Reproduction, Mortality and Conservation of the Hawksbill Turtle (*Eretmochelys imbricata*) in Barbados

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ABSTRACT

Data on nesting frequency, nesting behavior, and mortality of the hawksbill turtle (*Eretmochelys imbricata*) in Barbados were collected between November 1986 and October 1987. Nesting occurs between April and December with peak activity June-August. Using two separate approaches it was estimated that between 122 and 369 nestings occurred over the one-year study period. Clutch size ranged from 87 to 175 eggs, with a mean of 145. Incubation time ranged from 59 to 75 days with a mean of 66. Mean hatching success in nests was 88.0%. The major mortality factor affecting eggs was flooding of nests. Of all reported nestings, females were slaughtered in 22% and eggs were poached in 15%. Compaction of sand by heavy public beach use and disorientation of hatchlings by beach lighting were the two major mortality factors affecting hatchlings prior to entering the sea. Conservation activities encourage public involvement in quantifying nesting frequency and include relocating endangered nests, monitoring hatching success and hatching mortality, and tagging nesting females.

INTRODUCTION

The hawksbill sea turtle (*Eretmochelys imbricata*) is a circumtropical species inhabiting coastal reefs, bays, estuaries, and lagoons in the tropical and subtropical Atlantic, Pacific, and Indian Oceans (Witzell 1983). It has been exploited for its shell, and less widely for its meat and eggs, for thousands of years. International trade in hawksbill shell, particularly to support traditional Japanese craft industries, has resulted in the species being listed in Appendix 1 of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), as threatened with extinction and subject to special trade restrictions. More than half of Japan's hawksbill shell imports i.e. over 15,000 kg of shell, presently originates from countries of the western Atlantic region (Milliken & Tokunaga 1987).

The tendency of hawksbills to nest singly and to lay several very widely separated nests over an extended breeding season (Carr 1952, Carr & Stancyk 1975), rather than nesting in large numbers at specific breeding beaches, has made exploitation of them more difficult than other species, but this behavior

has also made them more difficult to study and conserve. Consequently, although it is known that hawksbills nest and are exploited on most of the islands of the Lesser Antilles, there is little quantitative information on their abundance and reproductive behavior in this region. In most territories legislation exists to protect turtles (*e.g.*, minimum size limits, closed seasons, and protection of nesting females), indicating recognition that numbers have declined to the point where conservation measures need to be taken. Hawksbills are typically considered to be less migratory than other species of sea turtle (Carr *et al.* 1966, Witzell 1983), feeding primarily on sponges associated with coral reefs and foraging in the general vicinity of breeding beaches throughout the year. To what extent hawksbills migrate the relatively short distances between islands of the Lesser Antilles is presently unknown, but this information will be of considerable importance in the development of management and conservation strategies.

The hawksbill is the principal turtle species exploited in Barbados. The fishery is seasonal in that trammel nets are only set during the breeding season. This occurrence may be because adult turtles are only available at these times, or it may be the result of fishermen targeting more abundant and therefore more profitable species as they come into season (*e.g.*, oceanic pelagic fish). Legislation in Barbados prohibits catching turtles under 30lbs in weight, on the beach or within 100 yds of the shore. No official catch records are kept at major fish markets, and since the legislation is not well enforced, an unknown number are caught illegally and sold from private outlets.

Compounding the effects of fishing mortality on hawksbill abundance, suitable nesting beaches may also be decreasing in Barbados. Beaches on the west and south coasts are severely affected by the activities of man. Beach vegetation is often removed in the process of beach 'cleaning' for aesthetic purposes and property development. This 'cleaning' may decrease the suitability of beaches for hawksbills since they typically prefer to nest amidst or underneath vegetation (Mortimer 1981, Olson 1985). Removal of beach vegetation and changes in water movement patterns resulting from coastal defences and groynes protecting beach front properties have resulted in severe beach erosion in several areas. Houses and hotels line the beaches on the west and south coasts for most of their lengths, so that even when females do locate suitable nesting beaches, it is difficult for them to nest undisturbed.

In this paper, we make a preliminary quantitative estimate of the number of hawksbill nests in Barbados over a one year period. We provide information on nesting locations, nesting behavior, and mortality factors affecting the hawksbill at different stages in its life cycle. Finally, we discuss conservation efforts currently underway in Barbados.

METHODS

Reproduction

Two approaches were used to estimate hawksbill nesting frequency and seasonality. First, three early morning surveys of all potential nesting beaches around the island were conducted between June and August 1987. A potential nesting beach was defined as one on which sand remains exposed at high tide. The Barbados coastline was divided into eight zones, and a separate group of volunteers walked each between 05:30 and 07:30 am, prior to most human activity on beaches. All nests and false crawls were recorded by each group. Since hawksbill tracks appear as quite faint indentations in the sand and are easily obliterated by rain and human activity, it is unlikely that tracks made on previous nights were still visible and hence counted.

