. Five turtles were used for each time interval, and five more used as controls.

Each turtle was placed in a small, 20 gallon experimental tank and sealed with a plexiglas barrier to keep the turtle submerged beneath the surface. A plexiglas lid covered the tank. The water was continuously bubbled with nitrogen to maintain anoxic conditions. The tank temperature was kept constant at 20° C.

All activity was monitored using a video camera and time lapse recording equipment. Blood samples were taken by tail-clip immediately following the experimental time interval. Plasma lactate values were determined using an enzymatic test kit (Sigma no. 826-UV) with a modified protocol developed by Ultsch and Jackson (1982).

RESULTS AND DISCUSSION

We found a significant relationship between plasma lactate concentrations and submergence time (Figure 1). The model shown here utilized polynomial regression and accounts for a significant amount of the variability in the data ($R^2 = 0.783$). It may still be necessary to adjust this model to either a higher order polynomial model, or to a segmental regression model in order to provide for more accurate predictions.

Early data on the relationship between swimming activity and submergence time suggest that over the first one to two hours of submergence, activity levels are initially high, and in most cases, drop precipitously and remain relatively constant thereafter throughout the remainder of the submergence time interval, although there was considerable variability between turtles (Figure 2). If sea turtles behave in a similar fashion in submerged nets, even if they have a lower tolerance to anoxia, we would expect survival for several hours, and reduced activity.

We hope to determine whether swimming activity is a useful measure of anoxic condition. If it is, then this procedure might be used for studies of sea turtle responses to anoxic conditions and avoid turtle mortality in such investigations. We anticipate that behavior in towed nets may differ from simple forced submergence in aquaria.

ACKNOWLEDGEMENTS

We thank Dr. Donald Jackson and colleagues for their many courtesies.

LITERATURE CITED

Jackson, D. C. 1988. Tolerable limits of hypoxia: the turtle as an extreme vertebrate example. pp. 337-349. In: "Hypoxia: the Tolerable Limits". Sutton, J. R., C. S. Houston, and G. Coates (Eds.). Benchmark Press, Inc., Indianapolis.

Jackson, D. C. and N. Heisler. 1982. Plasma ion balance of submerged anoxic turtles at 3° C: the role of calcium lactate formation. Resp. Physiol. 49:159-174.

Jackson, D. C. and G. R. Ultsch. 1982. Long-term submergence at 3° C of the turtle, Chrysemys picta bellii, in normoxic and severely hypoxic water. II. Extracellular ionic responses to extreme lactic acidosis. J. Exp. Biol. 96:29-43.

Musaccia, X. J. 1959. The Viability of Chrysemys picta submerged at various temperatures. Physiol. Zool. 32:47-50.

National Research Council. 1990. Decline of the Sea Turtles: Causes and Prevention. National Academy Press, Washington, D. C.

Shoop, C. R., C. A. Ruckdeschel, and R. E. Wolfe. 1990. The myth of the drowned turtle. Proceedings of the 10th Annual Workshop on Sea Turtle Biology and Conservation. NOAA Technical Memorandum NMFS-SEFC-278.

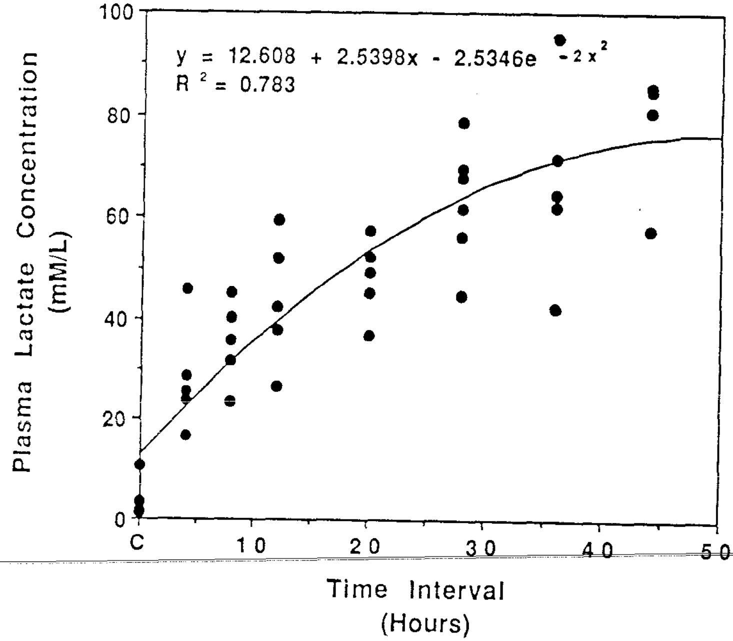

Fig. 1. Relationship between plasma lactate concentration and submergence time interval. "C" represents control animals (N = 5 per time interval, P < .05). Best fit regression model is given at the top of the graph.

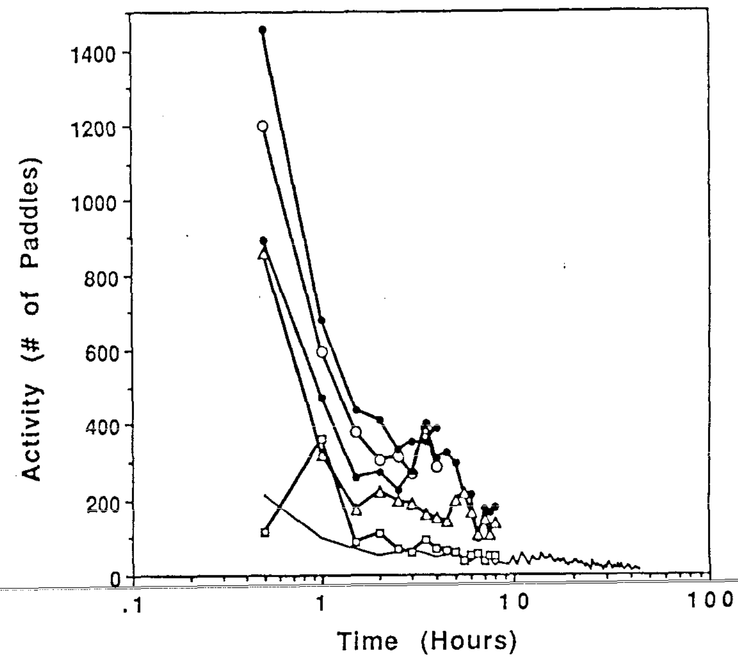

Fig. 2. Relationship between swimming activity and submergence time. Time is shown on a logarithmic scale for clarity. A paddle is defined as one complete swimming stroke of one hind foot. Data points represent the number of paddles in a half-hour period. Data from eight different animals are pictured.

A NEW VIEW OF SEA TURTLE ABUNDANCE IN NORTHEAST U. S. WATERS

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About nine years ago, the Cetacean and Turtle Assessment Program (CETAP) was completed. The program included extensive aerial and shipboard surveys of sea turtles in waters from Cape Hatteras northward to Nova Scotia. Seasonal distributions of sea turtles as derived from the CETAP data were presented in a chapter of the book Georges Bank (Shoop, 1987), but the high cost of the book reduced availability. Herein we present new analyses, under review for publication elsewhere, of loggerhead and leatherback distributions. The new analyses result in relative abundance distributions, or distributions corrected for sighting effort and therefore unbiased by amount of effort in any one area. To accomplish the new analyses, the study area was divided into 1,430 quadrats, each 10 minutes of latitude by 10 minutes of longitude (roughly 10 by 7-8 nmi). Effective kilometers of survey trackline in each of the quadrats were partitioned by season. The total sampling effort included 372,000 km of survey trackline during acceptable sighting conditions, resulting in 99.2 % coverage of the quadrats. More than 400 special aerial surveys also allowed estimates of absolute abundance.

The mean estimated summer abundance of loggerheads was much greater than leatherbacks (thousands vs. hundreds). Actual abundances could be an order of magnitude higher since surface sightings represent only a fraction of the entire population. Both species were sighted more frequently in relatively shallow waters, with leatherbacks showing a more northerly distribution. Relative density plots show real zero quadrats and no-effort quadrats, thereby presenting more realistic pictures of distributions. The relative densities of both loggerheads and leatherbacks were highest during the summer, and patterns of relative abundance were similar to simple sighting records. The continental shelf waters of the northeastern United States harbor relatively large populations of sea turtles and should be considered in endangered species recovery plans.

HOW MANY WILL IT TAKE?

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During a two-week period from 17 to 31 October, 1988, we found five stranded Kemp's ridley turtles on Cumberland Island, Georgia. Five more were found on other Georgia beaches at that time. From 14 to 24 November we found 6 more, while another 6 were stranded on other islands in Georgia. By early December the state total was 25 dead ridleys in 50 days. Alarmed at such a stranding rate for ridleys, to say nothing of the many stranded loggerheads and green turtles, we notified both state and federal agencies of our concern. It was then that we found there was apparently no contingency plan to resolve high stranding rates of sea turtles.

Kemp's ridley mortalities have continued. Georgia had at least 45 dead ridleys in 1990. Such levels of ridley mortality could represent a substantial portion of adult recruits in the future breeding population since we do not know the population numbers in the juvenile age stages, speculation on the significance of such levels of mortality is premature. Nevertheless, if present recruitment rates into the breeding population are stable, the results of such mortality could be significant. Irvin (these meetings) noted that the death of one ridley juvenile was legally determined to have a significant impact on adult recruitment.

The problem is not limited to ridleys. During the past eleven years, 709 juvenile loggerheads with intact carapaces have stranded on Cumberland Island. During that time mean carapace length of juveniles (measured in the same way by the same person) has decreased significantly (Kruskal-Wallis test or linear regression). The linear regression shows a 0.4 cm decrease in mean length per year. Such a decrease in mean length could be caused by increased numbers of smaller juveniles -- a good sign. It was not; it resulted from reduced numbers of larger juveniles. Such data mean something to fishery biologists. They are a sign of an over-exploited and crashing population. Wershoven and Wershoven (these meetings) presented a similar situation for juvenile green turtles during the past five years.

Our question is simple. How many sea turtles have to die following interactions with fishing gear before a fishing zone will be closed? Ten? One hundred? One thousand? Ten thousand?

The department of Commerce can and does close zones to fishing to protect fishing stocks. It has not closed fishing zones to protect turtles on the endangered list. Does the National Marine Fisheries Service (NMFS) have a contingency plan, based on turtle stranding numbers or rates, that would result in immediately alleviating the problem by closing impacted fishing zones? For a decade or more, volunteers have provided turtle stranding data, and those data have been used by the NMFS to characterize turtle populations, to show correlations with fishing effort, to delineate movements of tagged turtles, and to provide bases for generalizations about the 55,000 to 550,000 sea turtle mortalities associated with fishing activities. Why are the turtle stranding data not used as a rapid assessment of sea turtle mortality rates leading to quick curtailment of the responsible activity?

What other rapidly obtained data would be useful to assess local mortality problems? The number of nesting females is too variable and delayed to be of value in assessing fishing-associated morality, especially since most stranded turtles are juveniles. Aerial surveys give indices of living numbers, but limited data on mortality. Stranding data, with known effort, provide the best measure of mortality that we have. Why not use them?

With the coming of the Turtle Excluder Device (TED) regulations, we naively considered the issue moot. Unfortunately, even with the TED regulations in place, the stranding rate on Cumberland Island in 1990 was second highest of the past decade. The September total was the highest of the decade. Since the TED regulations have not significantly reduced the trawling-induced mortality, at least in Zone 30, additional actions are needed. Regardless of the reasons for the Zone 30 problem, the rapid solution would be to close the zone to trawl fishing until the causes of the mortalities could be determined. If there are no governmental mechanisms is place to judge stranding rates or numbers as unacceptable, they should be developed. So far, 5500 to 55,000 per year for the United States have not produced such a response. Does that mean those numbers are acceptable? Perhaps the judgement of unacceptability should not fall on the shoulders of the agency charged with assuring maximum sustained yields of fishery products. Sea turtles are not fishery products any more.

We suggest that some governmental agency make the hard decisions to close fishing zones if fishing-induced mortality reaches a predetermined, unacceptable level. A national maximum estimated rate of 55,000 per year is unacceptable in our view. So is the low estimate of 5500. A total of 45 ridleys a year in Georgia is also too many.

APPLICATION OF RECENT ADVANCES IN SATELLITE TRANSMITTER MICROTECHNOLOGY: INTEGRATION WITH SONIC AND RADIO TRACKING OF JUVENILE KEMP'S RIDLEYS FROM LONG ISLAND, NY

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During the past several years, we have been integrating a sonic and radio telemetry tracking program with standard tagging efforts to study juvenile Kemp's ridley sea turtles (Lepidochelys kempi) in the waters of Long Island, New York. The use of radio and sonic transmitters has allowed us to monitor intensively the behavior of individual turtles inhabiting inshore waters. From these efforts we have determined that the turtles enter Long Island's estuaries in July, exhibit diurnal feeding behavior, grow rapidly, and emigrate during autumn.

During the time Kemp's ridleys remain in inshore waters, these techniques have proven to be ideal for such behavioral studies. As turtles emigrate, however, alternative tracking techniques such as satellite telemetry become necessary. Since the Kemp's ridleys in this region are small (mean SCL = 30 cm) traditional satellite transmitters were too bulky to be used on these turtles. Recently, however, we were able to take advantage of a new miniaturized satellite transmitter. Since the movement patterns of Kemp's ridleys as they leave the northeastern U.S. are not known, we hoped the use of satellite transmitters would help reveal their migration route. In addition to tracking several turtles equipped with radio and depth-sensing sonic transmitters, we attached satellite and radio transmitters to two Kemp's ridleys to begin addressing this question. Besides reporting the turtle's location, the satellite transmitters provided water temperatures and diving frequencies.

To test the reliability of the satellite telemetry data, the turtles were closely monitored by boat for several days following release. Boat surveillance was maintained through the use of radio tracking. In addition to determining the movements of Kemp's ridleys exiting Long Island waters, three aspects of satellite telemetry were tested. 1) How accurate are the locations reported by the satellite transmitter? 2) Are the temperatures reported by the transmitter accurate? 3) Are the dive frequencies indicated by each type of transmitter accurate?

The accuracy of the locations given by the satellite transmitter are ranked by location class (LC), which ranges from 0 to 3. The lower the LC, the less accurate the calculated location. Literature provided by Argos states that readings with LC 0 require cautious interpretation because of a high potential for error, while LCs 1-3 range in accuracy from 1km to 150m. Our own ground truthing tests, conducted by comparing visual verifications (after locating turtles via radio transmitters) with those reported by the satellite system, confirm the Argos ranges. LC 0 was found to have a maximum error of 92 km and mean error of 14.7 km (Fig. 1). Comparisons of temperature data between that reported by the satellite system and on-site thermocouple readings indicated that the transmitter data were accurate.

Two types of satellite transmitter attachment techniques were evaluated to determine their ability to record accurately the number of dives per sampling time. Each transmitter was equipped with a microprocessor programmed to consider submergences as dives only when the animal was submerged for 60 seconds or more. One Kemp's ridley was equipped with a towable satellite transmitter and a carapace mounted (backpack) radio transmitter, while a second turtle had the opposite configuration, i.e., towable radio transmitter and backpack satellite transmitter. The radio transmitter allowed us to closely monitor the movements of the turtles and make direct visual observations of their behavior. By visually monitoring the amount of time the turtles spent at the surface and comparing the transmissions of the two types of satellite transmitters, it was noted that the backpack model often indicated the turtle was diving when in fact the animal was swimming a few centimeters below the surface. Because the towable transmitter accurately reflected the diving behavior of the turtle, we recommend this means of attachment (with appropriate tether length) for studies concerned with turtle surfacing times.

Both turtles equipped with satellite transmitters emigrated from the Long Island area as water temperatures began their steep decline during autumn. The backpack model ceased transmitting 14 days after the turtle exited Long Island's bays. At last contact the turtle was in the Atlantic Ocean adjacent to Fire Island, N.Y., heading in a direction that would take it to the New Jersey coast.

The turtle with the towable transmitter left Long Island's estuaries during the first week of November. This was ten days prior to the bay water temperatures reaching cold-stunning levels (<10^{o} C)(Fig. 2). The turtle proceeded southward for two weeks over a distance of 350 km before slowing its movements (Fig. 3). The animal remained in a limited area of the open ocean for 17 days until proceeding southward. Soon after moving southward the satellite transmitter indicated a sudden 5^{o} C increase in temperature (Fig. 2). The turtle's movements were compared with ocean current charts which revealed that the animal had intersected the Gulf Stream. Upon contact with the Gulf Stream the animal moved 200 km in the direction of the current over a two day period. Final contact with the satellite transmitter was received at this time (December 12).

ACKNOWLEDGEMENTS

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Fig. 1

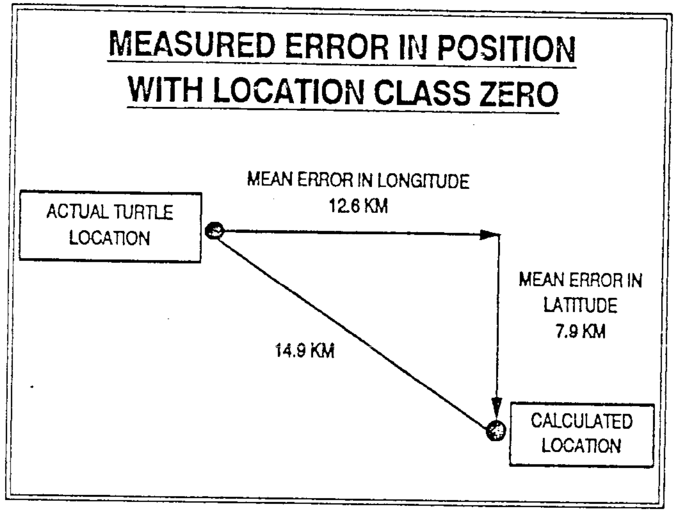


Fig. 2

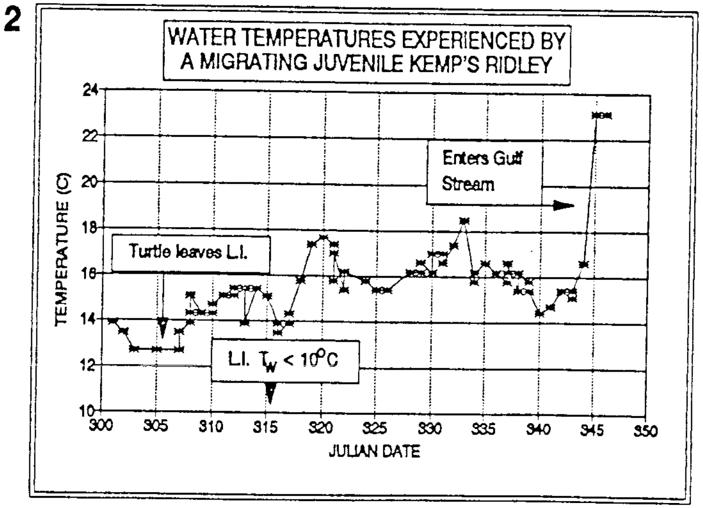
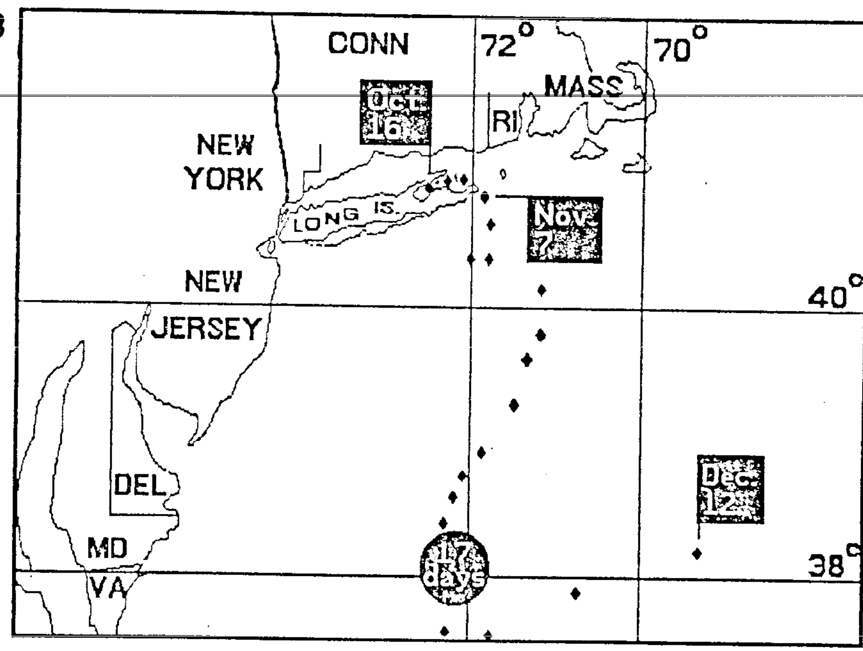


Fig. 3



THE EFFECTS OF HURRICANE HUGO ON THE NESTING BEHAVIOR OF HAWKSBILL SEA TURTLES ON BUCK ISLAND NATIONAL MONUMENT, UNITED STATES VIRGIN ISLAND

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Buck Island Reef National Monument (BUIS) is a small, undeveloped island 2 km north of St. Croix, USVI, and is managed by the National Park Service. BUIS provides 1.3 km of nesting beach for hawksbills (Eretmochelys imbricata). It is one of three known islands in the Caribbean where hawksbills nest in numbers large enough to warrant continued long-term monitoring of nesting beaches. The consistency of this annual breeding population on BUIS provides a unique opportunity to study hawksbill biology (e. g. population dynamics, nesting behavior, and habitat requirements).

For the past 3 years, nesting beach research on BUIS has provided the national Park Service (NPS) with valuable data on hawksbills nesting behavior. Concurrent tagging studies have indicated seasonal and inter-nesting cycles, site fidelity, and ultimately will provide information on migratory ranges, size and stability of the BUIS hawksbill population.

On 16 Sept., 1989, hurricane Hugo moved through the US Virgin Islands, and dramatically affected the landscape of BUIS. On BUIS, 75% to 90% of beach vegetation (manchineel, Hippomane mancinella; purple sage, Lantana involucrata; and sea grape Coccoloba uvifera), was killed due to salt spray and wind shear. Sand was washed away, exposing root tangles, and creating steep berms. Extensive piles of drift (rack) consisting of dead and downed trees accumulated at high water levels. Large trees and branches were knocked down by strong winds, and leaf litter created a thick layer of compost on the forest floor.

The objective of this study was to determine if post-hurricane conditions on BUIS affected hawksbill nesting behavior.

From 1986 to 1990 (May - Sept) activity of nesting sea turtles was observed during diurnal and nocturnal surveys on BUIS. Surveys were conducted on all nesting beaches from dawn until dusk, 4-7 nights a week. Turtle activities were recorded as confirmed nesting, suspected nesting, or false crawl (unsuccessful nesting attempt).

Pre-hurricane hawksbill activities were observed in 1987 (May - Sept, n = 113), 1988 (May - Dec, n = 158), and 1989 (June 15 - Sept, n = 89, Fig. 1). Number of false crawls during 1987 was 26 (24%), and for 1988 and 1989 (pre-Hugo) was 56 (23%). Post-hurricane hawksbill activities were observed in 1989 (16 Sept - 1 Jan, n = 81) and 1990 (June - Dec, n = 208). Number of false crawls for these combined periods was 154 (54%). Mean number of crawls per confirmed nest was 0.40 before hurricane Hugo and was 0.25 after Hugo. Post-hurricane nesting site fidelity was less than that observed in pre-hurricane years.

Changes in beach topography and of the forest floor can severely impact nesting activities of hawksbill turtles. Unlike other sea turtles, hawksbills nest within the beach forest of tropical islands. For nesting females, this habit necessitates an ability to move across obstacles, which open-sand nesting turtles would not usually encounter.

We attribute lower nest site fidelity and increased false crawl ratio to changes in beach topography and the forest floor resulting from hurricane Hugo. Increased amounts of dead-down material, rack and size of berms made it difficult or impossible for hawksbills to reach their nesting areas. Hawksbill were frequently observed returning to the sea after encountering obstacles which obstructed their movement to their nest site.'

The impact that hurricanes may have on nesting hawksbills has never been documented. As their population declines, factors that had only minor effects on the population previously, may now be of greater importance in determining species survival. Management should address the effects of hurricanes on hawksbill nesting activity, and consider implementing post-hurricane beach clean-up where hawksbill nesting success is threatened.

During the 1990 season on BUIS, beach berms were reconstructed and limited debris was cleared by the National Park Service. Hawksbills were observed to make use of these openings enabling them access to the beach forest and their nesting sites.

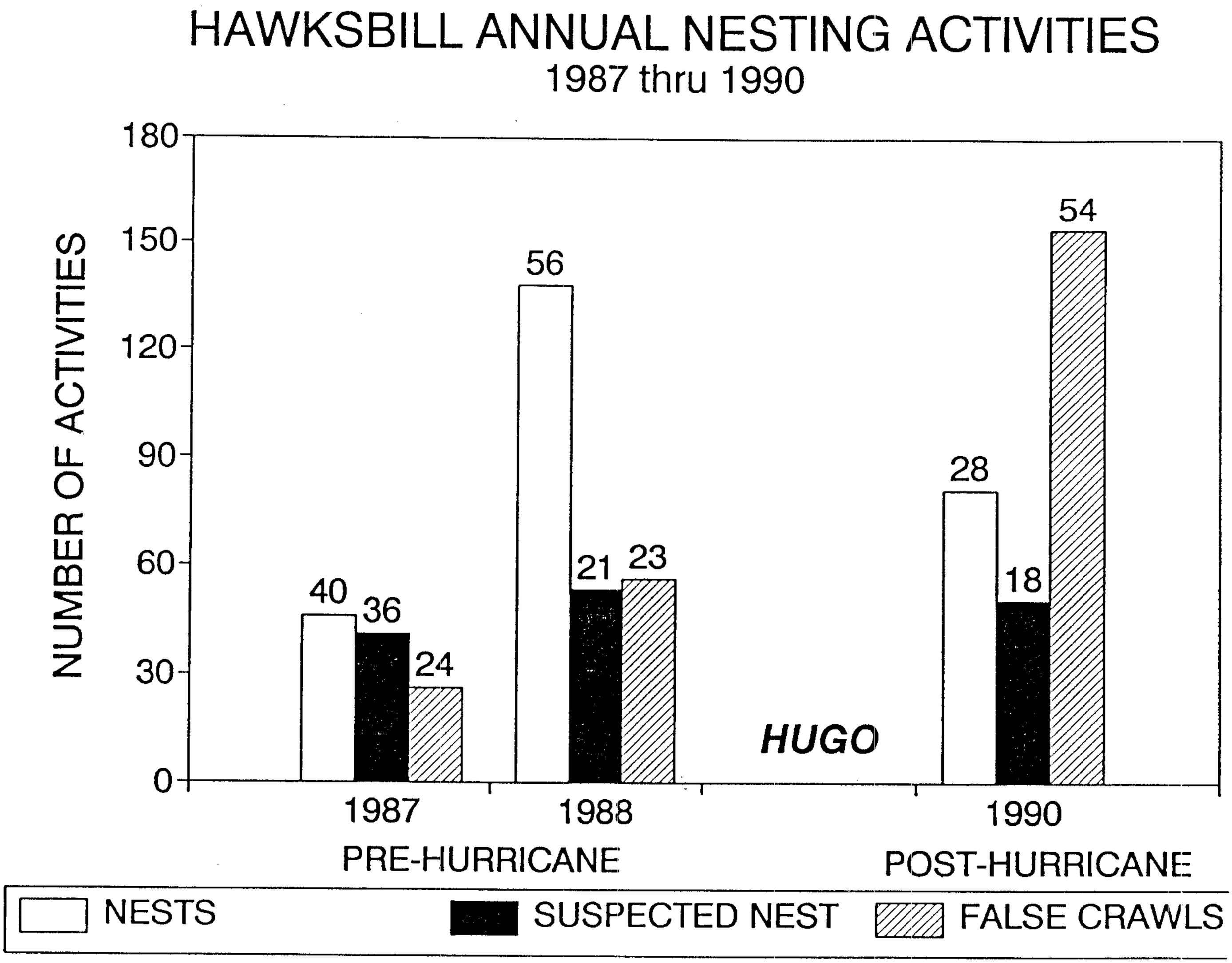

Figure 1. Hawksbill annual nesting activities(1987-1990). Numbers indicate relative percent of total annual activities. Data from 1989 pre-hurricane and post-hurricane were added to 1988 and 1990 respectively.