Second, the assistance of the general public was enlisted through an islandwide campaign in the press, on radio, and on television by Bellairs Research Institute and the Fisheries Division of the Ministry of Agriculture. The public was informed about sea turtle biology, the need for conservation, and the existing legislation protecting turtles. They were then asked to telephone if they saw a turtle nesting, attempting to nest, or any hatchlings. The dates and locations of all nestings and hatchings reported were recorded.

Mortality

Each time a nesting was reported by the general public, information on the fate of the female and her eggs was obtained, as well as the exact position of the nest on the beach. A sub-sample of nests were monitored and dug up two days after hatching or after the predicted hatch date, and the nest contents were examined. The numbers of hatched and unhatched eggs, as well as dead hatchlings remaining in the nest were recorded.

Conservation Activities

Whenever possible, females were double tagged with titanium tags on the front flippers after they had finished nesting. Any nests considered to be in danger from high tides, beach erosion, or coastal development were relocated to a safer location nearby. In this procedure, eggs were carefully removed from the old nest, without reorienting them, and carried in egg boxes in styrofoam containers to a new nest site nearby. At a similar location to that at which the original nest was made, a new nest was dug to the same depth and the eggs carefully reburied. These relocated nests were then monitored to assess hatching success.

RESULTS AND DISCUSSION

There are approximately 44 km of potential nesting beaches in Barbados (Figure 1). Of these, 19.4 km are on the west coast, 9.3 km on the south and

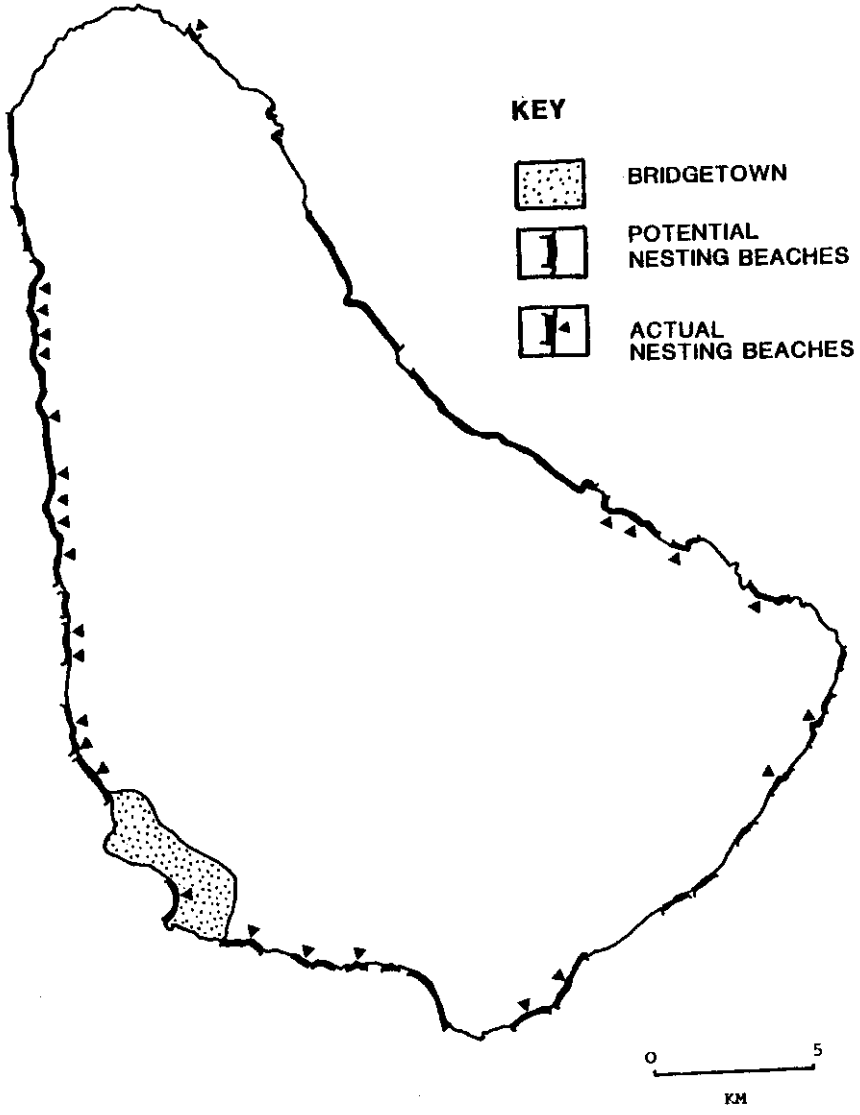

Figure 1. Map of Barbados showing potential nesting beaches and beaches where hawksbills nest.

southeast coasts, and 15.2 km on the east coast. The west coast beaches are typically narrow (10-20 m) and composed of fine-grained calcareous sand. Shallow sandy bays are separated by fringing coral reefs and wave action is usually of low energy. The south and south-east coast beaches are often wider and are also composed primarily of calcareous sands, but these beaches are affected by waves of higher energy. Finally, the east coast beaches are 20-40 m wide, composed of silica sand, and backed by dune systems in several areas. Wave action is more intense; east coast waves have an amplitude of at least 4 times that of west coast waves. East coast beaches are backed by few houses, and heavy beach use is confined to a small number of beaches. They are rarely traversed by people at night, and consequently, poaching is not as frequent as it is on the west and south coasts.