STUDIES ON THE FEEDING ECOLOGY OF THE HAWKSBILL TURTLE, *Eretmochelys imbricata*, IN PUERTO RICO

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INTRODUCTION

The hawksbill turtle (*Eretmochelys imbricata*) has historically been fished throughout its range (the tropical and subtropical seas of the world). Although protected by the International Union for the Conservation of Nature since 1970, by the Endangered Species Act of 1973, and by international agreements and programs, this species continues to be heavily poached throughout the Caribbean Region. Now, it is believed to be the most endangered turtle species in the West Indies.

Traditional management actions to restore hawksbill populations in Puerto Rico have almost exclusively been devoted towards increasing hatchling production through nest protection efforts. Increasing the reproductive success of hawksbills by protecting nesting sites does not assure the preservation of this species. Critical foraging habitats (coral reefs and reefoid habitats) must also be protected from disturbances associated with coastal development. Furthermore, there is a need to develop an effective recovery program for hawksbills which takes into account their feeding behavior.

The main objectives of our program are: 1) to locate, characterize and protect hawksbill foraging grounds; 2) to conduct food resources evaluations; and 3) to increase our knowledge on the feeding behavior of *E. imbricata*.

METHODS

Aerial and field surveys are conducted to delineate areas where hawksbills are repeatedly seen surfacing. Underwater surveys are aimed towards finding direct evidence of hawksbill feeding activities by searching for external morphological aberrations of specific epibenthic faunal components (e.g. sponges, gorgonians) within these areas. Areal extents of foraging habitats are estimated with photogrammetric tools.

Once found, a foraging habitat is described in terms of topography, substrate and dominant components. Prey items are identified in situ to the lowest taxonomic level possible. Large and small spatial scale assessments of food resources are conducted through stratified sampling techniques using quadrats and transects, U/W videotapes and photographs as sampling units. For relative abundance estimates of specific food items, both, percent cover (for encrusting taxa) and population densities (for erect, ramose and massive taxa) are used.

Gut content studies consist of determining the species composition of prey items and their relative proportion using dry weight as a criteria. Stomach and/or intestinal content are fixed in formalin, rinsed in fresh water, transferred to 70% ethanol and classified to the lowest taxonomic levels by means of microscopy.

Fatty acid composition and concentration is determined by freeze drying the sample, extracting it with chloroform/methanol (1:1, v/v), and separating the lipids by column chromatography. The phospholipid classes are investigated by thin layer chromatography. The fatty acyl components of the phospholipids are purified on column chromatography. The methyl esters are analyzed by gas chromatography-mass spectrometry (for details, see Carballeira and Maldonado, 1986).

RESULTS AND DISCUSSION

A major hawksbill foraging ground was found between Cayo Luis Pena and Culebra island, from 40 to 50 feet of depth. Scleractinian corals, octocorals and demosponges are the dominant epibenthic faunal components within this submerged reef. The most frequently grazed sponge species (of a total of 26 species found) was the haplosclerid sponge Niphates digitalis. Between 67% and 86% (n=26) of all specimens (N. digitalis) inspected were grazed by hawksbills. Population densities of N. digitalis varied between 4-10/m2 (n=4). Other haplosclerids were grazed to a much lesser degree (e.g. Niphates erecta, Amphimedon compressa, Spinosella plicifera, S. vaginalis). Other studies have reported that haplosclerids were avoided by hawksbill turtles. Field studies are being continued.

The stomach contents (see Table 1) of two adult hawksbills (one from Mona Island and one from Humacao, P.R.) consisted almost exclusively of choristid demosponges: Geodia neptuni (90%) in one, and Chondrilla nucula (95%) in the other. A third adult specimen from Culebra Island had only ingested the sea cucumber Holothuria cubana. Two juvenile specimens found in the north and east coast of Puerto Rico had only Chondrilla nucula in their stomachs. The gut content of another juvenile found on the west coast of P.R. consisted of the demosponges Myriastra sp. (65.5%), Cynachirella alloclada (22.4%), Chondrilla nucula (9.7%) and Tethya crypta (2.4). These observations confirms that sponges are major prey items for hawksbills (Meylan, 1984) and that C. nucula is the most frequently prey item found inside the guts. Haplosclerids (e.g. N. digitalis) are more quickly digested than choristid (C. nucula) sponges and may not be readily found inside the guts of hawksbills.

The most frequent fatty acid type (26%) found in N. digitalis were of the 5,9 series (double bonds in the 5th and 9th carbon). Fatty acids new to science were also found in other sponges reported inside guts of the hawksbill turtle.

Some of these acids are the 5,9-hexadecadienoic (16:2) isolated from Chondrilla nucula, the 2-Methoxy-5-hexadecenoic (16:1) isolated from Tethya crypta, the (6Z)-6-nonadecenoic (19:1) and the (17Z)-17-pentacosenoic (25:1) isolated from Geodia (see Carballeira and Rodriguez,in press; Carballeira and Maldonado,1986; Carballeira, pers.comm.; Vicente et al., in press).

The phospholipid fraction in the muscle tissue of hawksbills was found to be different from the green turtle (Table 2). Curiously, the 5,9-hexacosadienoic (26:2) acid (a demospongic acid) was found only in the C. mydas sample. Fatty acids are being evaluated as a fingerprint tool in law enforcement actions.

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LITERATURE CITED

Caraballeira, N. M. and L. Maldonada. 1986. Identification of 5,9-Hexadecadieonic acid in the marine sponge Chrondrilla nucula. Lipids 21: 470-471.

Caraballeira, N. M. and J. Rodriguez. (in press). Two novel naturally occuring phospholipid fatty acids from the Caribbean sponge Geodia gibberosa).

Meylan, A. B. 1984. Feeding ecology of the hawksbill turtle (Eretmochelys umbricata): Spongivory as a feeding niche in the coral reef community. Ph. D. Dissertation, University of Florida. 117 pp.

Vincente, V. P., Rutzler, K. and N. M. Carballeira. (in press). Comparative morphology, ecology and fatty acid composition of West Indian Spheciospongia (Demospongea). Marine Ecology.

Table 1. Gut content analysis of *E. imbricata* in Puerto Rico. Adult specimen #1 off Culebra (east coast). Adult specimen #2 off Mona Island (west coast). Adult specimen #3 off Humacao (east coast, Carapace: 73.5 cm. x 56.5 cm.). Specimen #4 off Humacao (east coast, Carapace: 20.3 x 14 cm.). Specimen #5 off El Negro reef (west coast, Carapace: 26 x 23 cm.). Specimen #6 off Isla Verde (north coast). S = stomach, H = Holothurian, S+I = stomach and intestine, P = Porifera, Pe = Pelecypoda, F= Foraminifera, B = Bryozoan, C = Coral, A = Algae, E = Echinoid, BA = brown algae, HC = hydrocoral, A = macroalgae, SG = Sea Grass, VP = vascular plant.

CONTENT	SP-1	SP-2	SP-3	SP-4	SP-5	SP-
Agelas(P)		+(S+I)				
Aplysina fistularis(P)					+(I)	
Arborescent bryozoans(B)			+(S)			
Benthic forams(F)		+(S+I)				
Chama macerophyla(Pe)		+(S+I)				
Cheilostomes(B)		+(S+I)				
Chondrilla nucula(P)			95(S)	100(s)	9.74	100(S)
Chondrosia sp.(P)					+(1)	
Coral rubble(C)		+(S+I)				
Crustoce reds(A)		+(S+I)				
Cynachirella alloclada(P)					22.42(S)	
Darwinellidae(P)					+(I)	
Dictyota sp.(BA)			+(S)			
Echinoid spines(E)		+(S+I)				
Geodia neptuni(P)		90(S+I)				
Hadromerid(P)		+(S+I)				
Holothuria *cubana*(H)	100(S)					
Myriastra sp.(P)					65.49(S)	
Rhodophytes(A)					+(I)	
Sand grains		+(S+I)				
Sargassum sp.(BA)			+(S)			
Stem(VP)					+(I)	
Stylaster roseus(HC)			+(S)			
Tethya crypta(P)					2.35(S)	
Thalassia testudinum(SG)					+(I)	
Vascular plant debris		+(S+I)				

Table 2. Fatty acid composition and concentration in the muscle tissue of the green turtle *Chelonia mydas* and of the hawksbill turtle *Eretmochelys imbricata*.

Chelonia mydas		*Eretnochelys imbricata*	
Fatty acid	Percent	Fatty acid	Percent
18:0	40.5	18:0	20.0
20:4 w 6	31.0	20:3 w 3	12.7
16:0	9.6	20:4	12.6
22:5 w 3	9.0	22:4 w 3	12.2
22:4	7.5	22:5	12.1
26:2 (5,9)	2.4	20.1	10.6
	100.0	20.1	10.4
		br-18:0	9.4
			100.0

JUVENILE GREEN TURTLES IN THEIR NEARSHORE HABITAT OF BROWARD COUNTY, FLORIDA: A FIVE YEAR REVIEW

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Observations of juvenile green turtles (Chelonia mydas) along the nearshore areas of Broward County, Florida have been made by divers and fisherman. Since 1986, a segment of this population has been monitored during nocturnal SCUBA dives on a year-round basis.

The offshore area of Broward County consists of three main series of limestone ledges which run parallel to the shore. The nearshore reef extends from 75 to 375 meters offshore, and is 4 to 7 meters in depth. Reefs are colonized by soft and hard corals, with algae proliferating on the limestone. No significant sea grass beds are known to the offshore area.

It is on the nearshore first reef tract that juvenile green turtles are most frequently sighted and where this study is being conducted. Turtles have been observed feeding upon the algae, and are known to use the ledges and large coral heads for sleeping and resting.

METHODS

A 20- by 1600-meter area of the first reef tract has been surveyed by the authors during SCUBA dives, both day and night. This reef is easily accessible and contains areas of significant relief. Dives are initiated from shore by swimming or by launching of an inflatable boat. During favorable conditions, dives are made at least once a week.

Nocturnal dives allow for the capture of swimming or resting green turtles. Once captured, the turtles are brought to the surface, examined, measured, and released. A #681 Inconel tag from the University of Florida is placed in both front flippers. Recaptured turtles whose tags are over 3 years old are given additional tags. While only curved measurements can be obtained during beach dives, both straight and curved carapace measurements are taken when the boat is utilized.

RESULTS

Since March 1986, 134 green turtles have been captured, with recaptures resulting in 187 total captures. A total of 347 dives have been made, resulting in a 53.89% capture to dive rate, and an expenditure of 4.26 man hours per capture. Turtles are captured during all months, with June, August, April, and May the most productive, and September and December the least. No incidence of papilloma has been observed.

The carapace lengths of turtles at initial capture range from 27.4 to 67.0 cm over the curve, with a mean of 43.47 cm and a median of 43.30 cm. This indicates a presence of turtles of smaller size than those observed by Ehrhart (1983) in the Indian River Lagoon system, but larger than those captured off Cape Canaveral (Henwood and Ogren, 1987) or at the St. Lucie Power Plant on Hutchinson Island (Ernest, et. al., 1989).

A total of 37 green turtles have been reencountered, 34 during dives and 3 as strandings. Multiple recaptures of 11 animals bring the total recapture events to 54. The shortest interval between first and last capture was 2 days; 4 intervals were longer than 3 years, the longest being 1160 days. Our overall recapture rate is 27.6%, with recaptures in 1990 increasing to 44.4% of the total encounters.

Growth rates were calculated at 0.26 cm per month. By mean size classes of 30 - 40 cm, 40 - 50 cm, and over 50 cm, growth rates were 0.30, 0.37, and 0.17 cm per month, respectively. The diet of these turtles has been determined through stomach content analysis of stranded greens of the same size class to consist primarily of red algae. Bjorndal and Bolten (1988) recorded more rapid growth rates among the Great Inagua population of Thalassia-grazing juvenile green turtles. In contrast, the Hawaiian greens found to feed upon algae displayed a slower growth rate (Balazs 1980, 1982). These differences may be due to contrasts in the nutritional quality of the diets. Another factor may be the amount of stress experienced by the turtles on the feeding ground.

We have identified three turtles as scavengers, that is, they have been captured proximal to fishing piers with fish hooks and monofilament line protruding from their mouths. Two of these animals were also re-encountered as strandings, their penchant for animal protein ultimately causing their death. The growth rate for two of these turtles was less than 0.01 cm per month. The third scavenger spent five months at a rehabilitation facility due to monofilament entanglement, therefore growth rates cannot be considered as natural.

CONCLUSIONS

The juvenile green turtles in Broward County waters are known to utilize a large expanse of hardbottom reef. This reef provides adequate food supplies and relief for successful feeding and sleeping activities. The turtles enter this habitat from the pelagic at approximately 30 cm curved carapace length and depart when they reach a length of 60 cm. The location of their subsequent habitat is still unknown, although the lack of sub-adult captures or strandings along Florida's mainland coast would indicate a migration to more tropical waters.

Broward County is a densely-populated, tourist-oriented area. In 1989-90, over 42,000 vessels were registered in Broward, with an additional 31,000 in Palm Beach County. The offshore waters, including the nearshore reef areas are visited by hundreds of boats a day. Numerous dive charters, private boats, and beach divers frequent the easily accessible and shallow first reef.

The juvenile green turtle population is under considerable stress from this human activity. Propeller injuries were cited in 34 of the 56 stranding deaths of this size class since 1986. Fishing hooks and line were responsible for another 7 deaths. Dive activity causes further stress to the animals through harassment and displacement from suitable resting and sleeping sites.

Another stressor related to human activity is that of frequent fresh water discharges from the water management canals during periods of heavy rainfall. This water of dubious quality may be linked to algal blooms which out-compete the preferred species upon the nearshore reefs, especially near the inlets. When this colder, fresh water is present on the reef, most frequently during July, the number of turtles captured is greatly reduced.

Beach renourishment projects can further displace and stress these juvenile turtles not only by the possibility of injury and death during the dredging activities, but by long-term siltation of nearshore feeding areas.

Monitoring this population should be continued, with attention given to population fluctuations and movement, and the causes for such changes. The above-mentioned impacts should also be closely monitored, with the parties responsible for these impacts made aware of the presence of this endangered population and the significance of the nearshore habitat for its survival.

LITERATURE CITED

Balazs, G.H. 1982. Growth rates of immature green turtles in the Hawaiian Archipelago, p.117-125. In: K.A. Bjorndal (ed.), Biology and Conservation of Sea Turtles. Smithsonian Institute Press, Washington, D.C.

Bjorndal, K.A. and A.B. Bolten. 1988. Growth rates of immature green turtles, Chelonia mydas on feeding grounds in the southern Bahamas. Copeia 1988(3):555-564.

Ernest, R.G., R.E. Martin, N. Williams-Wall, and J.R. Wilcox. 1989. Population dynamics of sea turtles utilizing shallow coastal waters off Hutchinson Island, Florida, p. 57-59. In: S.A. Eckert, K.L. Eckert, T.H. Richardson (Compilers). 1989. Proceedings of the Ninth Annual Workshop on Sea Turtle Conservation and Biology. NOAA Tech. Memo. NMFS-SEFC-232.

Henwood, T.A. and L.H. Ogren. 1987. Distribution and migrations of immature Kemp's ridley turtles (Lepidochelys kempi) and green turtles (Chelonia mydas) off Florida, Georgia, and South Carolina. Northeast Gulf Science 9(2):153-159.

STOMACH CONTENT ANALYSIS OF STRANDED JUVENILE AND ADULT GREEN TURTLES IN BROWARD AND PALM BEACH COUNTIES, FLORIDA

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Strandings of sea turtles occur on the beaches of Broward and Palm Beach counties throughout the year. Strandings are reported to Florida DNR, county environmental agencies, or to a telephone hotline monitored by the authors. SCUBA divers also report sightings of dead sea turtles on the reefs.

Broward and Palm Beach counties constitute the northern two-thirds of the highly developed Miami-Fort Lauderdale-West Palm conurbation of southeastern Florida. The coasts are highly developed, with most of the beachfront property in private ownership. The offshore areas of these counties consist of relict limestone reefs which support large recreational and commercial fishing and diving activities.

METHODS

Since 1986 a stranding hotline, first sponsored by Broward County Audubon Society, has been effective in gathering reports from Broward County. In 1990, this effort was expanded to include Palm Beach County. Stranding reports are investigated by volunteers, with necropsies performed when feasible, either in the field on the adults, or at our home on the juveniles. Live animals are taken to rehabilitation facilities.

Necropsies are performed in accordance with techniques outlined in Wolke and George (1981). Gross examination of organs are undertaken. The gastro-intestinal tract is thoroughly examined for identifiable food particles and for evidence of plastics or other foreign material. Due to the nature of injuries to most animals, many strandings are not intact. Food matter is often obtained from the esophagus if the lower organs are missing.

Stomach samples are preserved in 10% sea water-buffered formalin. Algae samples have been identified by Dennis Russell of Seattle Pacific University and Steve Blair of Dade County (Florida) Department of Environmental Resource Management. Specimens of sea grasses have been examined by Steve Blair and Paul Mikkelsen of Palm Beach County Department of Environmental Resource Management.

RESULTS

Of the over 100 strandings reported to us since 1986, 66 have been green turtles, 56 juveniles and 10 adults. A curved carapace measurement of 80 cm separates the juveniles from the adult category. The 10 adults were represented by 6 males and 4 females, and were reported in 1989 and 1990. Four of the 6 adults stranded in 1990 were reported in Palm Beach County. In 1990, a record 19 juvenile strandings were reported, 4 of which were from Palm Beach county. These figures do not represent total strandings, only those reported to the authors.

Juvenile strandings are reported year-round, with an increase in the spring and summer months. This may be indicative of more efficient reporting due to the presence of nest survey patrols. The decrease during the winter months also corresponds to the lowered number of captures made by the authors during SCUBA surveys in the Fort Lauderdale area for the same months (Wershoven and Wershoven, 1989). Adults have been reported only during the nesting season.

The curved carapace lengths of the juveniles ranged from approximately 8.0 cm to 72.4 cm, with a mean of 45.1 cm and a median of 43.0 cm. Stranded adult greens ranged in size from 98.5 cm to 113.5 cm, with a mean of 104.8 cm and a median of 105.45 cm.

Boat propellers were responsible for the most injuries to stranded green turtles, with 34 of 56 juveniles and 4 of 10 adults exhibiting severe cuts usually on the rear of the carapace. Entanglement in fishing line and other human artifacts has been the apparent cause of death for 8 juveniles and 2 adults. Evidence of possible shark attacks has been observed on 1 adult and 4 juveniles. One juvenile stranded just north of a fishing pier with a fishing hook in its mouth, its skull fractured, and its throat slit. The remaining strandings exhibited no apparent cause of death. No evidence of papilloma was observed on any stranded turtles.

Necropsies were performed on 42 of the 56 juvenile green turtles. Three of these turtles yielded no stomach or esophageal contents. Most of the specimens contained a mix of algae and/or sea grasses, only 11 stomachs contained a single species of food material. No plastics or foreign matter, other than fishing hooks and line, were found in the gastro-intestinal tracts of any of the necropsied juvenile turtles.

The most common food items by frequency of occurrence were the Rhodophytic algae of the family Gelidiaceae. The contents of 12 specimens were wholly comprised of these algae. Sea grasses were the second most abundant food element, completely constituting 4 samples, and occurring with Gelidiaceae and Gracilaria in 12 others. Of the remaining 15 genera of algae represented in the specimens, the red algae Gracilaria was most common.

The ingested algae were found to be representative of the offshore floral communities proximate to the location of the stranding. Although the offshore area is devoid of significant sea grass beds, floating rafts of grasses are blown in from other areas during periods of high winds. One juvenile green stranded on the shore of Lake Worth had been feeding primarily on sea grasses from the lake, Halodule wrightii and Halophila johnsonii.

Necropsies were performed on 8 of the 10 stranded adult greens. Eggs were present in the oviducts of 2 of the 3 females examined. Examination of the gastro-intestinal tract yielded only small amounts of food matter; two of the animals had empty guts. Four turtles had been feeding upon Sargassum natans; two exclusively, two had augmented their diet with hydroids and red algae of Gelidium and Gracilaria species. One adult presented a sample of Halimeda with unidentified sponge material; Hypnea was found with hydroid stems in the remaining specimen. No plastics or other foreign matter was found.

CONCLUSION

Strandings of green turtles, especially juveniles, occur with some frequency along the coasts of Broward and Palm Beach counties. Juvenile green turtles are known to utilize the offshore areas of Broward County as a developmental habitat (Wershoven and Wershoven, 1989), and have been frequently observed by divers along nearshore hardbottom areas of Palm Beach County. The paucity of food matter in the stomachs of stranded adult green turtles and the absence of sightings of adults in the offshore area during non-nesting months indicate that these turtles may be utilizing a different habitat and are migrating to South Florida beaches during the nesting season.

The presence of Rhodophytic algae within the gastrointestinal tracts of stranded juvenile green turtles, sightings of turtles feeding upon these plants and the abundance of these food items along the hardbottom areas of Broward and Palm Beach County underscore the importance of this habitat to an endangered species. At the present time there are several threats to the integrity of these nearshore reef areas: massive freshwater discharges during periods of heavy rainfall may result in the proliferation of algal species disruptive to growth and maintenance of food items preferred by green turtles. Beach renourishment projects result in frequent overloading of the nearshore environment with silts and clays not only during projects, but for years afterward. The disruptive activities of recreational boaters, while not a direct threat to algal growth, are clearly a cause of mortality. Similarly, commercial fishing activities that result in sea turtle deaths need to be regulated or modified. Efforts to control and monitor these threats should be implemented.

LITERATURE CITED

Wershoven, R. W. and J. L. Wershoven. 1989. Assessment of juvenile green turtles and their habitat in Broward County, Florida waters. p. 185-187. In: S. A. Eckert, K. L. Eckert, and T. H. Richardson (Compilers). 1989. Proceedings of the Ninth Annual Workshop on Sea Turtle Conservation and Biology. NOAA Tech. Mem. NMFS-SEFC-232.

Wolke, R. E. and A. George. 1981. Sea Turtle Necropsy Manual. NOAA Tech. Mem. NMFS-SEFC-24.

HOW ARE HATCHLING SEA TURTLES ABLE, AND UNABLE, TO LOCATE THE SEA?

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Hatchling sea turtles emerge at night and immediately move toward the ocean. However, sea finding is disrupted by artificial lighting (Verheijen, 1985). Why this disruption occurs, and what can be done about it are both questions that can be answered by studying the cues that hatchlings use to identify the seaward direction.

Since blindfolded hatchlings are unable to locate the sea from the beach (Carr and Ogren, 1960), vision is likely the primary sense in sea-finding. However, the eye is able to detect and distinguish a number of light characteristics, any one (or set) of which may provide dependable predictors of the seaward direction. Here, I discuss how hatchlings behave and, based on this information, offer some solutions to the disorientation problem.

Light intensity and color: I conducted experiments with loggerhead (Caretta caretta) hatchlings to determine the lowest light intensity necessary to elicit a directed orientation response (orientation threshold). Hatchlings were released into a circular arena, which was dark except for a window of diffusing glass. Light shown through the window was controlled for intensity and color. I released 30 loggerhead hatchlings individually, per treatment, beginning at sub-threshold light levels for each of six monochromatic colors. Hatchling orientation at these low light levels, and during control treatments (no light), was nondirected, or random (Raleigh test, alpha = 0.05). I then increased light intensity, released a new group of 30 hatchlings, measured the directivity of orientation, and continued to step up intensity for each color until orientation became significant. For all colors tested, the direction of orientation at threshold intensities was toward the lighted arena window. However, the threshold intensity at which hatchlings first oriented significantly, varied among colors. Photon flux (a measure of light intensity) of the orientation threshold for red (700 nm) light was highest (6.0×10^{-4} micromoles photons/s/m^2/nm), followed by yellow (600 nm, 1.5×10^{-7} micromoles photons/s/m^2/nm), near-ultraviolet (320 and 350 nm, 1.6×10^{-8} and 2.5×10^{-8} micromoles photons/s/m^2/nm), violet (400 nm, 9.2×10^{-9} micromoles photons/s/m^2/nm), and blue-green (500 nm, 5.1×10^{-9} micromoles photons/s/m^2/nm). In loggerhead hatchlings, threshold intensities necessary to evoke orientation, graphed as a function of color, form a curve comparable to that obtained from preference experiments conducted at higher light levels (Witherington and Bjorndal, in press). Experiments with other species (Chelonia mydas; Eretmochelys imbricata; (Lepidochelys olivacea) reveal similar patterns.

Light in the blue region of the spectrum (ultraviolet-green) is most attractive to hatchling sea turtles, but appears least bright to humans. However, yellow light is orders of magnitude less attractive than blue light to hatchlings, but is near the peak of spectral sensitivity in humans. The only commercial luminaire that emits light exclusively in this yellow range is low pressure sodium vapor (LPS). As a consequence LPS lighting is less disruptive to hatchling orientation than other commercial light sources at comparable illuminance levels (Witherington and Bjorndal, 1991).

Green-yellow to yellow-red light (560-630 nm) at intensities higher than threshold levels has an additional effect on orienting loggerhead hatchlings. In an experimental setup identical to the one previously described, I conducted experiments in which light above threshold levels illuminated the arena window.

Loggerhead hatchlings oriented more strongly toward the lighted window in treatments using higher intensities of 320 nm, 350 nm, 400 nm, 450 nm (blue), 500 nm, 540 nm (green), 650 nm (red), and 700 nm light. In contrast, orientation became less directed with increasing intensity of 560 nm (yellow-green), 580 nm (yellow), 600 nm, 620 nm (yellow-red), and 630 nm (red) light. As intensities of 560-620 nm light were increased to levels about that of bright moon light, hatchlings moved away from the lighted window. This aversion held for higher intensities of light in the yellow region of the spectrum. Loggerhead hatchlings show the same aversion to yellow light (xanthophobia) in experiments on beaches with yellow (590 nm) LPS lighting (Witherington and Bjorndal, 1991). Green turtles, hawksbills, and olive ridley hatchlings do not exhibit this response (unpublished data).

I found this aversion response to be additive. White light becomes more attractive to loggerhead hatchlings (more likely to attract hatchlings away from another light source, or the ocean) with increasing light intensity. As a white light source is enriched with yellow light from a LPS source, increasing the combined source intensity, it becomes less attractive to loggerhead hatchlings. This effect requires high levels of yellow light relative to white light (30:1 to 90:1, measured in lux), to sufficiently reduce attraction so that hatchlings are not misdirected away from the ocean.

A number of models link sea-finding in hatchling sea turtles to brightest direction orientation (Mrosovsky and Kingsmill, 1985; Verheijen and Wildschut, 1973). In fact, under controlled conditions, barring the special case for yellow light in loggerheads, sea turtle hatchlings are positively phototropotactic (i.e., they orient and move in the brightest direction). On natural beaches at night, my light measurements (across the visible spectrum and UV, and with varying angles of acceptance of the detector) indicate that the open sky over the ocean is often the brightest direction, but not always. Under conditions where the sun or moon was low on the horizon, and the azimuthal direction of these celestial bodies had the greatest influence on the brightest direction, hatchlings released during beach experiments oriented to the ocean irrespective of the brightest direction. Can hatchlings orient with respect to light cues other that brightness, and do they depend on these cues?

<u>Shape and the use of form vision</u>: To test whether loggerhead hatchlings are able to orient with respect to shape, I conducted experiments similar to those of Rhijn and Gorkom (1983). Hatchlings oriented within a half-striped (black and white), half-gray, walled arena uniformally lighted from above with 500 nm light. Each hatchling was in a harness that could pivot 360 degrees at the arena center. Thirty hatchlings were used per treatment. In the unlighted arena, orientation was random (Rayleigh test, alpha = 0.05). In four experiments, the arena was illuminated to a moderate nighttime light level, and light measurements were taken in azimuthal directions. Exp. 1: Although the black and white striped half of the arena was much brighter than the open gray area, orientation was random. Exp. 2: Conditions were identical to the previous experiment, except that light measurements were taken within, and hatchlings oriented within, a light diffusing cylinder of wax paper. Although the light field was the same as Exp. 1, hatchlings in this experiment, lacking the benefit of form vision, oriented toward the stripes, in the brightest direction. Exp. 3: Although the striped area was equal in brightness to the open gray area, orientation was highly directed, toward the open gray area. Exp. 4: Conditions were identical to Exp. 3, except that, like Exp. 2, wax paper was added. These hatchlings oriented randomly.

To test whether loggerhead hatchlings depend on form vision, I conducted experiments on a natural beach at Melbourne Beach, FL. I placed hatchling loggerheads within small, clear-acrylic cylinders placed on the beach. One cylinder remained clear, and hatchlings within the other received visual information through a layer of light diffusing wax paper, wrapped around the cylinder. On the night of the experiment, the setting moon and the brightest direction were opposite the ocean. Hatchlings in the clear cylinder (n = 30) oriented in the direction of the ocean. Hatchlings without the benefit of shape assessment in the wax paper cylinder (n = 30), oriented in the brightest direction, away from the ocean.

Solutions: To prevent hatchling mortality due to lighting on developed beaches, the primary tactic is to eliminate distractive lighting. Lighting not eliminated should be reduced by using LPS, lowering luminaires, shielding them, and directing them away from the beach.

The above tactics, however effective when implemented, are often precluded by real world scenarios. Delray Beach received much press in 1990 when loggerhead hatchlings were misdirected away from the ocean, toward heavily lighted Highway A1A, and were crushed by cars. To correct the problem, the city replaced luminaires lining Highway A1A with LPS lighting. But hatchlings continued to appear on the highway. I visited Delray in September and conducted some loggerhead hatchling release experiments. With highway LPS luminaires lighting the beach, hatchlings (n = 30) were misdirected toward the southwest, away from the ocean (which was to the east). With the LPS luminaires off, hatchlings (n = 30) were similarly misdirected; the direction of hatchling travel was not significantly different among LPS-on and LPS-off treatments (Watson U^2 test, $P>0.05$). In both cases, the light responsible for misdirecting the hatchlings originated from the thousands of luminaires contributing to the sky-shine, or glow, over the city of Delray Beach.

The effects of non point-source photopollution, as in the Delray example, are logistically difficult to remedy. Apart from reducing lighting as much as possible and substituting LPS light for remaining lighting, an additional tactic may be to enhance dune profile and structure. Because orienting hatchlings assess shape cues and are at least partially dependent on them, this tactic may improve hatchling orientation on lighted beaches. Workers on lighted beaches have shielded the dune side of emerging nests and seen improved hatchling orientation out of the nest, but it is uncertain whether proper orientation is maintained. An appropriate measure on a larger scale may be to enhance the natural vegetation and elevation of the dune. The prospects of these approaches are in further need of careful field study.

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LITERATURE CITED

Carr, A. and Ogren, L. 1960. The ecology and migrations of sea turtles. V. The green turtle in the Caribbean sea. Amer. Mus. Nat. Hist. Bull. 121:1-48.

Mrosovsky, N. and Kingsmill, S. F. 1985. How turtles find the sea. Z. Tierpsychol. 67:237-256.

Rhijn, F. A. van and Gorkom, J. C. 1983. Optic orientation in hatchlings of the sea turtle, Chelonia mydas. III. Sea-finding behaviour: the role of photic and visual orientation in animals walking on the spot under laboratory conditions. Mar. Behav. Physiol. 9:211-228.

Verheijen, F. J. and Wildschut, J. T. 1973. The photic orientation of sea turtles during water finding behaviour. Neth. J. Sea Res. 7:53-67.

Verheijen, F. J., 1985. Photopollution: Artificial light optic spatial control systems fail to cope with. Incidents, causations, remedies. Exp. Biol. 44:1-18.

Witherington, B. E., and K. A. Bjorndal. Spectral characteristics of hatchling sea turtle phototaxis with implications for sea-finding behaviour. Copeia: In press.

Witherington, B. E., and K. A. Bjorndal. 1991. Influences of artificial lighting on the seaward orientation of hatchling loggerhead turtles (Caretta caretta). Biol. Conserv. 55:139-149.

COMPARISONS OF OXYGEN UTILIZATION BY HATCHLING LOGGERHEADS, GREENS AND LEATHERBACKS DURING THE SWIMMING FRENZY: SPRINTING vs. MARATHON STRATEGIES REVISITED

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INTRODUCTION

Hatchling sea turtles undergo a period of hyperactive swimming, known as the "frenzy," which starts immediately after they first enter the water. During the "postfrenzy" period which follows the frenzy period, the species diverge in activity patterns and in their intensity of swimming. The reasons for divergence are unknown. Previous studies of swimming activity have shown that the swimming frenzy of loggerhead, green and leatherback hatchlings lasts an average of one day (Salmon and Wyneken, 1987; Wyneken and Salmon, in press). After 24 h in the water, hatchlings reduce the proportion of the dark period spent swimming. Green and loggerhead hatchlings switch to a diurnal schedule of swimming activity while leatherback hatchlings swim both diurnally and during 15-40% of the nocturnal period. The efficiency of swimming (metabolic costs) during the frenzy and postfrenzy were examined to expand our understanding of the proximate costs to each species. I discuss the implications of energetic differences to species-specific activity patterns.

METHODS

The efficiency of swimming during early (frenzy) and routine (postfrenzy) activity was described by measuring oxygen consumption ($V_O{}^2$) during frenzy and during postfrenzy swimming and resting. The values were then compared over time within each species and among species. Oxygen consumption was measured as hatchlings, tethered to the center of the respirometer by a nylon-lycra harness, swam in 23-25° C sea water. The volume of oxygen consumed per unit time was then scaled to body mass. Statistical comparisons were made using two-way analysis-of-variance and post hoc Tukey comparisons (Zar, 1984).

RESULTS

Oxygen consumption was highest during the frenzy, lowest during resting and intermediate during postfrenzy swimming activity. Over the course of the frenzy (24 h) oxygen consumption was highest at the start then slowly dropped to a rate similar to that seen during routine (postfrenzy) swimming. Comparisons among species showed that hatchling green turtles had the greatest aerobic scope (used greatest amounts of oxygen above resting) during the frenzy, loggerheads were intermediate in their scope and leatherbackhatchlings had the lowest aerobic scope. When species-specific swimming speeds were taken into consideration there were significant correlations between (i) $V_O{}^2$ and swimming speed and (ii) $V_O{}^2$ and stroke rate. Green turtle hatchlings are the fastest swimmers, use the fastest flipper stroke rates and consume the most oxygen per unit time per gram body weight. Loggerheads are intermediate in both categories and leatherback hatchlings (the slowest swimmers) use the slowest powerstroke rates while consuming the least oxygen. Calculations of the "cost of transport" (metabolic rate scaled by swimming speed) showed surprisingly little difference between green and loggerhead hatchlings. However, the cost of transport for leatherback hatchlings was as much as 20% lower than that of the cheloniids during the frenzy.

DISCUSSION

Green turtles (the fastest swimming hatchlings) use the fastest powerstroke rates and have the highest metabolic rates during the swimming frenzy. After the frenzy, they become diurnally active and remain relatively immobile during the nocturnal period. Loggerhead hatchlings are intermediate in their swimming speeds, stroke rates and metabolic rates. They too become diurnally active after the frenzy. Both loggerhead and green turtle hatchlings have relatively high costs of transport. Leatherback hatchlings typically use slow swimming speeds, slow stroke rates and have the lowest metabolic rates. Their cost of locomotion is consistently less than that of the cheloniids tested here. Hatchling leatherbacks are active throughout the daylight h and from 15-40% of the night (Wyneken and Salmon, in press). Because their cost of transport is low and their specialized forage (gelatinous zooplankton) is low in caloric content (Lutcavage and Lutz, 1986) they may need to swim longer in order to obtain sufficient nutrients for growth. Such a strategy is viable when the costs are low.

LITERATURE CITED

Lutcavage, M. and P. Lutz. 1986. Metabolic rate and feeding requirements of the leatherback turtle, Dermochelys coriacea. Copeia 1986:796-798.

Salmon, M. and J. Wyneken. 1987. Orientation and swimming behavior of hatchling loggerhead turtles Caretta caretta L during their offshore migration. J. exp. Mar. Biol. Ecol. 109:137-153.

Wyneken, J. and M. Salmon. Frenzy and postfrenzy swimming activity in loggerhead, green, and leatherback sea turtles. Copeia (in press).

Zar, J. H. Biostatistical Analysis. Prentice-Hall, Inc. New Jersey.

PART II. POSTER PRESENTATIONS

RETENTION RATE DIFFERENCE BETWEEN METAL AND PLASTIC TAGS ON THE BLACK TURTLE OF MICHOACAN

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To evaluate the retention time of plastic and metal tags, 306 black turtles were double tagged (one plastic on the left hindflipper and one monel tag on the left foreflipper) at Colola beach in 1985, 1986, 1988 and 1989. Tags were of two types: monel size -19 tags (National Band and Tag Co., USA) and plastic (41 mm x 35 mm, Allflex Tag Co., USA). Of 175 nesting turtles double tagged in 1985 and 1986 combined, 146 were seen again at least once during the nesting season. Tag losses were 44.0 % for metal tags and 2.8 % for plastic tags. The difference in performance was significant (chi square = 32, 1 d.f., $p < 0.001$). Seventeen of the turtles double tagged in 1985 and 1986 were documented nesting again between 1986 and 1989. The total loss of tags from turtles returning after 1 - 4 years absence was 16/17 (94.1 %) for metal tags and 0/17 (0.0 %) for plastic tags. In 1988 and 1989 a total of 131 turtles were double tagged with metal and plastic tags applied to both foreflippers and hindflippers with flipper placement selected randomly. Of the 131 turtles, 113 were observed again at least once during the season. The number of tags lost for 1988 and 1989 combined was 33 (29.2 %) for metal and 6 (5.4 %) for plastic. The difference in performance was significant (chi square = 17.3, 1 d.f., $p < 0.001$). The difference in loss rate between the four flippers was not significant for the metal or plastic tags. The results of double tagging indicate that independent of the flipper selected for tag application, plastic tags are retained better than monel tags by the black turtles in the East Pacific.

STUCK ON TURTLES: PRELIMINARY RESULTS FROM ADHESIVE STUDIES WITH SATTELITE TRANSMITTERS.

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The role of satellite telemetry in the investigation of sea turtle ecology is growing rapidly. Because of the high cost of transmitters, attaching a Platform Transmitter Terminal (PTT) to a turtle quickly, safely, and firmly is of primary concern to researchers. This eighteen month study at Sea World - California was undertaken in order to fulfill specific needs of researchers attaching PTTs to hard-shelled sea turtles while on board a research vessel which is underway. Primary objectives were to devise a method of attachment that: 1) involves a short application and curing time for quick release of the turtle near the point of capture, 2) is not chemically/mechanically harmful to the turtle or the researcher, and 3) will remain firmly attached for one year. Presented here are preliminary results and caveats for the three different methods tested on captive turtles: 1) fiberglass resin with a polyurethane molded transmitter base, 2) a two part epoxy which acted as a molded base, and 3) a light-cured resin based glass composite dental adhesive with an orthopedic fiberglass cast as a molded base. As of 26 Feb. 1991 all attachments were still secure to the turtles after 142 days. Application and curing times were: fiberglass: two hrs; Epoxy: 1 hr, 40 min; Dental Compound/Fiberglass cast: 40 min. Evaluations of the three methods and recommendations for other attachment-base combinations are discussed in detail. A modification of the dental compound/fiberglass cast was used by Beavers and Cassano on an olive ridley (Lepidochelys olivacea) in the eastern Pacific and preliminary results are encouraging.

BACKGROUND

Byles began the initial transmitter attachment study on captive-born Kemp's ridleys at Sea World - Texas using a combination of polyester resin, fiberglass and a cloth strip harness. It was soon apparent that the resin was adhering better than the harness, which was discarded. The dummy transmitter remained attached for four months. Byles attributed the earlier than hoped for shedding to the flaky build-up of keratinaceous material which often occurs on the carapacal scutes of long term captive ridleys. In this study we selected three loggerhead turtles (Caretta caretta) between 60-80 cm with relatively non-flaky carapaces. The selected turtles and their habits were known individually by the curator's staff. The daily observations by the staff enabled us to monitor any gross behavioral changes in the turtles that might be due to the attachment of the dummy transmitters. One of the drawbacks of using turtles of this size is that they each still had prominent vertebral scute spines which raised the profiles of the dummy transmitters by at least one inch. We recommend harmlessly filing the spines down, if encountered, to lower transmitter profile and reduce drag.

METHODS

Because the bottom of the PTT is flat and carapaces often aren't, it is necessary to supply a base which is molded to the carapace of the individual turtle. Each carapace is distinct, and this can cause some difficulty in deciding what base to use. Types of bases are discussed for each technique. The methods of attachment were similar for each technique: dummy transmitters were attached approximately over the second nuchal scute after the area had been lightly sanded and cleaned with acetone. In the case of the dental compound Geri-Stor, the scutes were cleaned with Dry Bond, a drying/degreasing agent.

POLYESTER RESIN & FIBERGLASS/CASTALL BASE

Polyester resin and fiberglass have been used with success by several researchers; the longest attachment to date was 10.5 months (M. Renaud, pers. comm.). Initially, we found fiberglass resin and cloth difficult to work with but it became more manageable as our experience grew. The use of fiberglass requires a pre-molded base. We pre-cast bases from polyurethane resin made by Castall Inc. using a plaster inverse mold of a turtle shell. The procedures to make the initial mold and the bases are time consuming and labor intensive (but does not affect actual attachment time). In addition, Castall is a two part mixture containing isocyanates which is a contact poison and requires at least twenty four hours to cure. Once cured, the material is inert. This type of base can be carved with a knife in the field to fit turtle and has been used successfully by Byles.

SPECIFICS

TOTAL ATTACHMENT TIME:	2.5 HOURS
SHEDDING TIME:	142 DAYS THUS FAR
SHEDDING EFFECT ON CARAPACE:	UNKNOWN
EFFECT ON TURTLE:	NO CHANGE IN BEHAVIOR OBSERVED
WEIGHT:	abt. 314 g

EPOXY

We used a two part Epoxy, Epoxy 1240, made by Yale Enterprises, San Diego, California. This expoxy compound is the type used for highway lane markers and is also used successfully by Sea World Inc. in many of their underwater exhibits. The expoxy is easy to work with. We unfortunately increased our setting time by not mixing the proper proportions correctly. We tested the heat generated by Epoxy 1240 by applying setting time by applying it first to an empty carapace and monitoring the temperature on the underside of the bone by touch.

SPECIFICS

TOTAL ATTACHMENT TIME:	1 HOUR, 50 MIN. (SHOULD BE SHORTER-1 HR)
SHEDDING TIME:	UNKNOWN; 142 DAYS THUS FAR
SHEDDING EFFECT ON CARAPACE:	UNKNOWN
EFFECT ON TURTLE:	NO CHANGE IN BEHAVIOR OBSERVED
WEIGHT:	abt. 350 g
STRENGTH:	SHEAR: 3000 psi (aluminum-aluminum)

DENTAL COMPOUND / FIBERGLASS CAST BASE

We used a two part, light-cured resin based glass composite dental adhesive: Geri-Stor, made by DenMat Corp., Santa Maria, California in conjunction with a base of polyurethane impregnated fiberglass casting tape, Scotchcast Plus, made by 3M Corp., St. Paul, Minnesota. Geri-Stor appeared to be the solution to a quick adhesion time (it will cure in darkness in eight minutes), and a very little (6 oz) was sufficient for PTT attachment. However it did not adhere to the PTT housing (Lexan) and so a base was necessary. The Scotchcast Plus worked well as a base. Essentially it is a polyurethane impregnated fiberglass bandage and will set in about three minutes if it is immersed in 70^{o} F water and squeezed. Setting time can be lengthened by using colder water. It must be allowed to dry completely before placing it in the ocean and this can add considerable time to the attachment process. If electricity is available in the field, a hair dryer can be used after thirty minutes.

SPECIFICS

TOTAL ATTACHMENT TIME:	40 MIN. (CAN TAKE LONGER WITH CASTING TAPE)
SHEDDING TIME:	UNKNOWN
SHEDDING EFFECT ON CARAPACE:	UNKNOWN
EFFECT ON TURTLE:	NO CHANGE IN BEHAVIOR OBSERVED
WEIGHT:	abt. 342g
STRENGTH:	SHEAR: 1600 psi (to dentin)
PRESSURE:	TESTED TO 220'

ATTACHMENT CONCLUSIONS AND RECOMMENDATIONS

Each method had positive qualities and some drawbacks. Based on our experiences, Beavers and Cassano chose to use the dental compound, Geri-Stor, over the fiberglass/resin and epoxy when tagging a turtle at sea.

Fiberglass resin has proven successful in the field for 10.5 months. CAVEAT: The primary drawbacks of polyester resin and fiberglass are that it has a long curing time, can be difficult to work with, the curing is harmful, and requires an additional base be made to properly fit the turtle. The process of base making currently used is potentially harmful to humans and very time consuming. RECOMMENDATION: may not be very useful in studies where attachment time is a limiting factor but has worked well for beach attachment. We recommend a different material for a base with this method: Thermoplast molding plastic can be molded to fit individual turtles and sets instantly. Its drawback is that it requires 142^{o} F water for softening. Thermoplast has not been tested on a turtle.

Epoxy was simple to work with and can have a relatively short attachment time. CAVEAT: Epoxy will set within 20 minutes but may remain tacky for up to 8 hours (we returned the turtle to the pool while the epoxy was still tacky and have had no problems), is relatively heavy, is harmful before curing, and generates some heat. RECOMMENDATIONS: We have no recommendations at this time in the study.

The Dental compound met our objectives of rapid attachment time and is non-toxic. We were impressed by the bond between the casting tape base and the carapace considering the small amount that was used. The compound would work well for beach attachment at night. CAVEAT: Curing time is very fast and leaves no room for errors. It is also dependent on a base material. Casting tape was a bit bulky. RECOMMENDATIONS: Thermoplast may work as a base, though it hasn't been tested. Some other light epoxy such as Ten-O-Set can be used to smooth edges flush to turtle.

We are continuing to monitor the condition of each of the adhesives at Sea World - California on a weekly basis and plan to report our findings in the Marine Turtle Newsletter upon completion of the study. At that time any dummy transmitters still attached to the turtles will be removed. Results of the field tracking study will be written up by Beavers and Cassano and submitted for publication by a refereed journal at a later date. A study to examine the amount of drag added to a sea turtle by a PTT is planned for March 1991.

FIELD TECHNIQUE

Since Geri-Stor adhered so well to both carapace and casting tape during the study attachment, we (Beavers and Cassano) felt that it was the best of the methods investigated to apply to field (shipboard) conditions. To eliminate the bulkiness of the backpack-base we wrapped the transmitter with Scotchcast Plus, leaving overhanging flaps on either side for increased surface area. We then painted it with anti-fouling paint. The PTT was attached (total time of turtle on board: 1 hour, 30 minutes) on November 26, 1990 and is continuing to transmit. We experienced some attachment problems in that too much Geri-Stor was used initially and began to harden early, the result being that the PTT is built up higher than is necessary. We feel that this can be overcome with practice.

ACKNOWLEDGMENTS

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FIBROPAPILLOMAS IN GREEN SEA TURTLES

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Fibropapillomas affecting the skin and conjunctiva of green sea turtles have been recognized for over 50 years. As the population of this endangered species decreases due to loss of habitat and drownings in shrimp nets, diseases represent a further complication for saving the turtles. Over the past seven years, over 50% of stranded green turtles have been affected with massive cutaneous fibropapillomas of ruminants. Ultrastructural evaluation of tumors and Southern blot analyses of DNA extracted from tumors have failed to demonstrate any evidence of a papillomavirus etiology, as would be expected for ruminants. Recently, several cases have had epidermal cytopathology consistent with a herpes virus infection. This has been confirmed with ultrastructural evaluation of affected areas. Transmission studies using tumors that did not have an active herpes virus infection were not successful. Isolation and molecular characterization of the herpes virus are in progress.

DIET OF GREEN TURTLES (Chelonia mydas) IN THE WATERS OF LONG ISLAND, N.Y.

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Although most green turtles (Chelonia mydas) in the eastern U.S. inhabit southeastern states, small numbers regularly occur as far north as Long Island, N.Y. At 41° N latitude, Long Island's waters are warm enough to support green turtles from June through October.

During our investigations of the biology of Kemp's ridleys, loggerheads and leatherbacks in Long Island, we have captured dozens of green turtles in the area. Green turtles represent about 10% of the sea turtles encountered during our research. One of the early questions regarding green turtle occurrence in the area was: Are the green turtles in Long Island able to feed and emigrate, or are they incidental stragglers outside of their normal range? By examining diet composition, growth rates and movements of green turtles we believe we now have a glimpse into the role of Long Island in the life histories of the green turtles found there.

Ninety percent of the green turtles in Long Island are between 25 and 40 cm standard carapace length, with the largest being 68 cm. Of 25 juvenile green turtles captured to date, fecal samples were collected from nine individuals and intestinal tract contents were preserved from two. Most had algae in their samples, but a large percentage had consumed the seagrass Zostera marina (Figure 1). Various genera of algae were consumed by the turtles (Figure 2), and many turtles had two or three genera in their samples. Zostera marina and algae occurred together in 45% of the samples.

Although mollusks, crabs, synthetics and natural debris (pebbles) occurred in the samples, the type and amount present indicated incidental ingestion. Algae and Zostera marina appeared to be the main diet items of the turtles, both by the percent of green turtles that had consumed them and by qualitative assessment of the amount of these items in each sample.

Three of the eleven turtles from the diet study were recaptured and remeasured, with intercapture intervals ranging from 21 to 82 days. Two of the three turtles showed gains in length and weight, while the third exhibited no change in length and lost weight (Figure 3, Figure 4). A fourth recaptured green turtle (not remeasured) was caught and released by a commercial fisherman in Pamlico Sound, N.C. The turtle's movement covered a distance of over 700 km. The capture in Pamlico Sound occurred as water temperatures in Long Island were nearing cold-stunning temperatures.

We believe these data indicate that some percentage of the green turtles in Long Island are feeding, growing and emigrating successfully. Long Island, therefore, should be considered within the range, possibly the edge of the range, of the green turtle, Chelonia mydas.

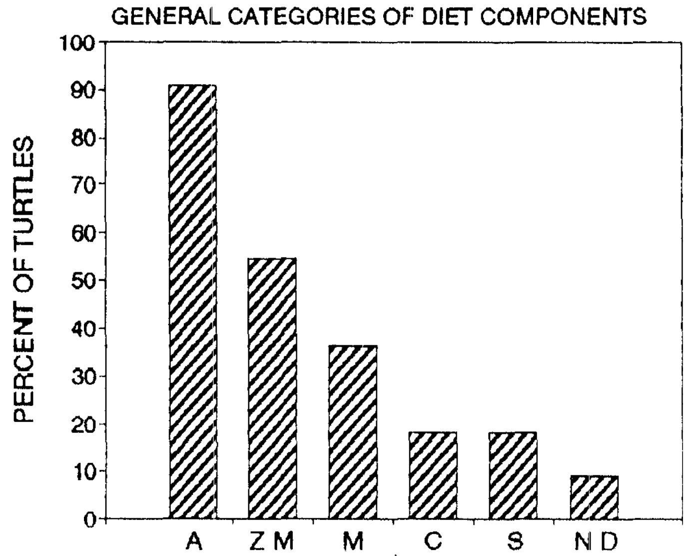

FIGURE 1. Percent of green turtles that consumed each of the general categories of diet items. Items represented are: Algae (A), Zostera marina (ZM), Mollusks (M), Crabs (C), Synthetics (S), and Natural Debris (ND).