Beaches where hawksbill nesting activity has been recorded in Barbados are also shown in Figure 1. Hawksbills nest primarily on the west and south coasts of the island and more rarely on some of the sheltered beaches of east coast bays. Some preference is shown for nesting under vegetation. Whether this behavior results in regulation of nest temperature (Mortimer 1981), or is simply a cue to the female that a stable location above the highest tide mark has been reached is not known. Females nesting on the south and west coasts where beach vegetation is sparse often move inland, even across roads, until they are physically stopped by walls, tables, or beach chairs. Unable to go further, they will often nest adjacent to these obstacles.

Between November 1986 and October 1987 hawksbills were recorded nesting in all months except January, February, and March. However, nesting activity peaked between June and August, and 77% of all nestings occurred over this period ($X^2 = 55.1$, $P < 0.001$; Figure 2). These figures suggests significant seasonality in nesting which is typical for the western Atlantic region (Witzell 1983), and coincides with the beginning of the rainy season. It has been suggested that rain may help to consolidate the excavation of the nesting chamber (*e.g.*, Frazier 1979), and perhaps makes it easier for hatchlings to dig themselves out. Interestingly, nesting activity decreases towards November when storm swells and associated high wave action affect the west and south coasts of Barbados.

The early morning beach surveys recorded a minimum of one and a maximum of three nests per night for the nesting period surveyed (June/July/August). If extrapolated, these figures suggests that between 90 and 270 nestings were attempted over this peak three-month nesting period in Barbados. Although obvious false crawls are not included in this count, it was not always possible or desirable to dig up the nest to confirm the presence of eggs. For a number of nestings, it was apparent that females were disturbed or slaughtered while in the process of nesting. This nesting frequency estimate may therefore represent the upper limit of successful nesting activity over the peak

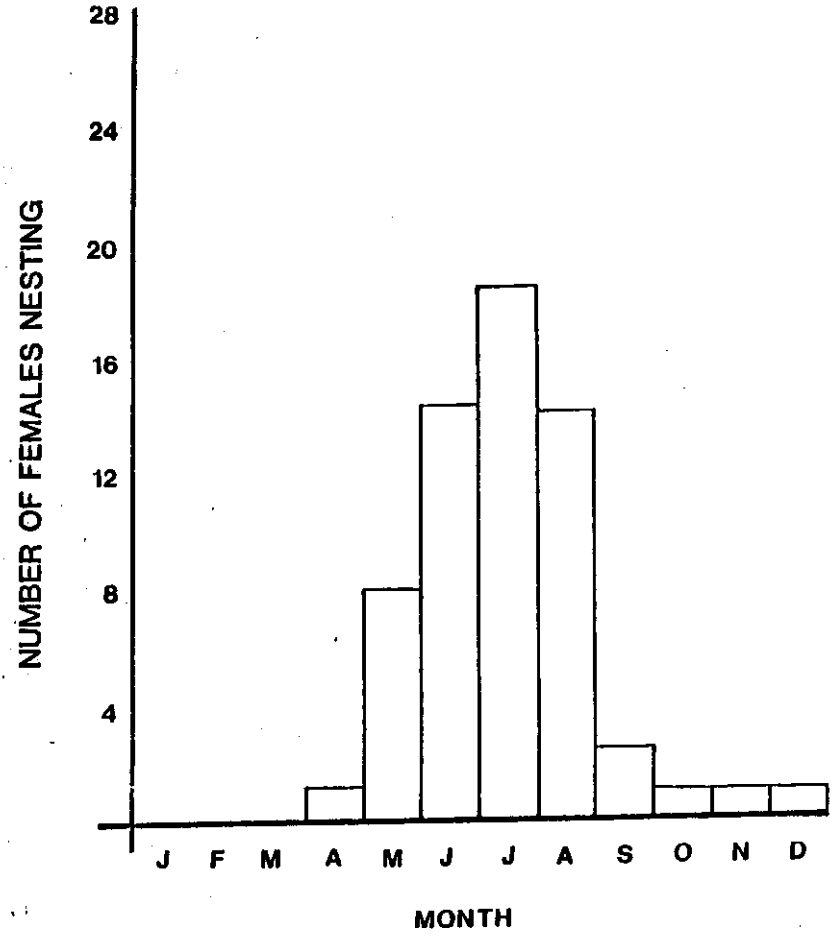

Figure 2. The number of reported hawksbills nesting per month between November 1986 and October 1987.