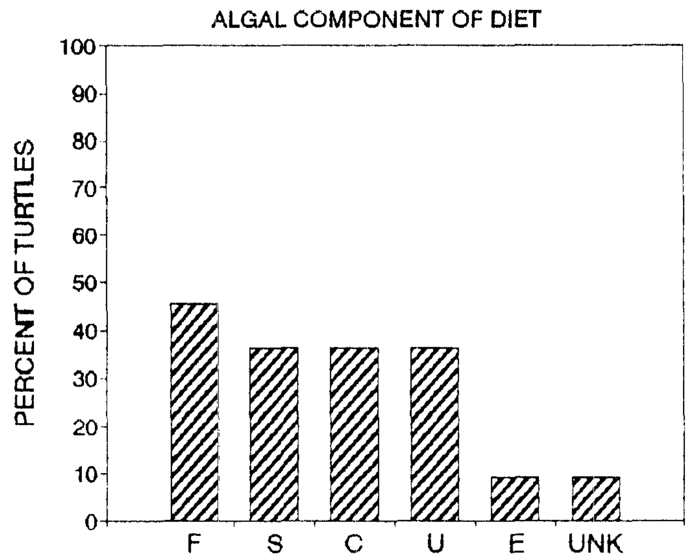

FIGURE 2. Percent of green turtles that consumed each of the various algal genera. Genera represented are: Fucus (F), Sargassum (S), Codium (C), Ulva (U), Enteromorpha (E), and unknown species (UNK).

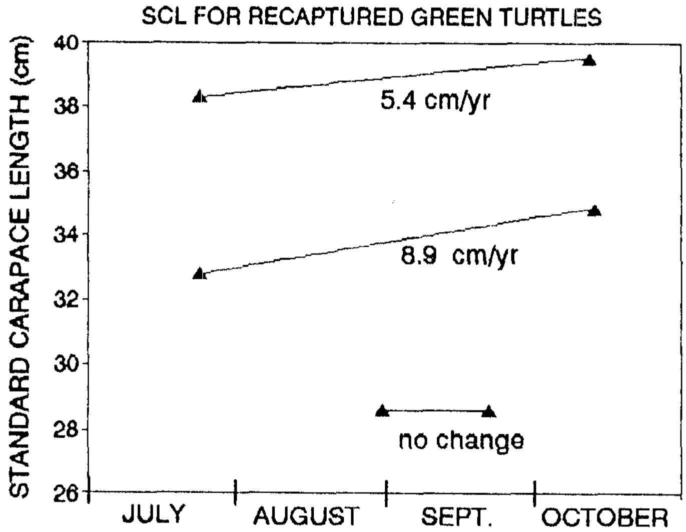

FIGURE 3. Length changes for three recaptured green turtles from the diet analysis study. X axis is the capture date. Triangles represent original and recapture SCLs. Annual rates are shown for each turtle.

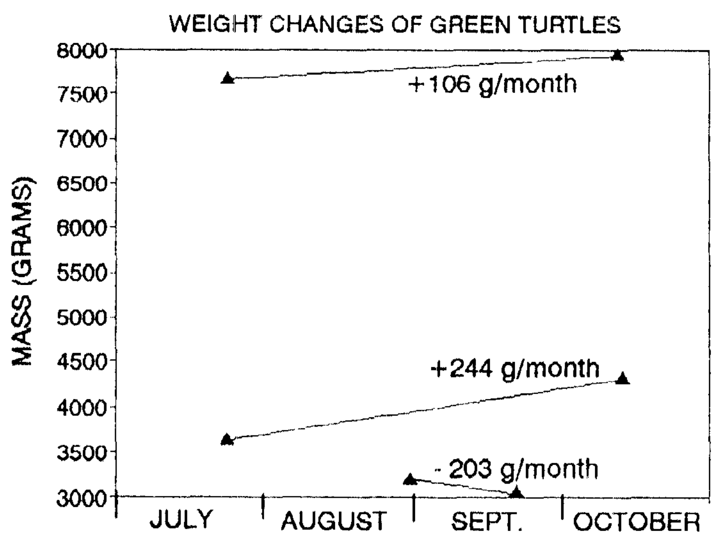

FIGURE 4. Weight changes for the three green turtles shown in Figure 3. Triangles represent original and recapture weights. Monthly rates are also given for each turtles.

SCANNING ELECTRON MICROSCOPY (SEM) OF LOGGERHEAD (Caretta caretta) EGGSHELL STRUCTURE.

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The ultrastructure of shells from hatched eggs of Caretta caretta was examined using scanning electron microscopy (SEM). The goals of the investigation were to contrast the structure with that reported in the literature for eggs of other sea turtle species, to observe post incubation eggshell structure, and to examine the qualitative effects of embryonic use of shell resources. The structure and composition of sea turtle eggs have been characterized by a number of investigators, with a variety of approaches and foci. Solomon and Baird (1976, 1977) contrasted morphology and biochemistry of oviducal and oviposited eggs of Chelonia mydas. Crystalline arrangements in farmed and wild C. mydas eggs were described by Baird and Solomon (1979). Eggshells of Dermochelys coriacea were examined for crystal morphology (Solomon and Watt, 1985) and resistance to fungal penetration (Solomon and Tippett, 1987). Packard et al. (1982) observed the gross structure of Caretta caretta eggs. These and other scanning electron microscope studies have provided information on egg morphology. Earlier work by Simkiss (1967) and Bustard et al. (1969) yielded data on calcium content in various egg compartments. The present study was a preliminary step toward a synthesis of morphology, composition, and function in sea turtle eggshells.

Eggshells from hatched clutches of Caretta caretta were collected and frozen within 12 hours of hatchling emergence. In addition one whole egg found in a hatched clutch and determined to be non-viable was collected. It contained a fully developed embryo that had failed to pip. All shell materials used from this egg are referred to as "non-viable, full-term" eggshell (N.F. eggshell). Shell sections were air-dried and mounted in various orientations on aluminum stubs with double-stick tape or colloidal graphite. The specimens were sputter-coated with gold/palladium and examined using a Hitachi S-450 scanning electron microscope, operated at an accelerating voltage of 20kV; photographs were taken with Polaroid Type 55 positive/negative film.

The basic eggshell structures were observed for both hatched and N.F. eggshells. The external calcium carbonate layer is attached to the fibrous membrane testacea or soft shell membrane. The points of attachment are the mammillae, protein cores that serve as nucleation sites for crystals as the eggshell is being formed. A smooth boundary layer, composed of mucopolysaccharides called glycosaminoglycans, lines the inner surface of the testacea. Caretta caretta eggs closely follow the patterns of sea turtle eggshells described by other investigators; the following points are worthy of special mention.

Both tabular calcite and spicular aragonite forms of calcium carbonate were reported in the eggshells of Chelonia mydas by Baird and Solomon (1979). Dermochelys coriacea eggshells contain both morphs as well (Solomon and Watt, 1985). In this study of C. caretta only aragonite crystals were observed, however, the degraded and depleted condition of the shell precludes the elimination of calcite as part of the structural unit.

Solomon and Baird (1977) observed both random and parallel fiber arrangements in the testacea of Chelonia mydas. The same was found in C. caretta. Presence of both these arrangements may indicate changes in the rotational pattern of the egg in utero as the fibers are laid down.

Pore structures observed on the inner boundary membrane have not been described in sea turtle eggs. Schleich and Kastle (1988) diagrammed a similar pore from Terrapene carolina. Solomon and Reid (1983) and Solomon and Watt (1985) noted that well-developed trans-shell pores like those in the calcitic shells of the Nile crocodile are unnecessary in aragonitic shells since the looser structure permits gas diffusion. Further investigation may elucidate the extent and function of the observed membrane openings.

Simkiss and Wilbur (1988) described mammillary cores in vertebrate eggs and the manner in which crystals emerge from them. The mammillary cores observed in the hatched eggshells were almost entirely lacking in emergent crystals. Dissolution of the core crystalline plugs (which provide a foundation for nodule or shell unit development) as calcium is mobilized for embryonic development may account for the characteristic sloughing of outer calcareous material in hatched shells.

LITERATURE CITED

Baird, T., and S.E. Solomon. 1979. Calcite and aragonite in the egg shell of Chelonia mydas L. J. Exp. Mar. Biol. Ecol. 36:295-303.

Bustard, H.R., K. Simkiss and N.K. Jenkins. 1969. Some analyses of artificially incubated eggs and hatchlings of green and loggerhead sea turtles. J. Zool. 158:311-315.

Packard, M.J., G.C. Packard, and T.J. Boardman. 1982. Structure of eggshells and water relations of reptilian eggs. Herpetologica 38:136-155.

Schleich, H.H. and W. Kastle. 1988. Reptile egg-shells: SEM Atlas. Gustav Fischer Verlag, Stuttgart.

Simkiss, K. 1967. Calcium in reproductive physiology. Reinhold Publishing Corp., New York.

Simkiss, K. and K. M. Wilbur. 1988. Biomineralization: Cell biology and mineral deposition. Academic Press, Inc. San Diego.

Solomon, S.E. and T. Baird. 1976. Studies on the egg shell (oviducal and oviposited) of Chelonia mydas L. J. Exp. Mar. Biol. Ecol. 22:145-160.

Solomon, S.E. and T. Baird. 1977. Studies on the soft shell membranes of the egg shell of Chelonia mydas L. J. Exp. Mar. Biol. Ecol. 27:83-92.

Solomon, S.E. and J. Reid. 1983. The effect of the mammillary layer on eggshell formation in reptiles. Animal Technology 34:1-10.

Solomon, S.E. and R. Tippett. 1987. The intra-clutch localisation of fungal hyphae in the eggshells of the leatherback turtle, Dermochelys coriacea. Animal Technology 38:73-79.

Solomon, S.E. and J.M. Watt. 1985. The structure of the eggshell of the leatherback turtle (Dermochelys coriacea). Animal Technology 36:19-27.

EMERGENCE OF HATCHLING LOGGERHEAD SEA TURTLES (Caretta caretta): TEMPERATURE AND TIME OF DAY

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INTRODUCTION

Hatchling sea turtles generally emerge from their nests by night (Hendrickson 1958, Bustard 1967, Mrosovsky 1968). However, little is known about the mechanism of nocturnal emergence. Hendrickson (1958) suggested that during the day heat inhibits activity and keeps the hatchlings below the surface until the sand cools off in the evening. This is supported by Mrosovsky (1968) who found that hatchling green sea turtles (Chelonia mydas) in Surinam generally become lethargic at temperatures above about 28.5 C. The surface sand temperature in Surinam is usually above this level during the daytime. This is also supported by Witherington et. al. (1990).

METHODS

Data on emergence times of loggerhead sea turtle hatchlings and the effect of temperature on their locomotor activity were collected at a turtle hatchery on Little Cumberland Island, Georgia in 1987 and 1988. Natural emergence times were correlated with temperature. Time of emergence was defined as that time at which the first hatchling or hatchlings breached the sand surface. Usually, when one hatchling emerged many others soon followed. Copper-Constantan thermocouples (TP-10 with WTW-26 wire, Sensortek, Inc., or NMP plugs with TYPE T-24 wire, Omega Engineering) were buried 2 cm below the sand surface at various locations throughout the hatchery and read with a BAT-12 digital thermometer (Sensortek, Inc.). For relating temperature to emergence of a particular nest, the reading from the thermocouple nearest that nest was used. These were always within 3 m of the nest (62% < 1.5 m).

Temperature was experimentally manipulated and locomotor activity of hatchlings measured. In 1988, for each of 12 replications, 30 hatchlings were taken from a single clutch as they emerged and randomly divided into six groups. Each group was placed in one of six 10-gallon aquariums filled with freshwater to a height of 15 cm. The water was heated with submersible aquarium heaters. Thermocouples were used to measure water temperature. Temperature in the aquariums ranged from 23.2-32.6^{o} C. The hatchlings were left in the aquariums for 30-60 minutes after which they were placed down individually on the floor 90 cm from a 7.5 W unshaded light bulb, which was the only source of light in the room. The distance traversed toward the light within one minute was recorded.

RESULTS

Hatchlings emerged earlier in the evening in 1988 than in 1987 (Mann-Whitney U; Z= -3.09, $P < 0.01$) (Fig. 1). This may be explained by the fact that there was a significant difference in surface sand temperature in the hatchery between 1987 and 1988. Between 3 August and 6 September, means of temperature readings at 1400 h for each week were higher in 1987 than in 1988 (Paired t-test, two tailed; t= 2.40, df= 40.025 < $P \leq$ 0.05). However, the temperature of the sand from which the hatchlings emerged was similar in both years; in the 23.6-29.6^{o} C range (Fig. 2). Usually, but not invariably, emergence occurred soon after the temperature fell with this range (Fig. 3). On the evening of emergence, speed significantly decreased with increasing temperature (Simple Linear Regression; F= 20.10, df= 80.0001 < $P \leq$ 0.005) (Fig. 4).

DISCUSSION

Most hatchling loggerheads in this study emerged within a four hour time span; 2100-0100 h. This agrees with the reports of nocturnal emergence for this and other species of sea turtles already cited in the introduction.

Several points support the view that nocturnal emergence of hatchlings is controlled by warm temperatures inhibiting activity: (1) Emergences were earlier in 1988, when conditions in the hatchery were cooler, (2) Activity as measured by speed decreased steeply as a function of increasing temperature, (3) The temperature range over which this decrease occurred was roughly coincident with the temperature range at which hatchlings emerged. At the upper end of this range, the hatchlings moved very slowly in the activity tests. At > 31^{o} C the hatchlings were virtually inert.

CONCLUSION

These data quantify nocturnal emergence for loggerhead sea turtles and provide evidence for the importance of temperature as a mediating factor in emergence.

ACKNOWLEDGEMENTS

I would like to thank the Little Cumberland Island Association for allowing me to work on Little Cumberland Island. I am especially grateful to Rebecca Bell, Nicholas Mrosovsky, and James I. Richardson for their encouragement and support. Financial support came from the Natural Sciences and Engineering Research Council of Canada to Nicholas Mrosovsky.

LITERATURE CITED

Bustard, H.R. 1967. Mechanisms of nocturnal emergence from the nest in green turtle hatchlings. Nature 214: 317.

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

Mrosovsky, N. 1968. Nocturnal emergence of hatchling sea turtles: Control by thermal inhibition of activity. Nature 220: 1338-1339.

Witherington, B.E.; K.A. Bjorndal; and C.M. McCabe. 1990. Temporal pattern of nocturnal emergence of loggerhead turtle hatchlings from natural nests. Copeia 1990 (4): 1165-1168.

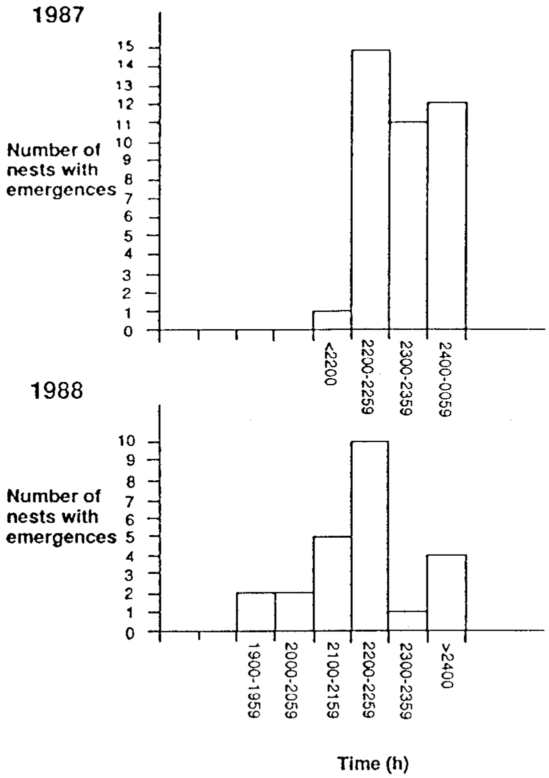

Figure 1. Frequency of emergence of loggerhead turtle nests in relation to time in 1987 and 1988.

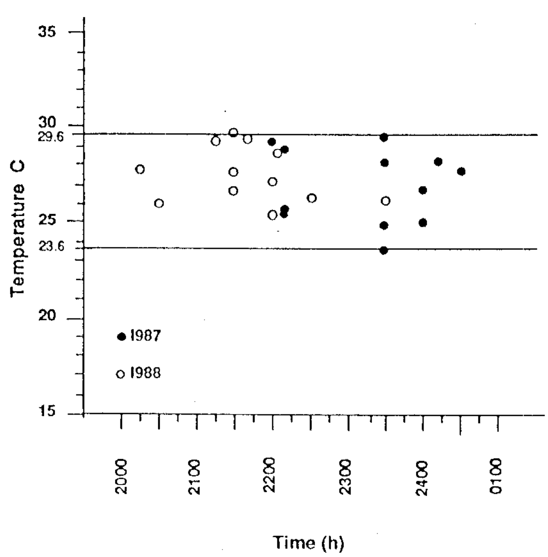

Figure 2. The temperature of the sand (2 cm depth) at the time when hatchlings emerged. Horizontal lines show temperature range for emergence.

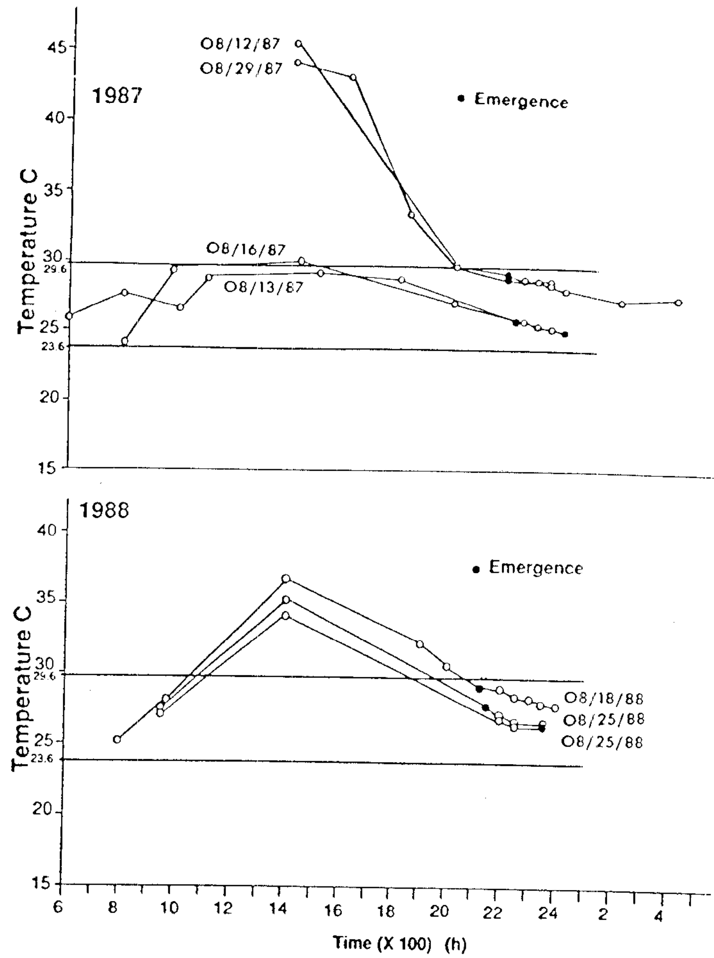

Figure 3. Daily sand temperature profiles (2 cm depth) near seven nests during parts of the day prior to emergence from those nests.

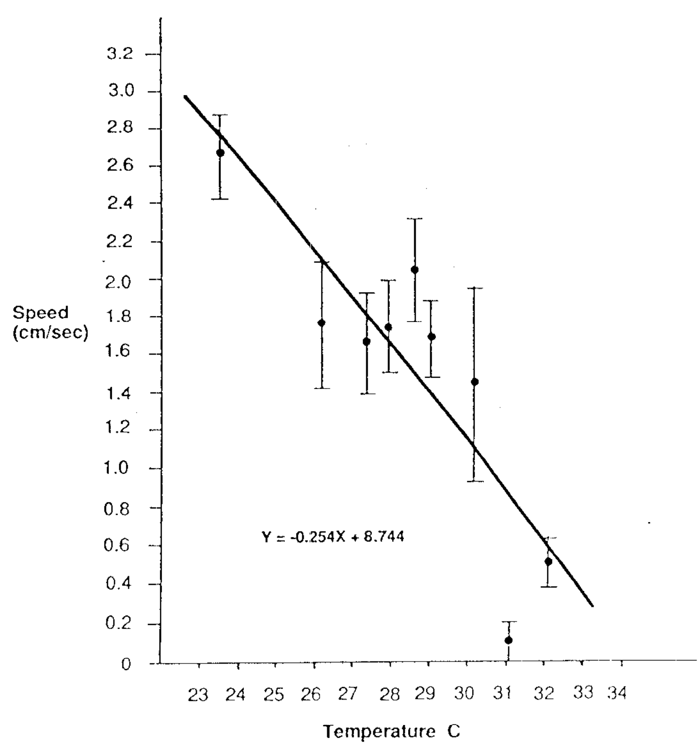

Figure 4. Relationship between hatchling speed and temperature (Mean + SE).

SUMMARY OF DREDGING IMPACTS ON SEA TURTLES: KING'S BAY, GEORGIA AND CAPE CANAVERAL, FLORIDA

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Five threatened and endangered species of sea turtles occur along the Gulf and Atlantic Coasts of the United States, and are potentially affected when channels are periodically maintained by hopper dredging activities. The activities of sea turtles associated with these ship channel habitats are virtually unknown. The National Marine Fisheries Service (NMFS) has determined, based on the best available information, that because of their life cycle and behavioral patterns only the loggerhead (Caretta caretta), the green (Chelonia mydas), and the Kemp's ridley (Lepidochelys kempi) are potentially put at risk by dredging activities (Studt 1987).

Mortalities or injuries of sea turtles from dredging operations have only been documented on hopper dredges and primarily in two channels--Cape Canaveral Harbor, Florida, and King's Bay, Georgia. The lack of reported impacts on turtles in other channels and on other types of dredges may be a result of reduced turtle occurrences in the channel during the time of dredging, reduced potential of turtle impingement by the dredge, or a lack of monitoring during dredging.

The incidental take of sea turtles during dredging operations has been documented in the Cape Canaveral ship channel since the first study conducted in 1980 and King's Bay, Georgia, ship channel since its construction in 1988 (Table 1). During the dredging period from 1980 to 1991, 160 incidents with three species of sea turtle (loggerhead, green, and Kemp's ridley) have been reported from Cape Canaveral and King's Bay entrance channels. This included 131 incidents at Canaveral and 29 incidents in King's Bay channel.

A Sea Turtle/Dredging Task Force was formally established by the US Army Engineer District, Jacksonville in May 1981 to address the issues of dredging impacts on sea turtles. A number of management alternatives have been implemented to potentially minimize impacts to sea turtles including seasonal restrictions, rescue and relocation operations, and modified dredging equipment.

A substantial reduction in documented sea turtle mortalities since the first reported incidents at Cape Canaveral ship channel in 1980 may have resulted from these modifications in dredging equipment and operational practices. The modifications were a result of recommendations from cooperative efforts by Federal and state agencies, universities, and the dredging industry.

The Endangered Species Observer Program was established in 1980 and evolved through consultation between the NMFS and US Army Corp of Engineers, as mandated by the Endangered Species Act. Recovery, accurate identification, and documentation of sea turtle parts is a vital part in the evaluation of dredging impacts and the success of alternative dredging equipment and procedures.

Restricting dredging to a season when turtles are least abundant or least likely to be affected was one procedure implemented. For King's Bay and Cape Canaveral dredging operations, the NMFS designated September through November as the best time for dredging based on sea turtle seasonal density trends and the presence of gravid females during the summer nesting season (Henwood 1990). The winter months were excluded due to the presence of higher numbers of turtles migrating into the area from colder more northern climates. In addition, the cooler water temperatures during the winter months may cause turtles to be in a more inactive state and more susceptible to impacts. The spring and summer months were excluded because this is the breeding and nesting season for turtles and protecting nesting females is a high priority.

During some dredging projects at Canaveral Harbor, The Center for Sea Turtle Research coordinated trawling operations to capture and relocate turtles from the dredged areas of the channel. The success of these operations is uncertain; however, relocation of turtles out of the channel may be feasible when there are low densities of turtles but requires additional investigation.

Dredging equipment alternatives and modifications are being tested and show potential for reducing turtle mortalities. These protective measures are difficult to evaluate because of the number of potential variables (i.e. dredge size, speed, and temporal differences) and previous inconsistencies in monitoring techniques.

Changing the type of draghead used on the hopper dredge from an IHC-style to a California-style may have been the most effective operational change used for reducing turtle mortalities. The design and upright positioning of the IHC-style draghead may cause its suction opening to act like a scoop, while the California-style draghead sits level in the sediment and appears to be less likely to entrain turtles (Studt 1987)

Various designs have been tested since 1981 of a "cow-catcher" type of turtle deflector for the draghead. Recent studies have been conducted through a combination of laboratory model tests and field application tests during dredging operations. As a result of the recent tests, designs for a flexible turtle deflector were developed which show promise of being effective in moving turtles resting on or in the sediment from the draghead. Deflecting efficiency for turtles depends on whether the deflector conforms to the contour of the sediment bottom at all times during dredging.

Further work is essential to provide the best available dredging technology and sea turtle life history information in order that a long-term management plan may be developed which most effectively minimizes sea turtle mortalities during dredging activities.

LITERATURE CITED

Dickerson, D., Nelson, D., and Banks, G. 1990. "Alternative Dredging Equipment and Operational Methods to Minimize Sea Turtle Mortalities," Environmental Effects of Dredging Technical Notes, EEDP-09-6, US Army Engineer Waterways Experiment Station, Vicksburg, MS.

Henwood, T. 1990. "An Overview of the Endangered Species Act of 1973, As Amended, and Its Application to Endangered Species/Dredging Conflicts in Port Canaveral, Florida," Proceedings of the National Workshop on Methods to Minimize Dredging Impacts on Sea Turtles, D.D. Dickerson and D. A. Nelson, Eds., Miscellaneous Paper EL-90-5, US Army Engineer Waterways Experiment Station, Vicksburg, MS.

Studt, J.E. 1987. "Amelioration of Maintenance Dredging Impacts on Sea Turtles, Canaveral Harbor, Florida," Ecology of East Florida Sea Turtles, Proceedings of Cape Canaveral Florida Sea Turtle Workshop, Feb 26-27, 1985, W.N. Witzell, Ed., National Oceanic and Atmospheric Administration Technical Report NMFS 53, Miami, FL.

Table 1. Reported sea turtle entrainment incidents by species during dredging activities from 1980 to 1991. (Adapted from Dickerson et al. 1990)

Year	C. Caretta	C. mydas	Unidentified*	Total
	Cape Canaveral Entrance Channel, Florida			
1980	50	3	18	71
1981	1	1	1	3
1984/85	3	0	6	9
1986	5	0	0	5
1988	8	2	18	28
1989/90	0	6	1	7
1991	3	4	1	8
Totals	70	16	45	131
	Kings' Bay Entrance Channel, Georgia			
1987/88**	7	1	1	9
1988	3	0	2	7+
1989	9	0	1	10
1991	3	0	0	3
Totals	22	1	4	29

*Fragments of sea turtle carcasses not identified to species. Most assumed to be C. caretta.
**Initial construction dredging at King's Bay
+Number also includes two L. kempi caught.

MARINE TURTLE NEWSLETTER / NOTICIERO DE TORTUGAS MARINAS

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The decade of the 1970's was a critical time for sea turtles, and an important time for sea turtle research and conservation activities. It was widely recognized that sea turtle populations were declining around the world. Some populations had been extirpated entirely and many others were threatened by commercial exploitation and habitat loss. In 1969, a Sea Turtle Specialist Group had been established under the auspices of the IUCN Species Survival Commission; in July 1975 all species of sea turtle were listed by the Convention on International Trade in Endangered Species (CITES). An increasing amount of attention was focused on the problem as scientists and managers around the world struggled to design and implement research and conservation programs on the basis of very limited knowledge about the biology of these long-lived marine creatures. There was no doubt that the survival prospects for sea turtles would be enhanced by the international and timely sharing of ideas and techniques.

Dr. Nicholas Mrosovsky (University of Toronto, Ontario, Canada) rose to the occasion. In August 1976 he published the first issue of the Marine Turtle Newsletter (MTN). He designed the MTN to be an informal publication which would serve the needs of a growing sea turtle research community by providing a forum to discuss emerging ideas and techniques. The charter issue opened with these editorial remarks: "Efforts are going on all over the world to save marine turtles from extinction. Marine turtles are widely distributed and their migrations take them across inter-national boundaries. These facts complicate both arriving at an understanding of their biology and devising the necessary measures for their conservation. Given this situation, the authorities at IUCN and the members of the IUCN Marine Turtle Specialist Group felt that better communication between workers in different parts of the world was needed. The aim of this Newsletter is: (1) to provide a forum for exchange of information about all aspects of marine turtle biology and conservation, (2) to alert interested people to particular threats to marine turtles, as they arise."

The Newsletter was a great success, and as the list of recipients grew so did the list of discussion topics. By the end of the decade, sixteen issues later, readers had been alerted to problems confronting sea turtles in Malaysia, the Solomon Islands, Sri Lanka, the USA, India, South Africa, Natal, Oman, Mexico, Suriname, Senegal, Ecuador, Costa Rica, Ascension Island, Reunion Island, and the Cape Verde Islands. Incidental drowning, tagging (including flipper tagging, carapace notching, and tattooing), tag loss, international trade, sonic and radio tracking, artificial incubation of sea turtle eggs, temperature and hatchling sex, growth rate and maturation, diet, captive raising of sea turtles, and the critical status of Lepidochelys kempi had been discussed. By 1980, circulation had risen to some 700 readers in 70 countries.

In November 1984, Dr. Nat B. Frazer took over as the Newsletter's second editor. He noted in his opening editorial that, "Under [Dr. Mrosovsky's] editorship, the MTN became a source document of inestimable value to all who study sea turtles --so much so that it is difficult to believe that anyone could ever hope to maintain a current understanding of sea turtle biology and conservation without regularly reading the MTN." As we enter the final decade of the twentieth century and the threats confronting sea turtles are no less alarming than they were 15 years ago, the role of the Newsletter is as important as ever. As the MTN's current editors, we strongly support the founding principles, including the Newsletter's timeliness, international scope, and free distribution. At the present time, the Newsletter is distributed to libraries, government offices, research facilities, conservation organizations, universities, inter-governmental bodies, scientists, policy-makers, donors, and interested persons in more than 120 nations and territories around the world, including 16 countries that receive it in Spanish (Table 1).

During the last three years, articles featuring the status of sea turtles in Pakistan, Mexico, Malaysia, the USA, Guyana, Sri Lanka, Barbados, Guatemala, Cyprus, Papua New Guinea, Venezuela, Turkey, the British Virgin Islands, Chile, Greece, Indonesia, Costa Rica, Colombia, the Philippines, Japan, Sumatra, Bali, Fiji, Brazil, Australia, Great Britain, and Trinidad have ensured that the Newsletter remains of "inestimable value". Many essential issues have been discussed, new organizations and campaigns have been described, and current events (CITES, TEDs, fibropapillomas) have been highlighted. A Spanish edition was introduced in July 1990, with the 50th issue of the Newsletter, and is now distributed to more than 200 readers throughout Latin America. Susana Salas is the Coordinator and production manager for the Spanish edition, which is mailed from Costa Rica, thanks to the support of the Caribbean Conservation Corporation, the Confederation of Central American Universities (CSUCA), and the Sea Turtle Program at the University of Costa Rica.

The quality of the Newsletter depends upon your literary contributions! We encourage you to share the results of your research and conservation efforts. Further, we welcome notes of general interest (conferences, literature reviews, employment), editorials on topics of current debate, and accounts of successful fund raising, public education, and/or legal campaigns. All contributions, whether literary or monetary, should be forwarded to the Editors. Thank you.

Table 1. Who reads the MARINE TURTLE NEWSLETTER? More than 1200 scientists, fisheries officers, conservationists, and other interested persons in more than 100 States and territories around the world. An asterisk (*) indicates that readers receive the Newsletter in their native Spanish.

AMERICAN SAMOA, ANGOLA, ANTIGUA, ARGENTINA*, ARUBA, AUSTRALIA, BAHAMAS, BARBADOS, BELGIUM, BELIZE, BERMUDA, BRAZIL*, BRITISH VIRGIN IS., BRUNEI DARUSSALAM, BURMA (=MYANMAR), CANADA, CAYMAN ISLANDS, CHINA, COLOMBIA*, COOK ISLANDS, COSTA RICA*, CUBA*, CYPRUS, DENMARK, DOMINICA, DOMINICAN REPUBLIC*, ECUADOR*, EL SALVADOR*, ENGLAND, FEDERAL ISLAMIC REPUBL. of COMORO, FEDERATED STATES OF MICRONESIA, FIJI, FRANCE, FRENCH GUIANA, FRENCH POLYNESIA, GERMANY, GILBERT ISLANDS, GREECE, GRENADA, GUADELOUPE, GUAM, GUATEMALA*, GUYANA, HOLLAND, HONDURAS*, INDIA, INDONESIA, IRELAND, ISRAEL, ITALY, JAMAICA, JAPAN, KENYA, KINGDOM OF TONGA, KUWAIT, LIBYA, MADAGASCAR, MALAYSIA, MARIANA ISLANDS, MARTINIQUE, MAURITIUS, MEXICO*, MONACO, NETHERLANDS ANTILLES, NEVIS, NEW CALEDONIA, NEW ZEALAND, NICARAGUA*, NORFOLK ISLAND, NORWAY, PAKISTAN, PAPUA NEW GUINEA, PERU*, PHILIPPINES, POLAND, PORTUGAL, PUERTO RICO*, REPUBLIC OF MALDIVES, REPUBLIC OF PALAU, REPUBLIC OF PANAMA*, REPUBLIC OF THE SEYCHELLES, SAINT KITTS & NEVIS, SAINT LUCIA, SAINT VINCENT & THE GRENADINES, SCOTLAND, SENEGAL, SOLOMON ISLANDS, SOUTH AFRICA, SPAIN, SRI LANKA, SUDAN, SULTANATE OF OMAN, SURINAME, SWEDEN, SWITZERLAND, TANZANIA, THAILAND, TRINIDAD & TOBAGO, TURKEY, TURKS & CAICOS ISLANDS, TUVALU, UNITED ARAB EMIRATES, USA, U. S. VIRGIN ISLANDS, URUGUAY*, VANUATU, VENEZUELA*, WESTERN SAMOA, ZIMBABWE.

DISTRIBUTION AND SPECIES COMPOSITION OF SEA TURTLES IN NORTH CAROLINA, 1989-1990.

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In June 1988 the National Marine Fisheries Service Beaufort Laboratory began a multi-year study, funded cooperatively by NMFS and USFWS, to assess the species composition and distribution of sea turtles in North Carolina. Survey methods included qualitative reporting of turtle sightings by the public, more quantitative surveys of sightings by intercept interviews of recreational fishermen and aerial surveys of Core and Pamlico Sound (Figure 1), and the hands-on approach of capturing and tagging sea turtles on the water. In 1988 a pilot project assessed the feasibility of these methods and in 1989-1990 they were fully implemented.

The public sighting program yielded 595 and 775 reports of live turtles in 1989 and 1990, respectively. The majority of sightings were in offshore waters (offshore COLREGS Demarcation Line) during the spring (March-May) and summer (June-August); in 1990 there were also a large number of fall (September-November) sightings. Sightings in offshore waters were reported year-round, and in inshore waters were reported all seasons except winter (December-February). The majority of inshore sightings were in Core and Pamlico Sounds.

The Marine Recreational Fishery Statistics Survey queried 10,869 anglers in 1989 and 10,894 in 1990; over 70% of the anglers were fishing in the Atlantic Ocean. Each year about 3% of the anglers reported sighting at least one sea turtle on their trip. In 1989, with the exception of Core Sound (8.0%) and North River (4.9%), sea turtles were sighted most frequently in the Atlantic Ocean (3.1%). In 1990, the frequency of Atlantic Ocean (3.3%) sightings was exceeded in Core Sound (5.6%), North River (3.4%), White Oak River (2 of 4 interviewed), Cape Fear River (4.0%), and Pamlico Sound (3.8%). Inshore and Atlantic Ocean sightings were reported during all months except January and February. In the Atlantic Ocean, sea turtles were sighted most frequently 3 miles or greater from shore (4.4-4.8%).

Aerial surveys revealed sea turtles in estuarine waters spring - early winter. Spring aerial surveys yielded sightings distributed mainly along the eastern edges of Core and southern Pamlico Sounds with only one sea turtle sighted in northern Pamlico Sound. Summer and fall surveys yielded sea turtle sightings along both the eastern and western edges of Core and Pamlico Sounds, but none were sighted during fall 1990. Pamlico Sound was not surveyed during the winter. In December 1989, 5 sea turtles were sighted in Core Sound (9 estimated on surface), including 3 leatherbacks (Dermochelys coriacea), but no sea turtles were sighted in January 1990. Densities of sea turtles on the surface of Core Sound were consistently higher than for Pamlico Sound, reaching a density of 0.28/km^2 in May 1989. As waters warmed, densities in Pamlico Sound increased, peaking one or two months later than Core Sound at 0.04 and 0.02/km^2 sq for southern and northern Pamlico Sound, respectively. Densities began to decrease in the fall. Fewer sea turtles were sighted during 1990 than in 1989.

The species composition of incidental catches of sea turtles reported by volunteer fishermen was similar throughout the three-year period. Most sea turtles captured were loggerheads (Caretta caretta, 71-90%) followed by greens (Chelonia mydas, 5-17%) and Kemp's ridleys (Lepidochelys kempi, 2-11%). All sizes of loggerheads were caught, but only the more common juvenile and subadult size classes were tagged.

Except for one adult green sea turtle caught behind Hatteras Island, only juvenile green and Kemp's ridleys were captured and tagged. Pamlico and Core Sound fishermen related an annual pattern of mixed-species catches (loggerheads and Kemp's ridleys) in May-early July, loggerhead only catches throughout the summer and early fall, and mixed-species catches (loggerhead, Kemp's ridley and green) again in the fall.

In summary, sea turtles were present in the offshore waters of North Carolina during all months of the year and were abundant inshore from April into December. Loggerhead, green, Kemp's ridley and leatherback sea turtles were documented occurring in both estuarine and offshore waters. In estuarine waters, sea turtles show a pattern of immigration in the spring, dispersal throughout the summer, and emigration in the late fall and early winter.

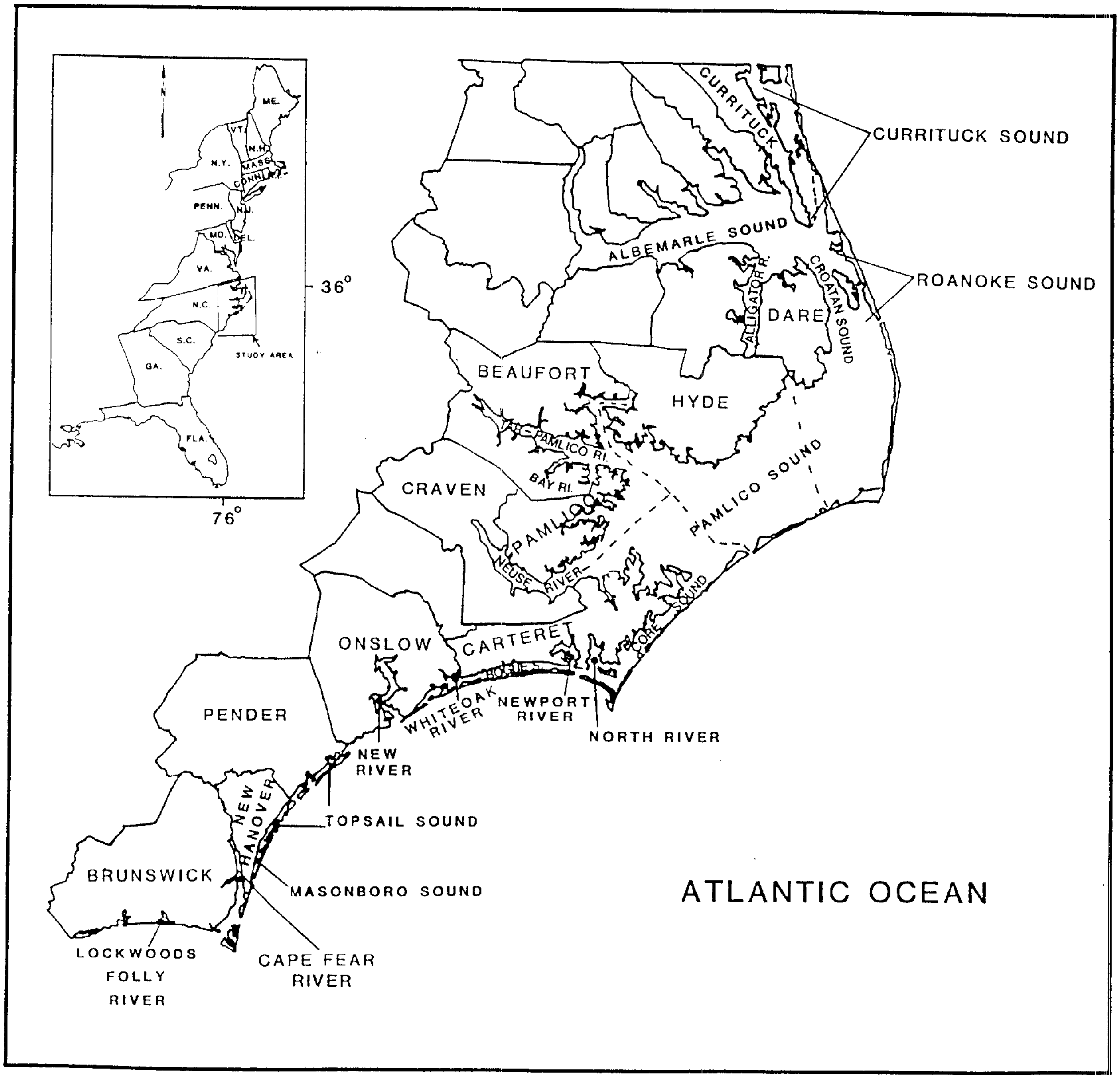

Figure 1. Coastal counties and water bodies of North Carolina

FIBROPAPILLOMA DISEASE IN GREEN TURTLES, Chelonia mydas AROUND BARBADOS, WEST INDIES.

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GREEN TURTLES IN BARBADOS

Despite the abundance of green turtles elsewhere in the Caribbean, Ligon noted that they were relatively rare around Barbados in 1647. Although adults are still rarely seen and nesting is not known in Barbados, juveniles in the range 15-40 lbs are quite common on the east and south-east coasts. There are 9 "mossy banks" (coral rubble/sand or sea grasses) where green turtles are regularly observed or netted/spearfished.

FIBROPAPILLOMA IN BARBADOS

According to fishermen who have spearfished or set nets for turtles for 15-20 years around Barbados, turtles with fibropapillomas have only been seen in the Barclays Park area. Fibropapillomas were first observed 7-8 years ago. Affected turtles are now seen more regularly and the number of tumours per turtle has increased. Green turtles in this area are typically 15-40 lbs, with a few weighing up to 100 lbs. In 1990, of 10 greens speared at Barclays Park, 9 were affected to varying degrees by fibropapilloma. Of 11 more netted at Barclays Park, 10 (all between 15-40 lbs) were affected. The only one free of the disease weighed 120-130 lbs. One fisherman noted that the minimum size of turtles on which tumours are observed is decreasing. This same fisherman, who also nets at Congor Bay and Consett Bay found all turtles caught at these locations to be free of the disease.

THE BARCLAYS PARK AREA

Offshore from Barclays Park is the only extensive area of rocky substrate along the East Coast Road. The substrate of the remainder of the nearshore strip to the north and south of Barclays Park is sand and land-derived sediments. Water depth at Barclays Park is 45 ft. Algal growth is lush and healthy, and fish are large and plentiful (e.g. barracuda, cavalli, and Spanish mackerel).

A sediment plume forms along the east coast during the rainy season (July-December). It is caused by material carried in land runoff via the Scotland District gully system. The Scotland District differs from the rest of Barbados in that the coral cap has been eroded away to reveal the sedimentary rocks that form its base. The plume originates at the mouth of Joe's River and receives input from numerous gullies. The plume drifts north and moves offshore at Pico Tenerife. The sediments around Barclays Park come from Joe's River primarily, with contributions from six other small gullies. The drainage basins of these gullies are largely composed of clays. Housing in the area is low density but sanitation is unsewered. Agriculture in this area is limited by wind and salt spray. Although sugar cane was grown in the more sheltered areas, much of the land in the vicinity of Barclays Park is now scrubland heavily overgrazed by cattle and sheep.

CAUSATIVE AGENTS OF FIBROPAPILLOMA

Fibropapillomas on green turtles from the Florida Keys were first described in 1938. More recently, fibropapillomas have been documented from Indonesia, Japan, Panama, Venezuela, Florida, California, Hawaii, the Bahamas, the Netherlands Antilles, and now, Barbados. Fibropapillomas have been found on juveniles as small as 30 cm to adults, and on both males and females. However, as is the case for cattle (see below), it appears to disproportionately affect young animals.

Herpesvirus, poxvirus, and papillomavirus have been associated with or found to be the cause of papillomas and fibropapillomas in other reptiles, in birds and in mammals. So far, studies have failed to find evidence of papillomavirus DNA or virus-like particles in tumours from green turtles. Moreover, the highly localised occurrence of the disease for 7-8 years at one location in Barbados suggests that, if virally caused, infectiousness may be low.

Additional factors are being examined as possible causes or contributing agents in the expression of the disease:

ECTO-PARASITES

Marine leeches, often found in association with fibropapillomas on green turtles, secrete hirudin which may have a stimulating effect on the growth of the tumour or affect it by improving the circulation. Leeches may act as vectors for viruses or other parasites that may be involved in the development of papillomas, or simply by breaking the skin, they may permit infection by viruses. Fibropapilloma in cattle in Barbados is particularly common along the east coast between Consett Bay and North Point. This disease affects young animals, but animals usually self-cure in 6 months to 1 year. It is associated with thin skinned breeds of cattle (e.g. Holsteins) who are more prone to tick infestation; ticks break the skin and expose cattle to infection. Where cattle are treated with insecticides, the incidence of fibropapilloma is rare. Cattle in Barclays Park are feral and rarely sprayed, and ticks and fibropapillomas are common. Veterinarians report that those cattle in which the disease does not resolve naturally are invariably from the Barclays Park area.

HEAT/RADIATION

High water temperatures and excessive solar radiation have been implicated in the activation of latent viral infections. For instance, the time of onset and the severity of gray-patch lesions in juvenile green turtles are influenced by water temperature. Such lesions could permit subsequent infection by fibropapilloma virus. Interestingly, in the context of a link between ticks and fibro-papillomas in cattle (see above), cattle and horses with dark hides (greater heat absorption) are more heavily infested with ticks than those with lighter coloured hides. Fibropapillomas in Japanese newts and renal adenocarcinoma in leopard frog both show seasonal variation, again suggesting the influence of temperature/radiation on the disease. Green turtles with fibropapillomas, which aggregate in warm water effluent in San Diego Bay, might be an interesting population to use in an investigation of the effects of temperature on fibropapilloma in this species. The temperature at Barclays Park is similar to other sites along the east coast (25.5-28.7^{o} C).

POLLUTION

Numerous cases of animals with fibropapillomas suggest that chemical pollution may activate latent viruses or indirectly increase their virulence. White suckers and brown bullhead populations inhabiting polluted areas of the Great Lakes show higher incidence of papillomas than in other areas, and a similar trend can also be observed in the distribution of Japanese newts affected by fibropapillomas. The highly localised occurrence of fibropapillomas in green turtles in Florida, Hawaii, and especially, Barbados, further suggest that pollution may be a contributing causal agent.

Sugar cane is the major crop grown in Barbados. The primary fertilizer used is a mix called 22:0:16 (nitrogen:phosphate:potassium). These days sugar cane shoots and field edges are usually sprayed with combinations of low or moderate toxicity herbicides (usually either Asulox/Actril-D or Gesapax/Gesaprim and Roundup). However, highly toxic organochlorines (e.g. DDTs, dieldrin, chlordane) and chlorophenoxys (e.g. 2,4,5-T) which are now officially banned, were still recently widely used. Preliminary examinations show that chlordane and DDT contamination of fish and sea urchin gonads is low compared to aquatic biota samples from other regions of the world, but is detectable in samples from most sites around the island. Chlordane levels were higher in samples from Barclays Park and Bathsheba than Bath, but were lower than most other sites in Barbados. Barclays Park had high levels of PCBs compared to other sites in Barbados, but again levels are low compared to most other countries. However, many of these countries have no resident turtle populations. Consequently, effects of PCBs on fibropapilloma in turtles remain largely unknown.

NEW NESTING LOCALITIES FOR SEA TURTLES IN THE SUCRE STATE, VENEZUELA

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Surveys on sea turtle nesting in the Sucre State, Venezuela, have been scattered and scarce. They are mainly from the eastern area of this state.

During terrestrial and marine surveys conducted between 1988 and 1990, seventy beaches were visited or observed from a boat. The sea turtle nesting beaches recorded are concentrated in the Peninsula of Paria, including thirteen new reported localities (Figure 1). Most of the nesting beaches in the peninsula are small (less than 100 meters in length and less than 15 meters in width). The species distribution of sea turtles in the new nesting localities is shown in Table 1.

The northern area of the Sucre State is widely used for reproduction of leatherbacks. Cipara is the most important of them and the largest beach (approximately 2 km of length).

In the southern Peninsula of Paria, the nests are strongly predated by foxes. In this area, fishermen take nesting sea turtle females and their eggs.

The Peninsula of Paria has a protected area: the Peninsula of Paria National Park (37,500 hectares), which includes three of the new nesting localities reported here. One of them, Los Garzos, is a very important nesting beach in the area for hawksbills.

We are planning to incorporate a marine area and new beaches to the National Park. This should offer integral protection to one of the main areas for sea turtle reproduction in the coast of Venezuela, one which at the same time is a focus of intensive trawler and fishing operations.

A more detailed study is needed in the Sucre State coast in order to obtain information about the numbers, composition and exploitation of the sea turtle populations.

Conservationist projects are also required because sea turtle meat, eggs, carapaces, and other products are widely used for local consumption and sale.

ACKNOWLEDGEMENTS

The 1988 and 1989 surveys were part of the "Inventory of the Sea Turtles on the Caribbean Coast of Venezuela" Project, from the Foundation for the Defense of the Nature (FUDENA). Surveys in 1990 were part of the Sea Turtle Project of the National Parks Institute (INPARQUES).

We are also indebted for their assistance to G. Medina Cuervo, and in the field to A. Acuna, I. Massa, G. Sole, N. Windevoxhel (FUDENA), G. Barreto, S. Garcia (PROFUANA-Ministery of the Environment and Natural Renewable Resources, E. Buchze, J. Canizales, A. Martinez, I. Morales, A. Reitmair and A. Vernet. Detachment of Coastal Vigilance supplied logistical support in 1990. Dr. M.G. Munoz offerred valuable comments and V. Vera drew the map.

FIGURE 1. NEW CONFIRMED LOCALITIES FOR SEA TURTLE NESTING IN THE SUCRE STATE, VENEZUELA.

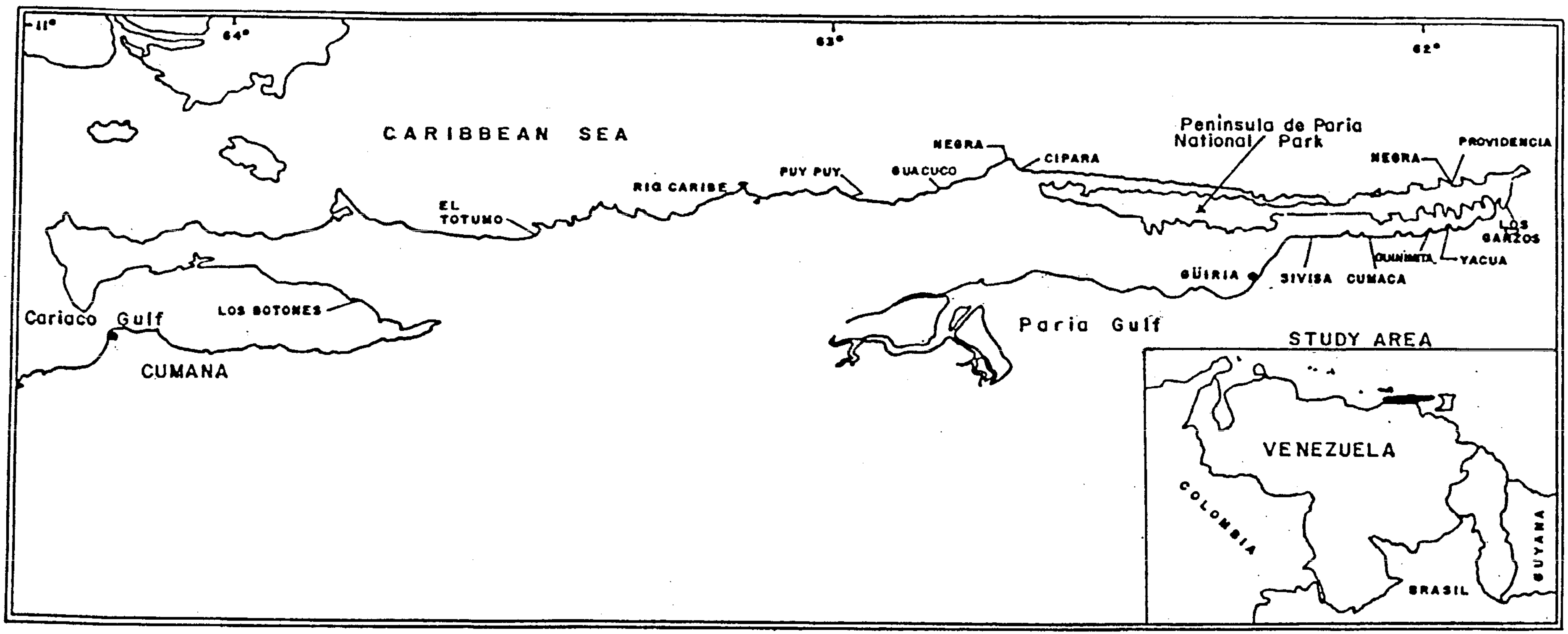

TABLE 1.- The sea turtles species in the new nesting localities in the Sucre State, Venezuela.