nesting period. Over the same period (June/July/August), 39 nestings and attempted nestings were reported by the general public. Public reports therefore represent only 14-43% of all nesting activities, as estimated by beach surveys. If the assertion that 14-43% of nestings are standardly seen by the general public is valid, then one can use the number of nestings reported by the public to estimate the actual number of nestings throughout the year (*i.e.*, 2-7 nestings in

April, 19-57 in May, 90-270 in June, July, and August, 5-14 in September, 2-7 in October, November and December (Figure 2). These figures suggests a total of 120-362 nestings over the one year study period.

In order to estimate the number of breeding females from nesting counts, it is necessary to have information on nesting frequency of individual females (Carr *et al.*, 1982). It has been suggested that hawksbills nest between three and five times per season (Witzell 1983). Conservatively, this estimation would suggest a nesting female population (using four nestings per season per female) of between 31 and 92 animals in 1987. These figures may underestimate the size of the breeding female population, if nesting females are killed on their first or second attempt at nesting over the season. Of the 60 nestings reported by the general public, females were slaughtered illegally while nesting in 22.0% of the cases. Since harvesting of turtles on the beach selectively removes breeding females, it has been argued to be the single most important factor in reducing hawksbill abundance (Witzell 1983). Further, since hawksbills are thought to breed at two to three year intervals, fluctuations in the size of the nesting population occur from year to year (Garnett 1978, De Silva 1981). Therefore, it will be necessary to continue estimating nesting frequency for several years in order to identify trends in population abundance.

Clutch size ranged between 87 and 175 eggs, with an average of 145 (n =15). This number is within the range reported for hawksbills in the western Atlantic region (Witzell 1983). Incubation time (time of first emergence) ranged from 59 to 75 days, with a mean of 66 days. The incubation period is dependent on temperature; the higher the temperature the shorter the incubation period within a physiologically tolerant range. (Limpus *et al.* 1983). The temperature of the nest is affected by clutch size (Garnett 1978), nature of the beach, position on the beach, and presence or absence of vegetation. Temperature regimes during incubation have recently become of special interest with the discovery of temperature-dependent sex determination in turtles (Mrosovsky and Yntema 1980, Limpus *et al.* 1983).

Man and occasionally dogs are the only vertebrate predators of turtle eggs in Barbados. Poaching of eggs occurred in 15.2% of all reported nestings. Flooding by salt and freshwater was the most serious threat to successful hatching in unpoached nests. Several reports of total nest destruction by wave action were recorded. Compared to an average of 88.0% (n = 12) from nests not subjected to flooding, the hatching success of eggs from a nest flooded a few days after laying was only 51.9%.

There are two primary mortality factors affecting hatchlings in Barbados, and both are indirectly attributable to man's activities. First, while hatchlings are still in the nest, heavy public beach use can compact the sand and prevent hatchlings from emerging. Of those nests monitored, one experienced 50% and another 100% mortality of hatchlings due to compaction. The extent of this

problem is not known, but it is probably appreciable on Barbados' beaches, given the high population density of residents and tourists and their frequent use of beaches as recreational areas. The second and probably more important mortality factor which affects hatchlings after emergence from the nest is disorientation by beach lighting. Disorientation of hatchlings is especially serious along the developed west and south coasts. Of 29 hatching events reported, 55.2% involved some degree of disorientation of hatchlings by lights. Without assistance from people, these hatchings would have resulted in up to 100% mortality of hatchlings.

Slaughter of nesting females and mortality of disoriented hatchlings have undoubtedly decreased since the public awareness campaign was mounted in Barbados, and since all reports of nestings are investigated. Relocation of endangered nests proved to be quite successful. Hatching success of relocated nests was 74.9% compared to 65.1% from nests relocated only after they were flooded. However, since eggs in relocated nests have a lower hatching success than eggs in natural undamaged nests (88.0%), relocation is only practised if nests are in extreme danger. Tag returns will ultimately provide information on migration patterns and renesting frequency, and efforts to tag as many animals as possible continue. If turtle stocks prove to be "shared" between islands, with hawksbills feeding around one island and breeding on another, then management and conservation activities will need to become regional in scope.

In Barbados, public involvement proved to be an effective way to gather information on hawksbills given financial and manpower constraints. Since it simultaneously served to inform people about the need for conservation and about existing legislation protecting turtles, this approach should enhance rehabilitation of turtle populations in the long term. A similar approach to the monitoring and conservation of turtles may be appropriate for other islands of the Lesser Antilles.

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