	SPECIES				
BEACHES	Chelonia mydas	Eretmochelys imbricata	Caretta caretta	Dermochelys coriacea	Unidentified
Los Botones				X	
El Totumo				X	X
Puy Puy		X		X	
Guacuco				X	
Negra					X
Cipara	X		X	X	
Negra			X	X	
Providencia					
Los Garzos	X	X			
Yacua	X				X
Guinimita	X				X
Cumaca					X
Sivisa					X

KEMP'S RIDLEY (Lepidochelys kempi) DISTRIBUTION IN TEXAS: AN ATLAS

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INTRODUCTION

The Kemp's ridley (Lepidochelys kempi) sea turtle has a unique history that has been widely discussed by sea turtle biologists. It is the most endangered of the sea turtles and as far as we know it has the most restricted breeding range. The primary nesting site for the Kemp's ridley is located in eastern Mexico approximately 322 km (200 mi) south of the United States border, near the village of Rancho Nuevo in the state of Tamaulipas (Hildebrand, 1963). Scattered nesting occurs to the south and north along the Mexican coast and along the southern and central coastline of Texas (Pritchard and Marquez, 1973; Werler, 1951; Carr, 1961; Fuller, 1978; Francis, 1978; Hildebrand 1963,1980; Shaver, 1988). There is one record of a nesting Kemp's ridley on the west coast of Florida (Meylan et al., 1990). Outside the breeding area, the Kemp's ridley range includes other coastal areas of the Gulf of Mexico, the east coast of the U. S. from Florida to Maine and into Nova Scotia (Pritchard and Marquez, 1973; Bleakney, 1965), and the Eastern North Atlantic along the European coast from the British Isles, Netherlands and France (Brongersma, 1972; Manzella et al., 1988). Brongersma and Carr (1983) reported one record from Malta in the Mediterranean. Two records are reported from the Madeira Islands and Western Africa (Brongersma, 1972; Fontaine et al., 1989). Distribution data is easily shown by mapping it in an atlas form. This was the suggestion, in August 1989, by a Blue Ribbon panel that reviewed the Kemp's ridley head start experiment. A comparison of distributions of head started and wild Kemp's ridleys could be used to indicate how well head started animals adjust to the wild. The panel also suggested that a distribution atlas using all available Kemp's ridley data would be helpful to the sea turtle community. Developing an atlas encompassing all known records of Kemp's ridleys requires cooperation from all researchers that have data concerning Kemp's ridleys. The present atlas, illustrating the geographic, seasonal and size distributions of Kemp's ridleys in Texas waters, is preliminary and suggests a format for a more complete atlas that would map all known records of Kemp's ridleys.

METHODS

The atlas data cover the time period from the late 1940's through April 1990. Eight hundred sixty five records of Kemp's ridleys from six sources and from the literature have been combined into one data base. The most records, 506, were from the Sea Turtle Stranding and Salvage Network (STSSN) data base that is maintained at the NMFS Miami Laboratory. Records from four data bases maintained at the NMFS Galveston Laboratory contributed 297 records including 260 recaptures of head started ridleys and 38 turtles caught incidental to fishing, rehabilitated turtles and sightings of sea turtles. The sea turtle data base at the NMFS Laboratory in Pascagoula, MS, contributed 4 records and a thorough literature search contributed 57 records dating from the late 1940's through the 1980's, including 13 reports of nesting Kemp's ridleys. Only records that were positively identified as Kemp's ridley were used; each record was double checked so none were duplicated (i.e., strandings and literature). The coast of Texas was divided into eight sections, the boundaries of which were selected for clarity in plotting. From NE to SW the maps are as follows: Section 1 - Sabine Pass/High Island Area; Section 2 - Bolivar Peninsula/Galveston Area; Section 3 - Freeport/East Matagorda Bay; Section 4 - Matagorda Bay and Peninsula; Section 5 - San Antonio Bay/Copano Bay/Matagorda Island; Section 6 - Corpus Christi Bay/Northern Padre Island; Section

7 - Central Laguna Madre/Padre Island; Section 8 - Southern Laguna Madre/Padre Island. Most of the data fall within the map section boundaries. Data that occur outside the section boundaries will be shown on complete Texas maps. Four groups of turtles are identified throughout the atlas. Wild turtles are represented with a triangle, head started turtles with a square, historical records (pre-1980) with a circle and nesters with a diamond. The historical records are comprised of wild turtles. A separate category was created because no major data base for pre-1980 reports was available and the majority of these records are from early literature. Head start tag recaptures for 1978-1979 are not included in the historical records, but are in the head start recapture records. Nesters are also wild turtles, but any nesting report in Texas was important and needed to be identified. The symbols for each category will remain constant on all maps throughout the atlas. The symbols plotted on the maps represent approximate turtle locations. When data are collected on turtle strandings, tag recaptures, sightings and incidental catches the latitude and longitude are almost always estimated.

GEOGRAPHIC DISTRIBUTION

Geographic distribution is shown on nine maps, one for each section of coastline and one map for turtles that occur farther offshore and outside the section boundaries. The maps show the distribution of the 865 available Kemp's ridley records. Head started ridleys were more numerous in sections 2, 5 and 6. Sections 5 and 6 include the areas of major releases. Wild turtles were found more frequently in sections 1, 2 and 6. Historical records show wild turtles more frequently in sections 6 and 8, and reports of nestings were concentrated in central to south Texas in sections 6, 7 and 8. Kemp's ridleys were found mostly in the offshore habitats; however, both wild and head started turtles were found in inshore habitats of the Texas coast. Section 7, which includes the central Laguna Madre, is the only exception. No ridleys were recorded from this inshore area. In section 8, farther south in the Laguna Madre, there were only two historical records.

SEASONAL DISTRIBUTION

The completed atlas will have 36 seasonal distribution maps, nine per season, with 850 turtles plotted. Dates for 15 of the 865 records are unknown. Seasons were defined as follows: Winter (January, February, March), Spring (April, May, June), Summer (July, August, September), and Fall (October, November, December). Almost 44% (371) of the turtle records occurred during the Spring followed by Summer, Fall and Winter with 32.1% (273), 14.6% (124), and 9.7% (82) respectively.

SIZE DISTRIBUTION

Thirty six maps will show the size distributions of 546 Kemp's ridleys, nine maps for each of four size classes: less than 20 cm, 20-40 cm, 40-60 cm, and greater than 60 cm. All measurements are curved carapace lengths (CCL). CCL were chosen, because most of the records that had accurate measurements used this method. The records that had only straight carapace length (SCL) measurements were converted to CCL. The conversion was based on the regression of 144 pairs of SCL and CCL measurements in which CCL = 1.059407 x SCL. Almost 76% (412) of the turtles with accurate measurements fell into the 20-40 and 40-60 cm CCL range. The >60 cm range encompasses 18.5% (101), and 6% (33) of the turtles were <20 cm.

SUMMARY

The atlas form easily shows the distribution of Kemp's ridleys along the Texas coast and the sympatric distribution among the head started turtles and wild turtles. The Texas Atlas will contain 80 or more maps and will be published as a NOAA/NMFS Technical Memorandum. Similar atlases showing the distribution of Kemp's ridleys throughout the United States would require cooperation of all researchers who have collected data on this species.

ACKNOWLEDGEMENTS

Texas Atlas Contributors: Wendy Teas, STSSN, NMFS Miami Laboratory; Sharon Manzella, Jo Williams and Marcel Duronslet, NMFS Galveston Laboratory; NMFS Pascagoula Laboratory; all STSSN participants. Special thanks go to Dr. Charles Caillouet, Jr. for his input in reviewing the manuscript, Mr. Larry Ogren and Dr. Terry Henwood for their suggestions and input and to Mr. Glen Machlan of the NOAA Library in Rockville, Maryland for helping with the literature search.

LITERATURE CITED

Bleakney, S. 1965. Reports of marine turtles from New England and eastern Canada. The Canadian Field Naturalist 79:120-128.

Brongersma, L.D. 1972. European Atlantic turtles. Zoologische Verhandelingen 121:318 p., 12 plt., 8 maps.

Brongersma, L.D. and A.F. Carr 1983. Lepidochelys kempi (Garman) from Malta. Proceedings of the Koninklijke Nederlandse Akademie, Serie C, 86(4):445-454.

Carr, A. 1961. The ridley mystery today. Animal Kingdom 64(1):7-12.

Fontaine, C. T., S. A. Manzella, T. D. Williams, R. M. Harris and W. J. Browning. 1989. Distribution, growth and survival of head started, tagged and released Kemp's ridley sea turtles (Lepidochelys kempi) from year-classes 1978-1983, p. 124-144. In: Caillouet, C.W., Jr. & A.M. Landry, Jr, (Eds.), Proceedings of the First International Symposium on Kemp's Ridley Sea Turtle Biology, Conservation and Management, Texas A&M University, Sea Grant College Program, TAMU-SG-89-105, vi plus 260 pp.

Francis, K. 1978. Kemp's ridley sea turtle conservation programs at South Padre Island, Texas and Rancho Nuevo, Tamaulipus, Mexico. Florida Marine Research Publications 33:51-52.

Fuller, D. A. 1978. The habitats, distribution, and incidental capture of sea turtles in the Gulf of Mexico. Louisiania State University, Baton Rouge, LA, LSU-CFI-85-31. 44 pp.

Hildebrand, H. H. 1963. Hallazgo del area de anidacion de la tortuga marina "lora", Lepidochelys kempi (Garman), en la costa occidental del Golfo de Mexico. Sobretiro de Ciencia 22(4):105-112.

Hildebrand, H. 1980. Kemp's ridley or tortuga lora, Lepidochelys kempi (Garman). Unpubl. report to Southeast Fisheries Center, NMFS. 6 pp.

Manzella, S. A., C. W. Caillouet, Jr. and C. T. Fontaine. 1988. Kemp's rildey, Lepidochelys kempi, sea turtle head start tag recoveries: distribution, habitat, and method of recovery. Mar. Fish. Rev. 50(3):24-32.

Meylan, A., P. Castaneda, C. Coogan, T. Lozon and J. Fletemeyer. 1990. First recorded nesting by Kemp's ridley in Florida, USA. Marine Turtle Newsletter 48:8-9.

Pritchard, P.C.H. and R. Marqez M. 1973. Kemp's ridley turtle or Atlantic ridley. IUCN Monograph #2: Marine Turtle Series, 30 pp.

Shaver, D. J., E. Cheeseman and J. Bjork. 1988. National Parks Service, Padre Island National Seashore. Action plan for nesting sea turtles, nests and hatchlings on Texas beaches from Matagorda Island southward. Unpublished report. 39 pp.

Werler, J. E. 1951. Miscellaneous notes on the eggs and young of Texan and Mexican reptiles. Zoologica 36(3).

INCIDENTAL CATCH OF SEA TURTLES IN GREECE: THE CASE OF LAKONIKOS BAY

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INTRODUCTION

Three species of sea turtles are found in Greece; the loggerhead turtle Caretta caretta, the green turtle Chelonia mydas and the leatherback turtle Dermochelys coriacea. Of these, only the loggerhead turtle is known to nest on the coasts of Greece. A known nesting area with moderate nesting activity is found in Lakonikos Bay in southern Peloponnesus (Figure 1). A turtle monitoring programme is carried out on the nesting beaches of Lakonikos since 1984.

The Bay faces to the south and has an opening of about 60 km. Nesting beaches in Lakonikos total about 23 km and are found at the head of the bay. At sea, in front of the nesting areas, there is a relatively extensive shallow shelf; the isobath of 50 m passes at about 3 km from the shore. After that shelf, the depths grow rapidly inside the Bay.

Although it is known that sea turtles are often caught in nets and long lines, the extent of incidental catch has not been investigated in Greece. Discussions with fishermen, during the turtle monitoring programme, revealed that turtles are frequently caught in the bay during winter. This information triggered the initiation of a study on the impact of fishing activities on marine turtle populations in Greece.

The present paper describes preliminary results of the work done in Lakonikos Bay during the fishing period 1989-1990.

METHODS

Three trawlers and eight beach seines comprise the professional fishing fleet at Gytheion, the main port in Lakonikos. The skippers and the crews of the vessels were approached and were invited to participate in the study. Their response was immediate and a genuine collaboration was established. All fishing trips of the monitored vessels, the duration of fishing effort and their catch were recorded during the fishing period (1 October to 31 May).

In case of incidental catch of a sea turtle, the following data were recorded: species, status, approximate size, and locality and depth of capture. All captured turtles were released as soon as possible.

RESULTS

Trawlers fish for 9-10 hours per fishing day. Trawling times range from 1 to 3 hours, depending on the area. Trawling depths vary from 36 to 270 m. Beach seines fish for 5-7 hours per fishing day in depths 5-30 m. Trawling time of beach seines averages 1 hour. During the 8-month fishing season the eleven monitored vessels worked for 1,314 days in total. Of these, 818 days were allocated to the eight beach seines and 496 days to the three trawlers.

Forty four turtles, 38 loggerheads (86.4%) and 6 greens (13.6%), were accidentally caught by the monitored boats during the fishing season. Of the captured loggerheads, 32 individuals (84%) were of mature size. All captured greens were immatures.

All but one of the captured turtles were alive and in good condition. One loggerhead was found dead, presumably drowned after a long trawl. Most of the turtles were captured during January and February. No turtles were caught during April and May (Fig. 2).

DISCUSSION

The present study shows that incidental capture of sea turtles in Greece is very high. Fishermen in Lakonikos admitted that they used to kill captured turtles because they considered them as pests. The onset of the turtle monitoring programme in 1984, gradually improved the attitude of the fishermen and after the present collaboration it can be said that no more turtles are deliberately killed in Lakonikos, at least by the professional fishermen of Gytheion.

The presence of marine turtles during the winter in the sheltered bay indicates a wintering area there. Since no turtles tagged in other areas have been recovered so far in Lakonikos, it is assumed that a population of Caretta caretta resides in the bay. This can be corroborated by marking the accidentally captured individuals, which is planned for the fishing season 1990-1991.

A very interesting result of the study is the presence of Chelonia mydas, a species that does not nest in Greece. Here it must be noted that almost all turtle nests on Lakonikos beaches are closely monitored, in the context of the monitoring programme, and no Chelonia nest has ever been found. The fact that all captured green turtles were immatures suggests that Lakonikos Bay might be a developing area of the green turtle in the Mediterranean.

ACKNOWLEDGEMENTS

The turtle monitoring programme in Lakonikos Bay was executed by STPS and received financial assistance from the EEC (MEDSPA programme). We thank all fishermen of Gytheion for their wholehearted cooperation.

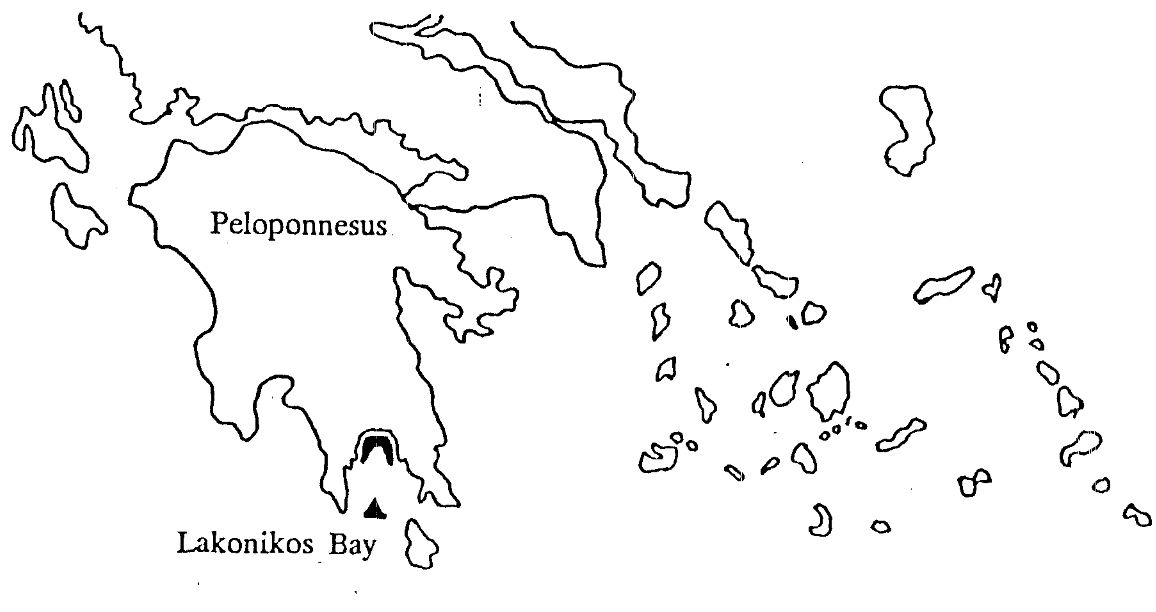

Fig.1. Sketch map of southern Greece showing position and main fishing areas in Lakonikos Bay.

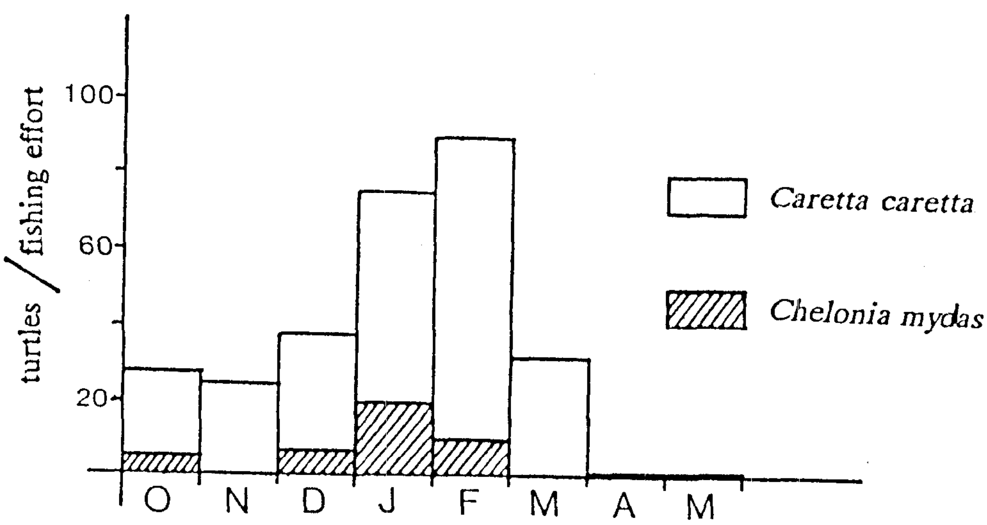

Fig.2. Incidentally captured turtles per fishing effort over the fishing season (October-May) in Lakonikos Bay, Greece.

NEST SITE PREFERENCE AND SITE FIXITY OF HAWKSBILLS ON LONG ISLAND, ANTIGUA

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Since 1986, the Georgia Sea Turtle Cooperative has been studying a population of nesting hawksbills at Pasture Bay beach, Long Island, Antigua, West Indies. A saturation tagging program with intensive nighttime patrols was begun in 1987, and since then much data has accumulated. Here, we report on nest site preference and site fixity among the nesting hawkbills at Pasture Bay.

Pasture Bay beach is approximately 1700 feet in length and is variable so that 5 distinct beach types are found. The beach has also been divided into 31 sectors for the general purpose of nest location data. The sectors range in length from 45 to 60 feet, the majority being 50 feet. Nest location data from 73 individuals from the 1987, 1988, 1989, and 1990 nesting seasons were recorded as sector number, and analyzed for site fixity. Only turtles laying more than 1 clutch were used in this study; the range of clutch number was 2-12 (Figure 1).

Each beach type offers a different nesting habitat type for the hawksbills (Table 1). Seagrape (Cocoloba uvifera) trees and areas of mixed shrub (Suriana maritima), small sea grape bushes, and other native shrubs are preferred nesting habitats for the population (Chi-Square= 209, P= .0001). An overall view of the data for individuals showed some turtles nesting randomly, while others were nesting in 1 or more sectors repeatedly (Figure 2). Also, some individuals were consistently nesting in seagrape trees, while others were nesting in the mixed shrub area at the other end of the beach. A Chi-Square test was performed on each individual to determine whether nesting was random along the length of the beach. 20 out of 73 turtles showed non-random nesting ($p < .05$), when taking all 31 sectors into account. When the beach was split up into 5 sectors, namely the 5 beach types, 33 out of 73 turtles showed non-random nesting ($p < .05$).

These data suggest that some hawksbills nesting on Pasture Bay exhibit site fixity in their choice of a nesting area. As stated earlier, some individuals seem to be choosing certain areas to nest in, while others are nesting randomly over the length of the beach. The nesting data I analyzed did not include the site at which the female landed on the beach, nor the sites of any abandoned cavities. These factors, along with beach access (tide dependent due to rocky areas along the shore), must be taken into account to determine whether the population of nesting hawksbills at Pasture Bay is truly exhibiting nest site fixity.

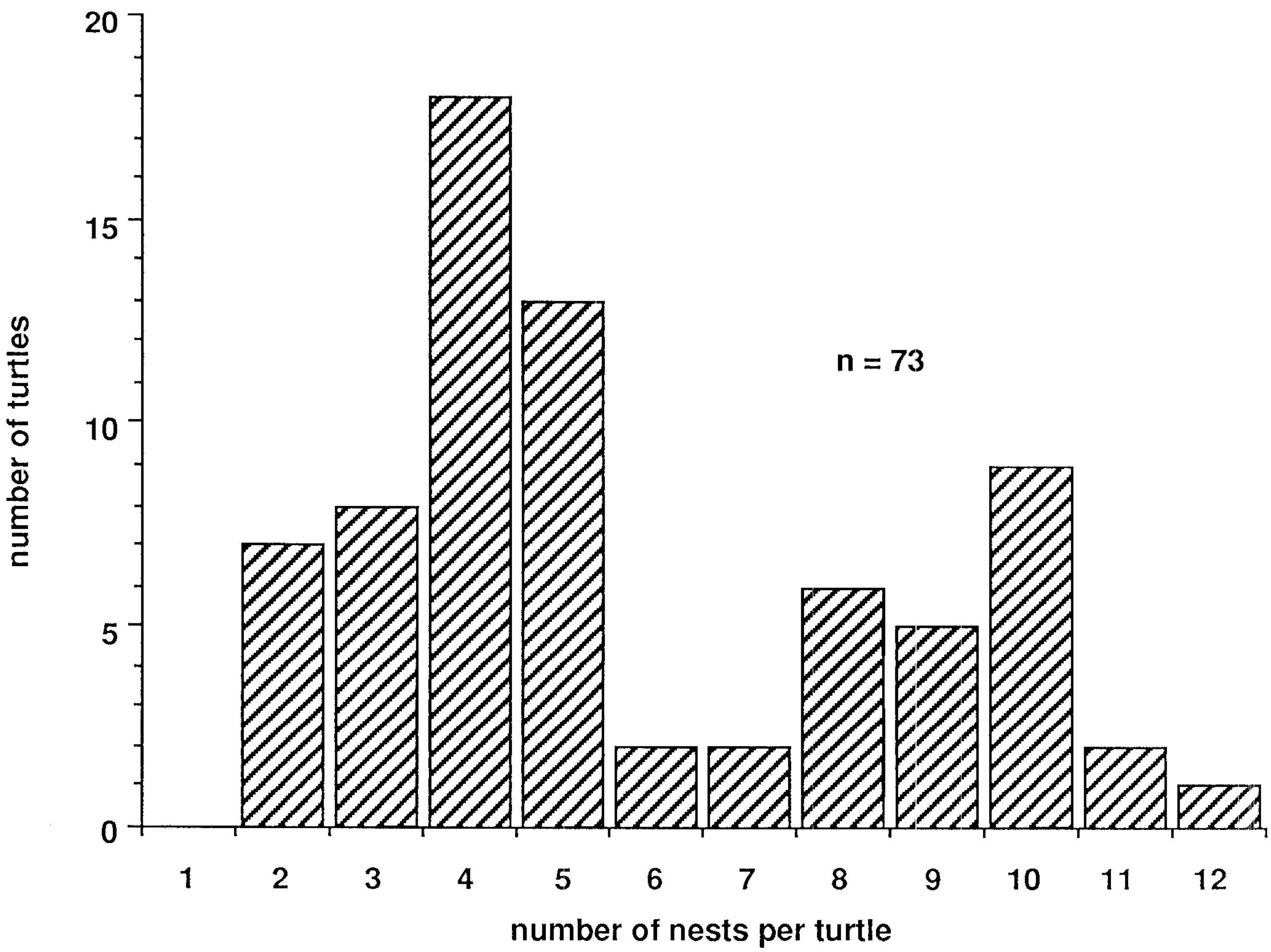

Figure 1. Number of turtles laying more than one clutch used in this study. Highest number of clutches laid in one season was 6; data was gathered from 1987 through 1990.

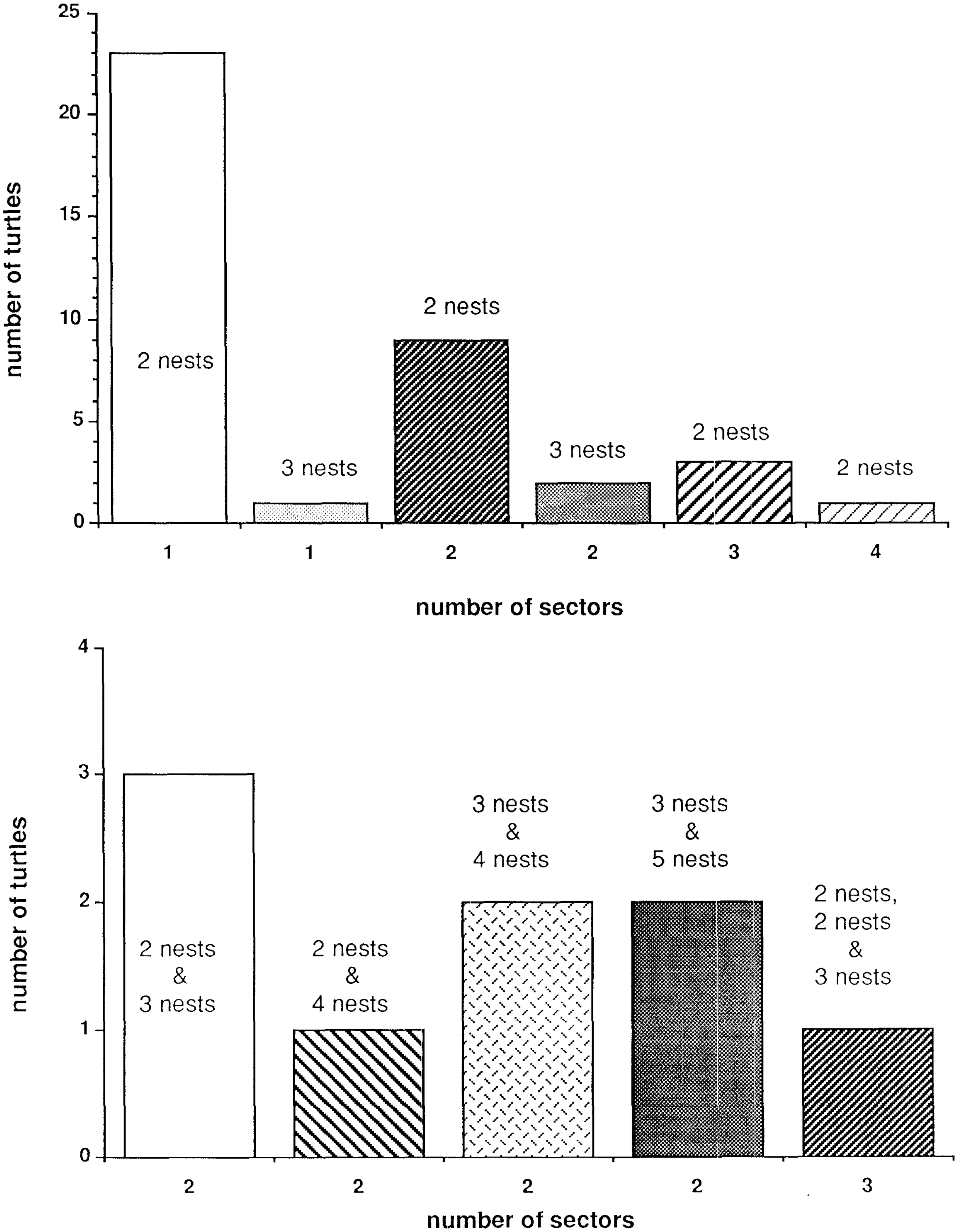

Figure 2. Number of turtles laying 2, 3, 4, or 5 nests in 1 or more of the same sectors

TABLE 1. Beach characterizations and nesting frequencies for the 5 beach types of Pasture Bay beach, Long Island, Antigua.

Beach type	Sector	Approximate length	Shrubbery setback	Total nests *
Lawn	1-3	150 feet	>100 m	5
Seagrape trees	4-9	350 feet	variable range 0-20 m	169
Wide beach	10-16	400 feet	30-40 m	41
Narrow beach	17-22	300 feet	10-20 m	76
Mixed shrub	23-31	450 feet	0-4 m	133

* numbers from turtles nesting more than once for the 1987, 1988, 1989, and 1990 nesting seasons

adopted from Ryder, C. et al., 1989, these proceedings

BEACH NOURISHMENT: A HELP OR HARM FOR SEA TURTLES?

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Nourished beach sand has the potential to be beneficial or detrimental to sea turtle nesting habitat depending on the physical properties of the beach before and after nourishment. Potential physical properties that may change include sand grain size, grain shape, sand color, silt-clay content, moisture content, beach hardness, mineral content, substrate water potential, and porosity/gas diffusion. Beach nourishment can affect sea turtle nest mortalities, number of false crawls, number of nests, hatchling sex ratios, and/or turtle mortalities. In addition, beach nourishment has the potential of affecting nest contents, nest location, nest depth, and nest excavation. If planned properly, most effects of beach nourishment on sea turtles can be ameliorated. Beach sand which is comparable to natural beach sand can be used to prevent a change in nesting substrate. Equipment selection and placement can be managed to prevent infringement on turtle nesting activities. Hard, compacted nesting sand can be softened with tilling/ripping. Scarps formed by the readjustment of the fill by waves and currents can be smoothed. The timing of material placement can be selected for a time when nests are unlikely to be buried. Nests jeopardized by burial can be relocated. Relocated nests can be carefully placed so that the optimum nest conditions are present. Managing beach nourishment to benefit turtle nesting beaches is hampered by a lack of understanding about the relationship of beach physical properties to sea turtle eggs and hatchlings.

A RECORD YEAR FOR LOGGERHEAD AND GREEN TURTLE NESTING ACTIVITY: ANALYSIS OF REPRODUCTIVE EFFORT AT MELBOURNE BEACH, FLORIDA 1990

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INTRODUCTION

The stretch of beach extending 21 kilometers south of the town of Melbourne Beach in south Brevard County, Florida, is generally referred to simply as "Melbourne Beach". Results of long-term studies conducted by the University of Central Florida Marine Turtle Research Group at Melbourne Beach make it clear that this is one of the world's most important marine turtle nesting grounds. Prodigious numbers of loggerheads and relatively large numbers of green turtles nest there each year.

ANALYSIS

Reproductive success was studied on Melbourne Beach by quantifying hatching success and emerging success. Hatching success is defined as the percentage of yolked eggs in a clutch that yielded hatchlings. Emerging success is defined as the percentage of yolked eggs per clutch that produced emergent hatchlings. Loggerhead and green turtle clutches were counted either as they were being deposited or within six hours of deposition. The sites of these nests were then precisely marked so that the nest contents could be thoroughly inventoried at a later date, after all viable hatchlings had emerged.

RESULTS

It is apparent that 1990 was an exceptionally productive year for both loggerheads and green turtles. Figures 1 and 2 show overall nest totals since 1982 and provide graphic evidence of the heightened nesting activity seen during 1990. Record means of 682 nests per km for loggerheads and 23 nests per km for green turtles were recorded at Melbourne Beach in 1990. Those nests produced an estimated 967,548 loggerhead and 39,882 green turtle hatchlings.

The results of 93 loggerhead and 16 green turtle nest inventories, as seen in figures 3 and 4, provided data for assessment of reproductive success. The mean hatching success rate for loggerhead nests was 59.62% and the mean emerging success rate was 58.70%. The mean hatching success rate for green turtle nests was 65.77% and the mean emerging success rate was 60.19%. The frequency of raccoon depredation has varied from approximately 10%-20% at Melbourne Beach in recent years. In 1990 no evidence of raccoon depredation was detected in any of the 16 green turtle nests, but raccoons destroyed 14 (15.1%) of the 93 inventoried loggerhead nests.

CONCLUSIONS

While the increases in nesting recorded during the 1990 nesting season are encouraging, they should not be misconstrued as a resurgence of either loggerhead or green turtle nesting populations utilizing these beaches. Each should be viewed as a probable apogee in the annual variation that is inherent in marine turtle nesting activity.

It seems clear that in recent years Melbourne Beach has experienced loggerhead nesting densities rarely equaled by other beaches on the western rim of the Atlantic. It also provides nesting habitat for significant numbers of the Florida green turtle stock. Unquestionably this beach is critically important to the recovery of Western Atlantic loggerhead and Florida green turtle populations, but the future of this south Brevard County shore as a nesting site for marine turtles is uncertain. The beach is under constant threat by the pressures of real estate development. Significant potential for protection of this nesting area is seen in the fact that portions of the beach are proposed for inclusion in the Archie Carr National Wildlife Refuge. State and federal officials have shown great interest in bringing portions of this beach into public ownership and the first steps have been taken in the acquisition process. Continued ardent support on the part of sea turtle conservationists and the environmental conservation community as a whole is essential to the realization of the Carr Refuge concept.

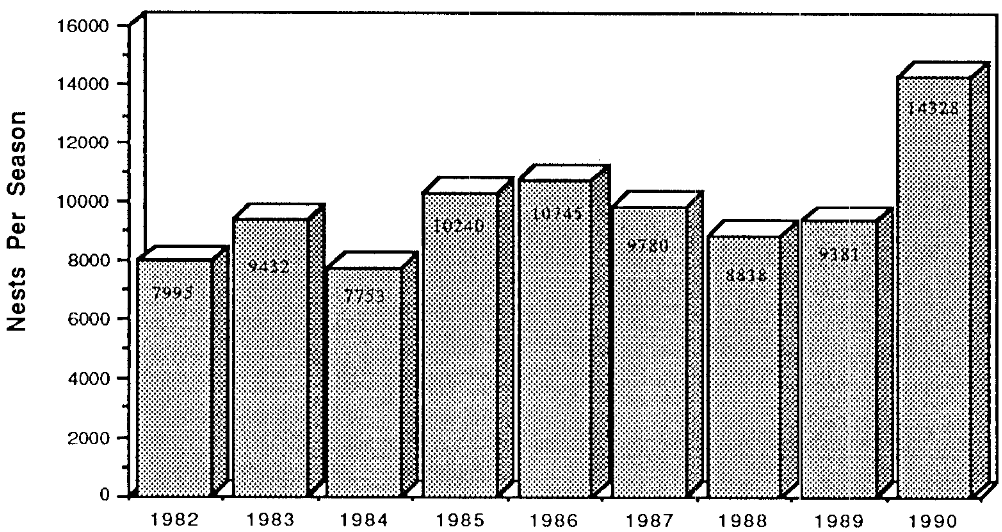

Figure 1. Loggerhead nest totals at Melbourne Beach, Florida, 1982
through 1990.

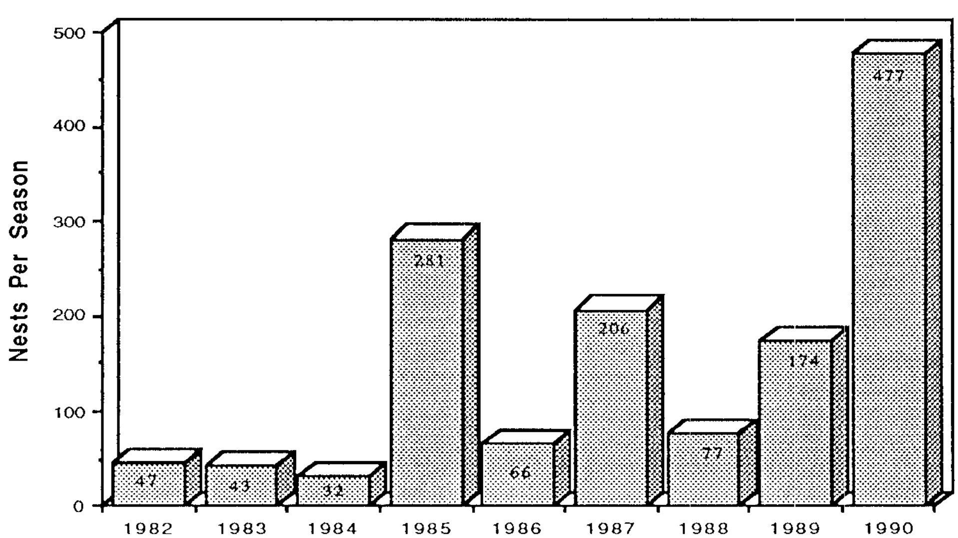

Figure 2. Green turtle nest totals at Melbourne Beach, Florida, 1982 through 1990.

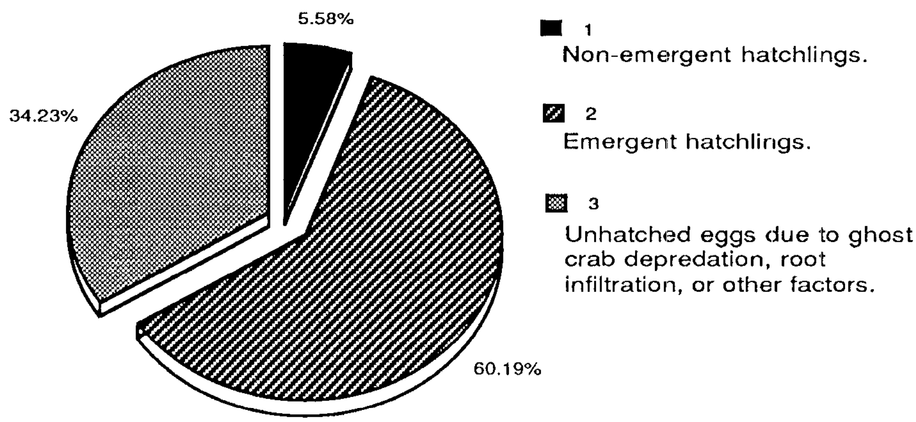

Figure 3. Loggerhead reproductive success assessment at Melbourne Beach, Florida, 1990.

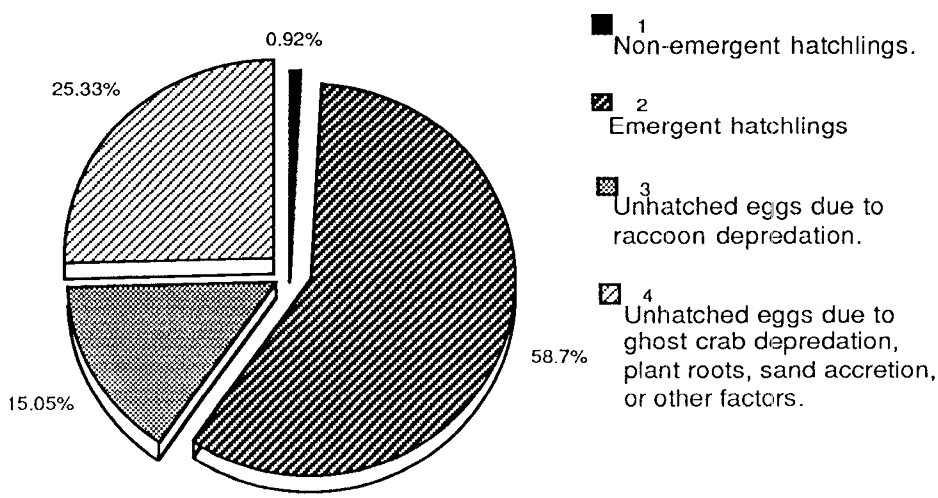

Figure 4. Green turtle reproductive success assessment at Melbourne Beach, Florida, 1990.

PHYSIOLOGICAL EVIDENCE OF HIGHER FECUNDITY IN WILD KEMP'S RIDLEYS: IMPLICATIONS TO POPULATION ESTIMATES

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The high nesting fecundity of sea turtles is unequalled by any other amniote. The green turtle (Chelonia mydas), the loggerhead (Caretta caretta), and the leatherback (Dermochelys coriacea) are all capable of producing multiple nests (4 to 10) in a season. The Kemp's ridley sea turtle (Lepidochelys kempi), however, has been reported to nest only 1.3 to 1.5 times per season unlike the other sea turtles. During the 1989 and 1990 seasons, research was conducted on wild nesters at Rancho Nuevo, Mexico to investigate their nesting physiology and evaluate the current estimates of nesting fecundity. The reproductive status of the female was determined using ultrasonography and serum testosterone. The turtles were scanned using an Aloka 500V ultrasound scanner with 5.0 MHz convex linear probe following nesting. Serum testosterone was measured by radioimmunoassay. The results of this study suggest that the nesting physiology of L. kempi is similar to that of other multiple clutch sea turtles such as the green turtle (C. mydas) and the loggerhead (C. caretta). Wild female L. kempi are capable of significantly higher nesting fecundity (approximately 2X increase) than the 1.5 nests per season cited in the literature.

These observations further suggest that the nesting female population is being significantly overestimated by > 30 % and that fewer than 400 females may nest each year. Determination of a more accurate value for the proportion of adult females nesting in a given year is required to accurately estimate the adult female population size based on nesting data. An accurate estimation of the adult sex ratio is then required to estimate the total adult population. (We would like to thank Rene Marquez (PESCA), Richard Byles (U.S. Fish and Wildlife Service), Pat Burchfield (Gladys Porter Zoo) and the bi-national crew at Rancho Nuevo for their assistance during the 1989 and 1990 nesting seasons. This work was supported by Texas A&M University Sea Grant College Program (Grant # NA85AA-D-SG128) and Sea Turtles Inc., South Padre, Texas).

APPLICATION OF ULTRASONOGRAPHY TO SEA TURTLE REPRODUCTION

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Recently, ultrasonography has been applied to sea turtle reproductive studies. Using ultrasonography, we monitored ovarian morphology, oviductal egg development, and follicular atresia *in situ* in wild *Lepidochelys olivacea* at Playa Nancite, Costa Rica during the 1990 nesting season. Ultrasonography examinations were conducted in September and November, using an Aloka 500V ultrasound scanner with a 5.0 MHz convex linear probe. During September, females captured while mating or following oviposition possessed gravid ovaries containing large pre-ovulatory vitellogenic follicles in the 2.5 cm range. Eggs observed *in situ* in females captured during the inter-nesting interval were in varying states of development. The yolks of eggs, early in development, are similar in size and appearance to pre-ovulatory follicles. As the eggs continue to develop, the vitelline membrane swells and a division of fluids occurs with the heavier yolk settling to the bottom. The yolk division appears to coincide with the development of the gastrula phase. Follicular atresia was observed throughout the nesting season. Follicular atresia is the reabsorption of large vitellogenic follicles that were not ovulated that season. Atretic follicles appear first as normal follicles with a small anechoic (fluid) center where the proteinaceous material has started to be reabsorbed. As atresia continues the anechoic region increases in size. Females ultrasounded following oviposition in November showed depleted ovaries. A depleted ovary is characterized by a lack of pre-ovulatory vitellogenic follicles, while, pre-vitellogenic and atretic follicles may be imaged. At this time, other organs (e.g., intestine) that were previously obscured by the enlarged ovaries and oviduct can be imaged. (We would like to thank Al Lord, Adam Alvarez, Susana Salas, Lic. Anny Chavez and the Programa de Tortugas Marinas at U.C.R. for their assistance. This work was funded by the National Science Foundation (grant #BNS-8819940) and Sea Turtles, Inc. of South Padre Island, TX).

EXCEPTIONAL GROWTH RATES OF CAPTIVE LOGGERHEAD SEA TURTLES

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INTRODUCTION

Growth rates of loggerhead sea turtles, Caretta caretta, have been reported for more than 60 years. Considering this great time span and the large numbers of loggerheads which have been captive-raised or head-started, there have been few published studies examining their growth. Although most of these studies have concentrated on captive-raised animals, they often had small sample sizes and details of the husbandry conditions were not reported. As a result, comparisons of data and applications of these figures to the calculation of true growth rates for loggerhead sea turtles have been difficult (Dodd, 1988). Examinations of growth rates from published studies of captive-raised loggerheads have indicated a wide range of results. Figure 8 shows a comparison of results for the first year of growth, while Figure 9 depicts growth beyond the first year (Fraser, 1982 in Dodd, 1988). Variations in quality and/or quantity of food probably account for much of the observed differences (Stickney, et al., 1973; Nuitja and Uchida, 1982), while rearing conditions such as water temperature, salinity, and light quality may also be important factors.

PROJECT DESCRIPTION

In 1989, the Virginia Marine Science Museum (VMSM), Columbus Zoo, Virginia Institute of Marine Science (VIMS), and Back Bay National Wildlife Refuge (BBNWR - U.S. Fish and Wildlife Service) joined in a cooperative research project to study head-started loggerhead sea turtles (Keinath and Musick, 1989). This research involved a unique partnership among the participating institutions and agencies to achieve four major objectives. 1) Document husbandry practices used to raise loggerhead sea turtles and compare the results to past and present head-start programs. 2) Monitor and record information on growth, behavior, and diet regimes of the young sea turtles. 3) Tag and release healthy 2-3 year old head-started loggerheads into the wild. Selected individuals will be fitted with satellite transmitters and their post-release movements will be monitored. 4) Institute public education programs on the biology, ecology, research and conservation of sea turtles (Swingle, et al., 1990). This paper presents preliminary results of the growth and feeding components of the project during the study period from October 1989 through December 1990.

MATERIALS AND METHODS

In October of 1989, VIMS researchers removed hatchling loggerhead sea turtles from 2 nests in the BBNWR, Virginia Beach, VA. Following initial acclimation and assessment at VIMS, hatchlings from NEST

Note: Due to space limitations, the figures and tables in this paper have been omitted. Copies may be obtained from WMS.

A and NEST B were distributed to the participating institutions (Table 1) for commencement of the growth and feeding studies. From the beginning of the study period, NEST A individuals exhibited more vigor and were generally in better health than those from NEST B. Several individuals from NEST B were born with shell or body deformities which retarded the initiation of normal feeding and growth. These conditions may have resulted from a late nesting period in an already marginal northern range for this species. Seawater systems in each institution were designed to maintain specific physical and qualitative parameters. Water quality was routinely monitored, with some parameters such as salinity and temperature being recorded on a daily basis. Salinities ranged from 28-35 ppt and temperatures from 25-29^{o} C during the study period for all institutions. The only inconsistent variables between each location were the holding tank sizes which ranged from 10-300 gallons during the study period. Food for the loggerheads consisted of a marine animal gelatin diet developed at VIMS (Table 2) (Choromanski, et al., 1987). This diet was prepared by each participating institution using raw materials originating from a single source and lot, assuring qualitative uniformity of food. The amount of food consumed by each individual was recorded on a daily basis during the study period (Table 3). Growth of the loggerheads was recorded weekly by straight-line caliper measurements of 6 carapace and plastron dimensions as well as by measurements of total weight. For the purposes of this paper, total weight and carapace length/tip-tip (CLTT) were used for growth comparisons (Table 4, Table 5).

RESULTS

Comparisons of our growth rates (Table 4, Table 5) with those from previous studies reveal extremely rapid development of our young loggerhead sea turtles. Mean weights for NEST A individuals at one year ranged from 4500 g at VMSM to 7500 g at Columbus Zoo. These values indicate growth rates 4-5 times greater than those from comparable time periods in Figure 8 from Frazer (1982). Figure 9 (Frazer, 1982) shows loggerhead growth rates beyond the first year, with the Uchida (1967) and Parker (1929) data indicating the most rapid development. Allowing for a correction to the Uchida (1967) data in Figure 9 (growth curve should begin at age 3), projected growth rates from our study will surpass those indicated by both Parker (1929) and Uchida (1967). One exceptional loggerhead (#92) at the Columbus Zoo is projected to reach a weight of 20,000 g in 1.5 years (Warmolts, 1991, personal communication). This level of growth was not reached until the age of 3 by any of the loggerheads in the Parker (1929) or Uchida (1967) studies (Dodd, 1988).

SUMMARY

Preliminary analysis of the data from this study period has provided new insights into the early growth potential of loggerhead sea turtles. Further statistical examination of this data as it relates to food consumption and parameters such as salinity, temperature, and tank size may yield even more valuable information on the husbandry of these threatened animals. In addition, completion of the project objectives will allow for evaluation of this accelerated development as it relates to post-release viability of head-started loggerheads.

LITERATURE CITED

Caldwell, D.K., A. Carr, and T.R. Hellier,Jr., 1955. Natural history notes on the Atlantic loggerhead turtle, Caretta caretta caretta. Q. J. Fla. Acad. Sci. 18:292-302.

Choromanski, Joseph M., Robert H. George, and Sarah A. Bellmund, 1987. Nutritional benefit of a marine animal gelatin diet as measured by sea turtle blood chemistry values. Proceedings of 1987 AAZPA National Conference, Portland, OR.

Dodd, C. Kenneth, Jr., 1988. Synopsis of the biological data on the loggerhead sea turtle Caretta caretta (Linnaeus 1758). U.S. Fish and Wildlife Service, Biological Report 88(14), 110 pp.

Frazer, N.B., 1982. Growth and age at maturity of loggerhead sea turtles: review and prospectus. Mar. Turtle Newsl. 22:5-8.

Hildebrand, S.F., and C. Hatsel, 1927. On the growth and care and behavior of loggerhead turtles in captivity. Proc. Natl. Acad. Sci. USA 13:374-377.

Hughes, G. R., A. J. Bass, and M. T. Mentis, 1967. Further studies on marine turtles in Tongaland, I. Lammergeyer 7 :5-54.

Kaufmann, R., 1967. Wachstumsraten in Gefangenschaft Gehaltener Meeresschildkroten. Mitt. Inst. Colombo-Aleman Invest. Cient. 1:65-72.

Keinath, J.A. and J.A. Musick, 1989. Loggerhead sea turtle head start evaluation: a research and management study proposal. Submitted to U.S. Fish and Wildlife Service, Back Bay National Wildlife Refuge, Virginia Beach, VA.

Nuitja, I.N.S., and I. Uchida, 1982. Preliminary studies on the growth and food consumption of the juvenile loggerhead turtle (Caretta caretta L.) in captivity. Aquaculture 27:157-160.

Parker, G.H., 1929. The growth of the loggerhead turtle. Am. Nat. 63: 367-373.

Rebel, T.P. , 1974. Sea turtles and the turtle industry of the West Indies, Florida, and the Gulf of Mexico, Rev. ed. University of Miami Press, Coral Gables, FL.

Schwartz, F.J., 1981. A long term internal tag for sea turtles. Northeast Gulf Sci. 5:87-93.

Stickney, R.R., D.B. White, and D. Perlmutter, 1973. Growth of green and loggerhead sea turtles in Georgia on natural and artificial diets. Bull. Ga. Acad. Sci. 31:37-44.

Swingle, W. Mark, Doug Warmolts, and John Keinath, 1990. Loggerhead sea turtle head-start evaluation project: a classic example of the conservation role of zoological parks and aquariums. Proceedings of 1990 AAZPA National Conference, Indianapolis, IN. Uchida, I., 1967. On the growth of the loggerhead turtle, Caretta caretta, under rearing conditions. Bull. Jpn. Soc. Sci. Fish. 33:497-507.

Witham, R., and C.R. Futch, 1977. Early growth and oceanic survival of pen-reared sea turtles. Herpetologica 33:404-409.

SEASONAL VARIATION IN CLUTCH SIZE FOR LEATHERBACK TURTLES, *Dermochelys coriacea*

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Although studies of trends in clutch size through a season are reported in the literature, at least three disparate methods have been used to obtain these data in reproductive ecology. Such differing methodologies make meaningful comparisons difficult, both within and among species. To avoid these problems, we have analyzed data for a nesting assemblage of turtles by investigating within season trends in clutch size by examining the data at three levels: 1) at the temporal level, 2) at the individual level and 3) at the population level.

To investigate seasonal patterns of variability in clutch size, data were used from the 1984-1987 seasons at Culebra National Wildlife Refuge, Isla de Culebra, Puerto Rico. The shortness of the nesting beaches (< 2.4 km), lack of nearby alternative nesting habitat (91% - 100% of all nesting in the archipelago occurred on the study site), and frequency of coverage resulted in a high probability of encountering each female to verify all seasonal nesting events. After oviposition, leatherbacks were double-tagged with monel or titanium tags for individual identification. Nest locations were marked by triangulation and allowed to incubate in situ. Nest contents were exhumed and enumerated to determine clutch size following hatching. Clutch size refers only to yolked eggs. Clutch sizes were plotted to seek the following relationships: variation through time, variation at the population level, and variation within an individual.

At the temporal level, all clutch sizes were analyzed with respect to the year day that they were deposited. To remove some of the inherent variation in this approach (turtles nesting later in the season having an individual history that overlaps with turtles that nested earlier), all nests were also grouped by internesting interval, in the manner of previous studies (Frazer and Richardson, 1985; Bjorndal and Carr, 1989; Hall, 1989). The date for all first reproductive events of the season was recorded and subsequent nine day groupings (mean internesting interval for the study population was nine days as reported in Tucker and Frazer, 1991) of all clutches were averaged to derive a seasonal clutch trend.

At the population level of analysis, all first clutches were averaged, all second clutches were averaged, and so on so that mean clutch size for sequential clutches could be compared for the population.

At the individual level, a female's reproductive history was examined and clutch sizes were compared both among and within females having equivalent nesting frequencies (trends among 5-time nesters, 6-time nesters, etc.).

SUMMARY

1) Temporal variation: Clutches laid later in the season are substantially smaller than clutches laid earlier.

Groupings by nine day intervals also decrease though the season.

2) Population variation: When sequential clutches were examined across the nesting season, clutch size remains relatively constant through the fifth clutch followed by a slight decline for remaining sixth through tenth clutches.

3) Individual variation: Individuals having a given clutch frequency were compared. A monotonic decline was noted for individuals laying two or three sequential nests. Females laying more than five nests within a season also exhibited a gradual increase followed by a decline in clutch size although in some cases small sample sizes (ten time nesters) precluded testing for statistical significance.

4) Preliminary analyses of mean clutch size data also indicate that neophytes lay fewer clutches of smaller size than remigrants, a factor that may be one source of the substantial variation in the trends reported here.

LITERATURE CITED

Bjorndal, K.A. and A. Carr. 1989. Variation in clutch size and egg size in the green turtle nesting population at Tortuguero, Costa Rica. Herpetologica 45: 181-189.

Frazer, N. B. and J. I. Richardson. 1985. Seasonal variation in clutch size for loggerhead sea turtles, Caretta caretta, nesting on Little Cumberland Island, Georgia, USA. Copeia 1985: 1083-1085.

Hall, K. V. 1989. Intraseasonal variation of Dermochelys coriacea reproductive characteristics at Culebra, Puerto Rico. pp. 69-71 in S.A. Eckert et al. eds. Proceedings of the Ninth Annual Workshop of Sea Turtle Conservation and Biology, NOAA Tech. Mem. NMFS-SEFC-232.

Tucker, A. D. and N. B. Frazer. 1991. Reproductive variation in leatherback turtles, Dermochelys coriacea, at Culebra National Wildlife refuge, Puerto Rico. Herpetologica 47(1):115-124.

THE HAWKSBILLS OF MONA ISLAND, PUERTO RICO

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Mona Island, which lies between the islands of Puerto Rico and Hispaniola, harbors one of largest known nesting populations of the hawksbill (Eretmochelys imbricata) in the Greater Antilles. The island measures about 7 by 10 kilometers and with its 21 beaches provides some 7.2 kilometers of nesting habitat. In recognition of Mona's importance as a nesting ground for sea turtles of the region, research was conducted here by Thurston (1974), Olson (1984), Kontos (1985-87) and Tambiah & Conger (1988). The current project, which was initiated in 1989 and has continued for the 1990 nesting season, intends to combine scientific interests with specific management needs such as education and conservation.

Our main objectives are (1) to estimate population size through nest counts and tagging, (2) to maximize reproductive output by protecting nests and nesting turtles, (3) to evaluate the effectiveness of new fencing installed to keep feral pigs from destroying nests, and (4) to make students and visitors aware of sea turtles and their conservation needs.

From the second half of August to the first week of December 1990, nightly patrols were held on several nearby beaches and daytime surveys of the remaining beaches were made. During this period, 24 individual nesting hawksbills were identified through tagging and a total of 196 hawksbill nests were counted. With evidence of significant nesting activity occurring both before and after the study period, the actual number of nests laid during the 1990 hawksbill nesting season on Mona Island may have been well over 200.

On Mona Island feral pigs have long severely restricted sea turtle reproduction by their habit of digging up and consuming nests. Following years of discussion on how best to deal with the problem, fences to exclude pigs was installed on all of the affected beaches. The work was completed prior to the 1990 hawksbill nesting season by a team from the Department of Natural Resources and was funded by the U.S. Fish & Wildlife Service. To evaluate the effectiveness of the fences at excluding the feral pigs, beaches were examined for pig tracks and predated nests. During the study period no such evidence was found, which proves the effectiveness of the fences' design and construction. Studies of previous nesting seasons on Mona Island have shown that without human intervention most of the turtle nests on these beaches would have been lost to predation by feral pigs.

ACKNOWLEDGEMENTS

This project was made possible by support from: Foundation for Scientific Research in the Tropics (Treub Maatschappij), Amsterdam, The Netherlands; Chelonia, Sociedad Herpetologica de Puerto Rico (Puerto Rican Herpetological Society), Rio Piedras, Puerto Rico; Departamento de Recursos Naturales (Department of Natural Resources), San Juan, Puerto Rico.

SEA TURTLE SIGHTINGS AT PASSES ON THE TEXAS GULF COAST

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INTRODUCTION

In 1989 "sea turtle sighting signs" were placed at the north and south Fish Pass jetties in Mustang Island State Park near Port Aransas, Texas and at the north jetty of the Brazos Santiago Pass on South Padre Island, Texas. The signs consist of descriptions and colored illustrations of the five species of sea turtles that occur in the Gulf of Mexico and explain that sea turtles are often seen near the jetties. Attached to each sign is a box holding sighting cards to be filled out and a box for the deposition of completed cards. The purpose of the signs is to collect information from the public on the frequency, species, and sizes of sea turtles associated with the passes, with a minimum investment of funds, time, and personnel. Public response to the signs was favorable and as a result the program was expanded in 1990 to encompass eight passes on the Louisiana and Texas Gulf coasts.

MATERIALS AND METHODS

In mid-July 1990, additional signs were placed at Calcasieu Pass near Cameron, Louisiana, and in Texas at Sabine Pass, Galveston jetties, San Luis Pass, Freeport jetties, and Port Aransas jetty. A sign was erected at the Brazos Santiago Pass south jetty in late August 1990. Signs at the west sides of Sabine Pass and Calcasieu Pass were placed at boat ramps near the jetties because of inaccessibility by automobile and because fishermen most frequently utilizing those jetties do so by boat. No signs were placed at the east side of Sabine Pass and the north side of Aransas Pass because of their inaccessibility. Unfortunately, the sign at the east side of Calcasieu Pass was in place only 4 days before being torn down.

All of the passes, except San Luis Pass, are bordered by rock (granite) groin jetties of varying lengths. All provide access to inshore waters from offshore Gulf waters except for the Fish Pass which had gradually filled in over time. With the exception of San Luis Pass and Fish Pass, all are major navigation channels allowing access to ports at Lake Charles, Louisiana, Sabine Pass and Port Arthur, Galveston and Houston, Freeport, Corpus Christi, and Brownsville, Texas.

RESULTS

As of 31 December 1990, 283 sea turtles had been sighted at the passes as a result of the sea turtle sighting signs. Most of the sightings have been reported from the southern half of the Texas coast. The largest number of sightings were reported from Fish Pass and Brazos Santiago Pass, with 153 and 83 sightings respectively. Signs at these two sights have been in place the greatest length of time. The number of reported sightings decrease northward, with 36 in Port Aransas, 9 in Freeport, 1 in San Luis Pass, 1 in Galveston, and none in Sabine Pass or Calcasieu Pass. Slightly more turtles were seen within the channel than outside the channel at all locations except for the Fish Pass jetties where considerably more turtles were seen on the side of the jetties not bordering the pass (Figure 1). This is noteworthy because Fish Pass is the only location where the channel does not provide access to inshore waters.

Monthly variations in reported sightings (Figure 2) could reflect seasonal utilization of the jetties by the public. Observations by National Marine Fisheries Service (NMFS) personnel who visit the jetties at Brazos Santiago Pass and Port Mansfield on a regular basis, and netting efforts by the National Park Service (NPS) at Port Mansfield, verify that sightings are seasonal, with the majority of turtles being present during the summer and early fall (D. Shaver, NPS, personal communication, June 1990). Observations by NMFS personnel also confirm the size classes reported as being seen by the public. Most turtles seen are of a juvenile to subadult size. Over 76% of the turtles sighted are reported as being less than 60 cm, with approximately 45% being between 40 and 60 cm. Reports by the public include all 5 species of turtles. However, NMFS personnel report sighting green turtles most often. Inexperience of public observers and short surfacing times by the turtles may make identification of species difficult or inaccurate.

Most of the turtles are sighted during midday. Approximately 62% of the turtles are reported as being sighted between 10 AM and 2 PM CDT. This could be due to several factors, including more frequent surfacings by the turtles, longer surface intervals, increased likelihood of the turtles being present or more frequent utilization of the jetties by the public during these time periods.

DISCUSSION

Caution must be exercised in interpreting results of sightings reported by the public. Times, dates, and locations of the sightings reflect times, dates, and locations in which the passes are utilized most often by the public. However, because it is not feasible to place trained observers at all the locations, compiling public reports of sightings is a cost-effective method of monitoring sea turtle occurrence at the passes on a regular basis.

Many of the passes monitored are major navigation channels maintained by dredging. The entrance channels or jetty channels at Brazos Santiago Pass, Port Aransas, and Freeport are maintained either annually or biennially by Hopper dredges (U.S. Army Corps of Engineers, 1990). If these jettied passes are important developmental habitat for juvenile and subadult sea turtles in south Texas, as suggested by the frequency of sightings, then turtles may potentially be impacted by dredging activities. As suggested by Magnuson et al. (1990), seasonal dredging may be the best method to lessen the impact of dredging on sea turtles. Data collected through the sighting sign program aid in determining the occurrence and distribution of sea turtles in selected navigation channels in Texas. They can contribute to development of measures to mitigate the impacts of dredging on sea turtles.

In the summer of 1991, a study will be undertaken to characterize the habitat and identify potential food items utilized by the turtles at Brazos Santiago pass. The behavior, movements and diving patterns of turtles around the jetties will be monitored through radio and sonic telemetry. This can provide a model of sea turtle behavior at this and similar entrance channels that may be useful in determining why they are attracted to such channels.

LITERATURE CITED

Magnuson, J.J., K.A. Bjorndal, W.D. DuPaul, G.L. Graham, D.W. Owens, C.H. Petersen, P.C.H. Pritchard, J.I. Richardson, G.E. Saul and C.W. West. 1990. Decline of the sea turtles: causes and prevention. National Academy Press, Washington, D.C., 259p.

U.S. Army Corps of Engineers, Galveston District. 1990. Dredging Conference, 1 November 1990, Galveston, Texas.

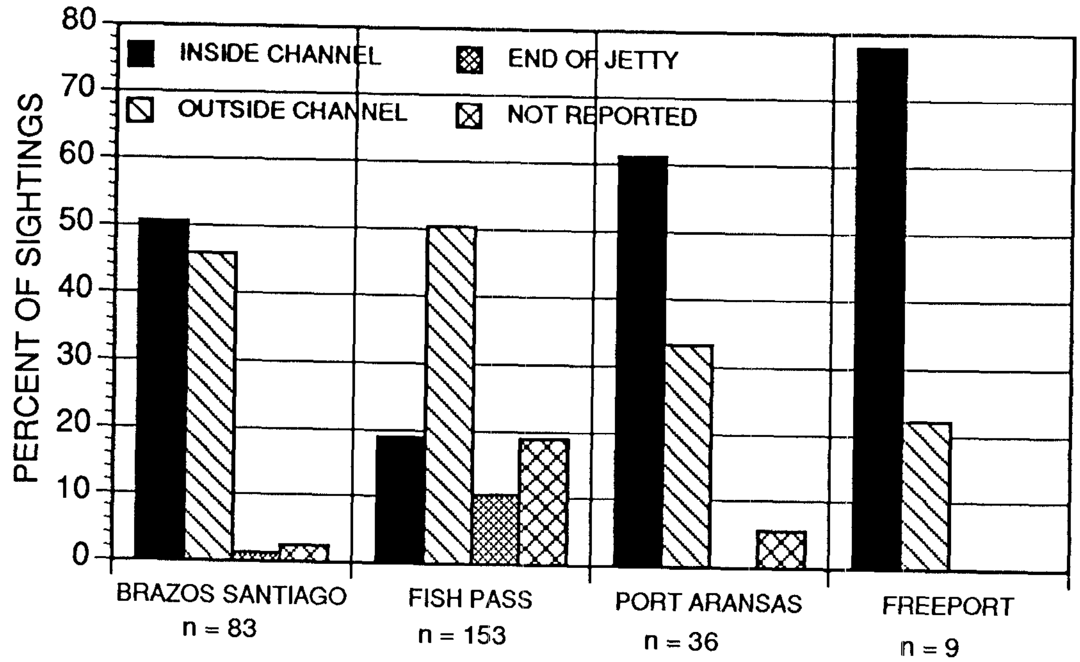

Figure 1. Locations of sea turtle sightings reported by the public at Brazos Santiago Pass, Fish Pass, Port Aransas, and Freeport, Texas.

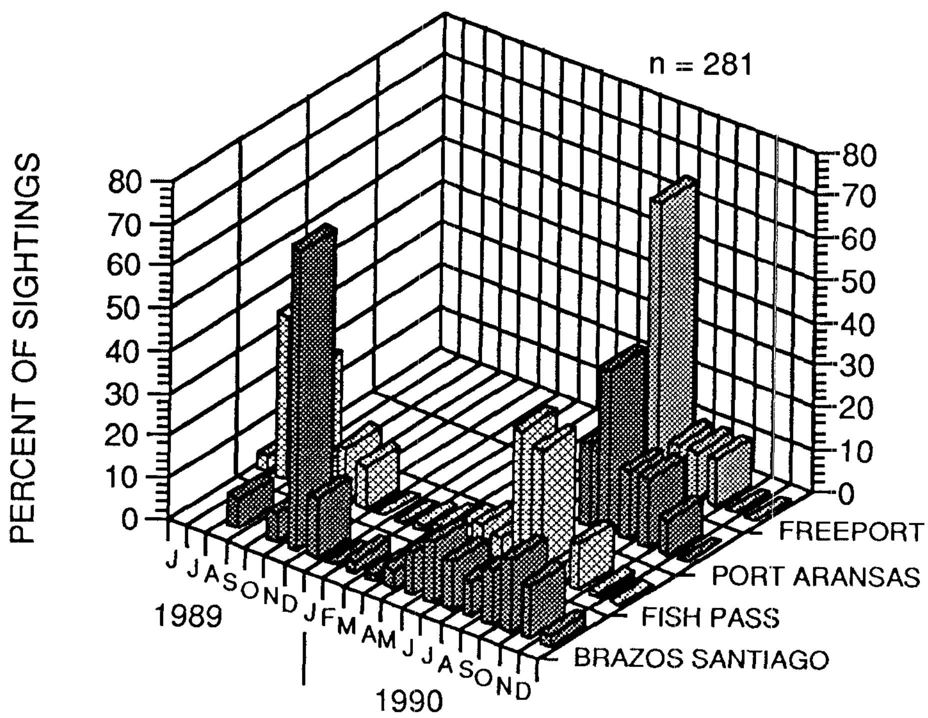

Figure 2. Monthly distribution of sea turtle sightings reported by the public at Brazos Santiago Pass, Fish Pass, Port Aransas, and Freeport, Texas.

PROGRESS AND RESULTS OF HEAD STARTING KEMP'S RIDLEY

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The Kemp's ridley head start experiment of the National Marine Fisheries Service Galveston Laboratory entered into its thirteenth year in 1990. Improvements included the completion of a new head start facility in April 1990. Two of the original quonset huts used to house turtles were destroyed by Hurricane Jerry in October 1989; however, no turtles were lost as a result of the storm. The new 550 m^2 metal frame, concrete-floored building is capable of housing 1600 hatchlings.

Additional changes include the discontinuation of the Padre Island phase of the experiment in 1989. From 1978-1988 we attempted to establish a second nesting beach at Padre Island, Texas in cooperation with the National Park Service. Eggs were collected at Rancho Nuevo, Mexico and then transferred to Padre Island National Seashore to be artificially incubated in polystyrene foam boxes. To date, there have been no confirmed reports of head started Kemp's ridleys nesting at Padre Island. Hatchlings are now received directly from the nesting beach at Rancho Nuevo. As of 31 December 1990, 21,682 hatchlings had been received for head starting. Of these, 72.9% were "imprinted" to Padre Island, 26.2% to Rancho Nuevo, and .9% represented F1 generation turtles from head started Kemp's ridley that were held at the Cayman Island Turtle Farm (1983) Ltd.

Average survival rate for year-classes 1978-1989 was 86.5%. As of 31 December 1990, 16,590 (84.4% of those received alive for head starting) had been head started, tagged and released in the Gulf of Mexico.

As of 31 December 1990, 675 recoveries of head started turtles have been reported. Most of the recoveries were reported from Texas (62.2%) and Louisiana (13.0%); this is not surprising, since 78.6% of the turtles were released in Texas waters. Only 18.8% of the releases occurred in inshore waters, while 46.4% of the recoveries for which an area was reported were from inshore waters. Strandings accounted for the majority of the recoveries with 43.8%. Sixteen percent of those stranded were reported as alive and 27.8% were stranded dead. Twenty-two percent were incidentally captured in shrimp trawls, the second most frequently reported method of recovery. Of those captured in shrimp trawls, 71.3% were reported as alive, 19.3% dead and no condition was reported for 9.3%. Over half (57.3%) of the turtles recovered by all recovery methods have been reported as alive.

MESSAGE TO THE MASSES! AN EXAMPLE OF THE ROLE OF ZOOS AND AQUARIUMS IN THE CONSERVATION, EDUCATION AND RESEARCH OF SEA TURTLES

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INTRODUCTION

In 1989, the Columbus Zoo and the Virginia Marine Science Museum (VMSM) entered into a cooperative research program with the Virginia Institute of Marine Science (VIMS) and the Back Bay National Wildlife Refuge (BBNWR) (U.S. Fish and Wildlife Service) to evaluate the effectiveness of head-starting loggerhead sea turtles (Keinath and Musick, 1989). This would be achieved through tagging and releasing 2-3 year old head-started loggerheads fitted with satellite transmitters into the wild. The post release movements and behavior would then be monitored. In the 2-3 year interim, several other observations would be made including: the documentation of husbandry practices used to raise loggerhead sea turtles, careful monitoring of captive growth, behavior and diet. Finally, all participants recognized a critical component in the success of the program would be to initiate public education programs on the biology, ecology, research and conservation of sea turtles. This paper presents a summary of these efforts over year one of the program.

PARTICIPATION IN AND FUNDING OF RESEARCH

Seventeen hatchling loggerheads taken from the BBNWR were divided among the Columbus Zoo, VMSM, and VIMS in December 1989 (Swingle et al. 1990). Weekly carapace/plastron and mass measurements were taken and recorded. A standardized gelatin diet developed at VIMS (Choromanski, et al. 1987) was fed to all turtles with amount ingested recorded daily. Preliminary growth rates proved to be quite remarkable (see Swingle et al., this conference). The Zoo and VMSM committed nearly $30,000 towards the purchase of satellite transmitters for the research project. VIMS in turn committed over $30,000 towards personnel, satellite reception time, and data acquisition and processing. As the principal investigators, VIMS was responsible for initiating and organizing the project as well as providing assistance to the participants throughout the study. The cooperation and support from the BBNWR was essential for USF&WS approval of the project and access to the sea turtle hatchlings.

CLASSES, OUTREACHES, MINI-LABS, LECTURES

To increase the awareness and exposure of young students and the general public to marine science and conservation issues, the Columbus Zoo and VMSM incorporated sea turtle biology and conservation into their educational programming through classes, outreaches, and mini-labs. The Columbus Zoo offered in-house classes through "creature features", school group tours, "summer experience", and regular classes with a total attendance of 2,615 students. Columbus Zoo outreaches consisted of visits to local schools, colleges, Columbus parks and recreation centers, and environmental groups where lectures and demonstrations were given on sea turtle endangerment and solutions with an attendance of over 3,000 in 1990. The Columbus Zoo is currently exploring the possibility of a cooperative effort with Guatemalan biologists to support hatcheries and hatchery personnel in Monterrico, Guatemala.

In turn, VMSM offered in house programing at a rate of 5 per day during the summer, which was attended by 28,300 visitors. Special in house classes for school groups were held for 65 groups totalling 3.109 participants. Fourteen mini-lab outreaches and assemblies reached an additional audience of 1,220. In addition, the sea turtle conservation message in both institutions was further passed on through over 300 docents and adult volunteers, and dozens of newsletters, brochures, and special publications. Public lectures by prominent sea turtle biologists such as Dr. Nat Frazer also highlighted conservation outreach efforts.

VIMS personnel have presented 25-30 educational seminars each year, tours of their private research facilities, and their public aquarium and Sea Grant center has served as a focal point for the interaction of research and education (Swingle, et al. 1990).

Through the operations of a visitor center and public programs, BBNWR personnel presented educational information on coastal ecology (Swingle et al. 1990).

SUPPORT OF CONSERVATION ISSUES

As a part of on-going outreach efforts, the Columbus Zoo and VMSM highlighted current conservation issues such as the establishment of the Archie Carr National Wildlife Refuge and enforcement of the use of TEDS. Support for these issues was achieved through petition drives and letter writing campaigns. In July 1990, the Columbus Zoo hosted its first annual endangered species weekend where it collected over 1,500 signatures in support of the Carr Refuge and use of TEDs. Warmolts and Swingle (1990) presented a poster and petition urging support for the Carr Refuge at the 1990 American Association of Zoological Parks and Aquariums National Conference. Over 250 signatures were obtained. Similar petitions gained over 500 signatures at other national zoo meetings over the past year. Outreaches to Central Ohio schools, colleges, special groups, and zoo visitors regularly encouraged letter writing which yielded an estimated 5,000 letters in support of the Carr Refuge and use of TEDs to key decision makers (senators, congressmen, governors, federal and state officials). Sea turtle paintings, stories and an information booth by local school children decorated the Johnson Aquatic Complex during the zoo's winter Wildlight Wonderland which attended by nearly 100,000 visitors. Afterward, the artwork and stories were sent to state of Florida officials as a show of support for the Carr Refuge. Local SCUBA stores, school clubs, and environmental groups have given support through fundraising, petition drives, and conservation articles in newsletters and industry publications. Such activities create a source of involvement in the issue on behalf of the public and are well received and supported.

INTERACTIVE PUBLIC EXHIBITRY

In May, 1990, a major exhibit entitled "Virginia Sea Turtles: Timeless Travelers", opened at VMSM. This exciting multi-faceted exhibit includes interactive displays on turtle biology, ecology and conservation and is the largest of its kind to be produced at VMSM. An up-close look at the sea turtle research project and the VMSM stranding and rehabilitation program are highlights. Its message reached an estimated quarter of a million visitors and 50,000 school children.

In January 1990, the Columbus Zoo opened a sea turtle exhibit at its Johnson Aquatic Complex. The exhibit emphasizes the ecology and conservation of sea turtles as well as the research project which was viewed by an estimated one million visitors.

STUDENT PARTICIPATION : HANDS-ON EXPERIENCE

In 1989, the Columbus Zoo joined with a local middle school in providing an opportunity for interested students to participate in the research project. As part of an after school club, the students visited the zoo trice a month where they shadowed zoo staff while project data were being collected. Eventually students began hands-on participation through activities such as water quality testing, food preparation, and data recording. Prior to and during each visit, students explore in depth components of the study, conservation issues, and possible solutions. In turn, these young students create and initiate their own outreaches, fundraisers, and letter campaigns.

At VMSM, college interns participated in the sea turtle research program while gaining college credits. Through their involvement, the growth, feeding, and behavioral data were computerized.

MEDIA COVERAGE

Year one of the project has been markedly successful, as shown by the local, regional and national media coverage it received. National coverage included exposure on ABC's Good Morning America.

DISCUSSION

Although the effectiveness of head-start programs is in doubt (Woody 1990), the use of a small number of young turtles for public education and research is invaluable. Allen (1990) emphasized the importance of such efforts in generating media and public attention. The pooling of resources amongst diverse agencies in this study have yielded many positive results. A detailed picture of husbandry method and captive loggerhead growth rates is currently on-going and a minimum of seven head-started loggerheads fitted with satellite transmitters will be released next summer. Perhaps most importantly, the message of sea turtle conservation has reached a vast audience of nearly one and a half million people. Of this group, nearly 40,000 received an in depth presentation and over 7,000 letters and signatures were gathered in support of conservation issues. Public awareness, participation, and support is critical to stopping human-induced mortalities and in providing protection for wild populations. This program demonstrates the value of a committed zoo or aquarium joining in effort with a research oriented institution. All participants benefit mutually and contribute to sound research and conservation efforts. This program is a model of the role zoos and aquariums can implement in the conservation, public education, and research of rare and endangered species.

LITERATURE CITED

Allen, Carole H. 1990. Guest Editorial: Give "headstarting" a chance. Marine Turtle Newsletter 51:12-16.

Choromanski, J. M., R. H. George and S. A. Bellmund. 1987. Nutritional benefit of marine animal gelatin as measured by sea turtle blood chemistry values. Proc. 19887 AAZPA National Conf., Portland, OR.

Keinath, J. A. and J. A Musick. 1989. Loggerhead sea turtle head start evaluation: A research and management study proposal. Submitted to USFWS.

Swingle, W. M., D. I. Warmolts and J. A. Keinath. 1990. Loggerhead sea turtle head-start evaluation project. A classical example of the conservation role of Zoological Parks and Aquariums. Proc. 1990 AAZPA National Conf., Indianapolis, IN.

Warmolts, D. I. and W. M. Swingle. 1990. Save the Sea Turtles, or "Is a Pair of Shoes the End Product of Two Hundred Million Years of Evolution?" Poster Abstract, Proc. 1990 AAZPA National Conf., Indianapolis, IN.

Woody, J. B. 1990. Is "head-starting" a reasonable conservation measure? "On the surface, yes; in reality, no". Marine Turtle Newsletter 50:8-11.